Transcatheter Aortic-Valve Procedures

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Rabin Medical Center, Petach Tikva, Israel
27/7/2010
Annual publications of Transcatheter AV procedures

In the title: “transcatheter” OR “percutaneous” OR “transfemoral” OR “transapical” AND
In the title: “aortic”
Presentation Sections

- Aortic Stenosis
- Aortic valve replacement
- Transcatheter AV implantation (TAVI)
- Screening patients for TAVI
- The Israeli TAVI experience
- Rabin Medical Center TAVI experience
Aortic-Valve stenosis
Aortic Stenosis Pathology

Aortic Valve

Left atrium

Mitral valve

Left ventricle

Aortic arch

Normal aortic valve

Bicuspid aortic valve

Bicuspid aortic stenosis
Potential pathway depicting calcific aortic valve disease

- T-lymphocyte
- Monocyte
- LDL lipoprotein
- Aortic side
- Endothelium
- Subendothelium
- T-lymphocyte
- Macrophage
- Oxidized LDL
- Foam cell
- Apolipoprotein B (ACE co-localized with ApoB)
- Fibrosa
- ↑ IL-1β
- ↑ TGF-β
- ↑ MMP
- ↑ Tenascin C
- Cell proliferation and matrix synthesis
- Valvular myofibroblast
- Calcium nodule and bone formation
- Ca++
- Ca++
- TGF-β
- Osteopontin
- Oxidized lipids
- Other growth factors
Aortic Stenosis Pathology

On gross inspection, the diseased aortic valve has areas of irregular thickening and calcification on the aortic side.

Microscopically, the diseased aortic valve leaflets reveal disruption of the endothelium on the aortic side.

At all stages of the disease, aortic valve lesions show a disrupted basement membrane with subendothelial accumulation of intracellular and extracellular lipids and lipoproteins, and also a chronic inflammatory infiltrate made up of foam cells, non-foam cell macrophages, and T lymphocytes.

Ventricular side of leaflet
Normal Aortic Valve
Aortic Stenosis Pathology
“When it is considered how narrow the opening is….it is difficult to conceive how such an organic derangement can continue for years…if such an obstacle to the circulation were suddenly introduced into a healthy subject, death would immediately follow…but as these obstacles are slowly formed, the circulation is gradually impeded and nature seems to be habituated to such a perversion of her laws…”

J. N. Corvisart  1803
French Cardiologist to Napoleon
A pioneer of cardiac auscultation
Pathophysiology of aortic stenosis

Aortic stenosis

LV outflow obstruction

↑ LV systolic pressure

↑ LV mass

LV dysfunction

↑ Myocardial O₂ consumption

↓ Diastolic time

↓ Myocardial O₂ supply

Myocardial ischemia

LV failure

↓ Ao pressure

↓ LV diastolic pressure

↑ LVET

↑ Diastolic time

LV failure

LV systolic pressure
Pathophysiology of aortic stenosis
Pathophysiology of aortic stenosis

Definition of Severe Aortic-Stenosis

- Valve area < 1.0 cm²  (Normal-2-3 cm²)
- Valve area index < 0.6 cm²/m²
- Jet velocity > 4.0 m/sec
- Mean valve gradient > 40 mmHg

ACC/AHA 2006 guidelines
Prevalence of significant Aortic-Valve Disease

- AS is the most frequent significant heart valve disease in Western countries.
- Significant AS in ~2% of US population >65 years. 

- Bicuspid AV- 0.5-2% of the population (men>women) 

- 68% of all heart valve operations!
- In Israel: until recently ~1,000 AVR per year.
Echocardiography
Echocardiography
Aortic Stenosis: Clinical Manifestation

- Asymptomatic
- Effort dyspnea
- Angina
- Weakness
- Pulmonary edema
- Syncope
- Sudden cardiac death
Natural History of Patients with Aortic-Stenosis

Onset of severe symptoms

Latent period (increasing obstruction, myocardial overload)

Average age death (male)

Average survival (yr)

Age (yr)

Survival (%)

Natural History of Patients with Aortic-Stenosis

THE PROGNOSIS OF AORTIC STENOSIS HAS CHANGED LITTLE SINCE THE CLASSIC REPORT OF ROSS AND BRAUNWALD IN THE 60'S

Surgical Aortic-Valve Replacement
AVR should be performed in symptomatic severe AS patients

Carabello et al. NEJM 2002;346 (9)
Surgical Aortic Valve Replacement

- Surgical AVR is the standard treatment for adults with symptomatic severe AS!
- Perioperative mortality rates are based on large databases: 2-3% in young pts with elective cases.
- Patient’s lifespan returns to near that of general population.
Surgical Aortic Valve Replacement

AORTIC VALVE REPLACEMENT TECHNOLOGY

Valve Design

- Bi-leaflet
- Ball and cage
- Single disk

Implantation Technology

- Stentless porcine
- Stented Porcine
- Stented bovine pericardial
- Cadaver (homograft)

Mechanical

Tissue

Surgical

Repair
Management strategy for patients with severe aortic stenosis.

ACC/AHA 2006 guidelines
Mechanical valves

Caged Ball

Tilting Disk

Bi-Leaflet

Starr-Edwards
Albert Starr 1960

Bjork-Shiley
V. Bjork 1969

St Jude
D. Nicoloff 1977

Multiple generations and brands of each design type
Mechanical valves

- Panus
- Thrombosis
- Wearing

- Obstruction
- Thrombo-Embolism
- Malfunction
Mechanical valves: the need for anticoagulation

Warfarin "is the second-most-likely drug, after insulin, to send Americans to the emergency room". By one estimate, it accounts for 43,000 ER visits a year in the US. Wall Street Journal 8/16/07

INR was only introduced in the 80's

Horstkotte D. JTCVS 1994;107:1135-45
Tissue Valves

Porcine Heterograft
Edwards

Pericardial Xenograft
Edwards

Stentless Heterograft
Medtronic

Homograft
Cryolife

Multiple generations and brands of each design type
Tissue Valves

- **Early 60’s**: limited success with allograft and autograft replacements (D. Ross)

- **1968**: A. Carpentier showed that glutaraldehyde preservation improved stability of porcine tissue & prevented valve degeneration

- **1970’s**: development of 1st Bioprosthesis namely the Carpentier porcine valve with elgiloy stent

- **1980’s**: development of Perimount bovine pericardial valve and Stentless tissue valve (T. David)

- **1990’s**: anti-calcification treatment
Tissue Valves

Functional valves (%) vs. Years of follow-up

- > Age 60
- Age 35-60
- <Age 35

Carpentier A. Nature Medicine 2007;13:10
Bioprosthesis valves vs. Mechanical valves

Graph showing the percentage of event-free patients over years of follow-up for mechanical and bioprosthetic valves. The graph indicates a higher risk of bleeding and TE with mechanical valves compared to bioprosthetic valves, along with higher risk of dysfunction and reoperation for bioprosthetic valves.
Risk factors for Impaired Prognosis after AVR

- Advanced age (> 80 yrs)
- Impaired LV function
- Prior heart surgery
- Renal insufficiency
- Previous stroke
- Lung disease
- Emergency operation
Survival of Octogenarians after surgical AVR

740 Octogenarians, 277 (37%) had Aortic Stenosis, 89 (29%) were operated

Patients suitable for SAVR had a significant survival benefit at 2-, 4- and 6-years follow-up... this was true even after a propensity score matched analysis.

Outcome of 108,687 patients after isolated AVR

Risk-adjusted in-hospital mortality

From 1997 till 2006, in-hospital mortality has fallen significantly from 3.5 to 2.3%

Mortality in-hospital vs Age

The most significant reduction in mortality was observed in the elderly

p<0.01

p<0.05
Change in population undergoing isolated AVR

Relative changes in frequency of baseline characteristics of 108,687 patients selected for sAVR between 1997 & 2006

Age ≥ 70 years  + 10%  < 0.001
Renal failure     + 36%  < 0.001
BMI ≥ 30kg/m²     + 38%  < 0.001
Cerebrovascular disease + 64%  < 0.001
Any diabetes     + 65%  < 0.001
COPD             + 218%  < 0.001
Bioprosthesis    + 80%  < 0.001

A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease


Aims To identify the characteristics, treatment, and outcomes of contemporary patients with valvular heart disease (VHD) in Europe, and to examine adherence to guidelines. Methods and results The Euro Heart Survey on VHD was conducted from April to July 2001 in 92 centres from 25 countries; it included prospectively 5001 adults with moderate to severe native VHD, infective endocarditis, or previous valve intervention. VHD was native in 71.9% of patients and 28.1% had had a previous intervention. Mean age was 64±14 years. Degenerative aetiologies were the most frequent in aortic VHD and mitral regurgitation while most cases of mitral stenosis were of rheumatic origin.

Coronary angiography was used in 85.2% of patients before intervention. Of the 1269 patients who underwent intervention, prosthetic replacement was performed in 99.0% of aortic VHD, percutaneous dilatation in 33.9% of mitral stenosis, and valve repair in 46.5% of mitral regurgitation; 31.7% of patients had ≥1 associated procedure. Of patients with severe, symptomatic, single VHD, 31.8% did not undergo intervention, most frequently because of comorbidities. In asymptomatic patients, accordance with guidelines ranged between 66.0 and 78.5%. Operative mortality was <5% for single VHD. Conclusions This survey provides unique contemporary data on characteristics and management of patients with VHD. Adherence to guidelines is globally satisfying as regards investigations and interventions.
~30-40% of Patients with Severe Symptomatic AS are “Untreated”!

Severe Symptomatic Aortic Stenosis
Percent of Cardiology Patients Treated

<table>
<thead>
<tr>
<th>Study</th>
<th>AVR</th>
<th>No AVR</th>
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</thead>
<tbody>
<tr>
<td>Bouma 1999</td>
<td>59</td>
<td>41</td>
</tr>
<tr>
<td>Iung* 2004</td>
<td>68</td>
<td>32</td>
</tr>
<tr>
<td>Pellikka 2005</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>Charlson 2006</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Bach Spokane (prelim)</td>
<td>52</td>
<td>48</td>
</tr>
<tr>
<td>Vannan (Pub. Pending)</td>
<td>55</td>
<td>45</td>
</tr>
</tbody>
</table>

Under-treatment especially prevalent among patients managed by Primary Care physicians

2. Iung B et al. A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease. European Heart Journal 2003;24:1231-1243 (*includes both Aortic Stenosis and Mitral Regurgitation patients)
Introduction to Transcatheter Aortic-Valve Implantation
Balloon Aortic Valvuloplasty

- Rapid ventricular pacing.
- First performed in children with congenital AS.
- 1\textsuperscript{st} adult palliative case in 1985.

Balloon Aortic Valvuloplasty

- Results in 50-70% decrease in gradients and a 40-60% increase in AVA.

- Problems
  - Complications (vascular,…)
  - Sub-optimal results
  - Early restenosis ~50%
To avoid restenosis:
Why not place a stent within the valve?
1993-1994: Post-Mortem implantations of AV stent

Post-BAV: 23mm balloon

Post-Stent: 23mm Palmaz Stent

Stent respects adjoining structures

Coronary ostia

Height 14mm

IV Septum

Mitral Valve

Post-Stent Longitudinal cut

More than 2kg of traction force required to dislodge the stent
1st original drawings: The concept of stented valve
1994-1999: Trying to convince investors to create a biomedical company

Negative comments and skepticism of experts, surgeons but also cardiologists

“Totally unrealistic, major technical issues”
“Definitely impossible to stent a calcific aortic valve”
“Occlusion of coronary arteries in 100% of cases”
“Would never be approved by FDA”
“Surgery covers 100% of the need. No indication”

“Most stupid project ever heard…”
1999: Percutaneous Valve Technologies (PVT) was eventually created
Device System and Engineers

Delivery catheter system
- Valve housing, shaft, working handle, recapture, reposition, retrieve, profile, ergonomics

Loading system
- Atraumatic, user-friendly

Bioprosthetic heart valve
- Support structure, leaflets, sealing skirt, attachment posts, anchoring/function, sutures

Design - Geometry

Material selection and characterization

Material manufacturing and processing
1st prototypes of stented valves

- Polyuréthane valve
- Bovine pericardium Stainless steel stent
- 23mm max diameter
Cribier-Edwards Aortic Bioprosthesis

Accelerated Wear Tests

> 600 M cycles (15 yrs equivalent)
Cribier-Edwards Aortic Bioprosthesis

**Animal Tests**

**PHV IMPLANTATIONS**
- Native aortic valve
- Native pulmonary valve
- Descending aorta

More than 100 implantations in normal sheep (CERA, Paris and Biomatec, Lyon)
Implantation technique

Balloon valvuloplasty and valve implantation during rapid ventricular pacing (~180/min)
April 16\textsuperscript{th}, 2002.
First in Man TAVI, Rouen, France

57 year-old man

- Severe calcific Aortic Stenosis in cardiogenic shock
- Valve replacement declined by three surgical teams due to hemodynamic instability and comorbidities
- Severe peripheral arterial disease with subacute ischemia of the right leg (occluded aorto-bifemoral bypass)
- Silicosis and lung cancer (lobectomy in 1999)
- Balloon aortic valvuloplasty proposed as a last possible option
April 16th, 2002.
First in Man TAVI, Rouen, France

LVEF = 14%
April 16th, 2002.
First in Man TAVI, Rouen, France
Percutaneous Aortic Valve Replacement

Cribier et al. Circulation 2002;106:3006-3008
Day 8 post-implantation
Cribier-Edwards Aortic Bioprosthesis

Animal Tests: The initial phase

- Poorly defined patients characterization
  - Desperate cases (including those beyond cure)
- Poorly defined procedural specifications
- Prototype equipment
- Procedural learning curve
  - Pioneering experiences

Yrs: 2002-2005

- ↑ procedural complications
- ↑ peri-procedural and short-term mortality
- Questionable procedural role & medical benefits
Learning Curve

- Improved Results—mostly related to improved patient selection!
- The importance of meticulous screening process.
Gradient (mm Hg)

\[ P = 0.007 \]

AVA (cm²)

\[ P = 0.007 \]

Hemodynamic Effect

Pre | Post
--- | ---
42  | 9

Pre | Post
--- | ---
0.55 | 1.73
Hemodynamic Effect

Pre PAVI

Gradient 55mmHg
AVA=0.6 cm²

LV
Ao

Post PAVI

Gradient 0mmHg
AVA=1.7 cm²

LV/Ao
Hemodynamic Effect

45 → 10 → 10 mmHg

REVIVE II + REVIVAL II + CSA (n=193)
Edwards TAVI bioprosthesis

<table>
<thead>
<tr>
<th>Year</th>
<th>Model</th>
<th>Materials</th>
<th>Dimensions</th>
<th>Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>FIM</td>
<td>THV</td>
<td>Bovine pericardium, Stainless steel frame</td>
<td>23mm Preclin. &amp; FIM</td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td>THV</td>
<td>Equine pericardium, Stainless steel frame</td>
<td>23mm 2003-2006</td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td>Cribier-Edwards</td>
<td>New transapical approach</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td></td>
<td>Edwards Sapien XT</td>
<td>Bovine pericardium, Cobalt Chrome frame</td>
<td>23 and 26mm Next: 20-29mm</td>
</tr>
</tbody>
</table>
Cribier-Edwards/Sapien™ Aortic Bioprosthesis
Cribier-Edwards/Sapien™ Aortic Bioprosthesis
Cribier-Edwards/Sapien™ Aortic Bioprosthesis

**Trileaflet bioprosthesis**

- Highly resistant stent cage
- Equine → Bovine pericardium
- Optimal hemodynamics
- > 5 years durability (bench testing)
- Two sizes
  - 23/26 mm diameter
  - (29 mm planned)
- AVA=1.7-1.9 cm²

First generation - polyurethane
Cribier-Edwards/Sapien™ Aortic Bioprosthesis

RetroFlex™ Transfemoral Valve Delivery System
Cribier-Edwards/Sapien™ Aortic Bioprosthesis
Cribier-Edwards/Sapien™ Aortic Bioprosthesis
Cribier-Edwards/Sapien™ Aortic Bioprosthesis

1 valve, 2 methods

Transfemoral approach using the RetroFlex™ Delivery System
24 French Sheath Delivery System

Transapical approach using the Ascendra™ Delivery System
Trans-Apical Aortic Valve Implant
Transapical Procedural Steps Using The Ascendra™ Delivery System
Transapical Edwards implantation

The Edwards SAPIEN Transcatheter Heart Valve

Transapical Procedure Using the Ascendra Delivery System
Team Approach

- interventional cardiologists
- cardiac surgeons
- echocardiographers
- vascular surgeons
- radiologist
- anesthesiologists
- ICU physicians
- electrophysiology specialists
- dedicated nursing staff
- industry specialists
The Bipolar or Triangular Approach

Surgeon

Interventional Cardiologist

Surgery

Transcatheater apical

AVR

Surgeon/Cardiologist

Transfemoral
<table>
<thead>
<tr>
<th></th>
<th>PARTNER N=130</th>
<th>SOURCE N=1038</th>
<th>Webb et al N=168</th>
<th>FRANCE N=166</th>
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</thead>
<tbody>
<tr>
<td>Stroke</td>
<td>3.0%</td>
<td>2.5%</td>
<td>4.2%</td>
<td>3.6%</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>3.0%</td>
<td>7.0%</td>
<td>5.4%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Vascular</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complications</td>
<td>10.0%</td>
<td>7.0%</td>
<td>6.6%</td>
<td>6.0%</td>
</tr>
<tr>
<td>(major)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Pooled monitored studies**

**30-day mortality: 6-10%**

![Graph showing mean gradient and EOA progression](image)

- Predicted Mortality TF
- Observed Mortality TF
- Predicted Mortality TA
- Observed Mortality TA

- TF Age = 81.7
- TA Age = 80.7

25.7 6.3 29.2 10.3
The CoreValve Self-Expandable System
The CoreValve Self-Expandable System

- Specifically designed for transcatheter delivery
- Single layer porcine pericardium
- Tri-leaflet configuration
- Tissue valve sutured to frame
- Two sizes accommodate 90% of pts
The CoreValve Self-Expandable System

- **HIGHER PART**: fixation/axes the system

- **MIDDLE PART**: constrained to avoid coronaries / carries the valve in its lower portion

- **LOWER PART**: High radial force pushes aside the calcified leaflets - avoids recoil / para-valvular leaks (covered sleeve/skirt)

- A porcine pericardial tissue valve

- Fixed to a nitinol stent frame in a surgical manner with PTFE sutures
18F Delivery Catheter System

Loading/Release Handle

18F Capsule

12F Shaft

Over-the-wire 0.035 compatible
Deployment of the CoreValve System

Before annular contact

After annular contact

Before device release

Self expandable deployment mechanism
Allows valve repositioning before final valve release
CoreValve Hemodynamic Effect

50 → 3 mmHg
(catheterization)

44 → 8 → 11 mmHg

CoreValve Safety Studies (n=175)
Transfemoral CoreValve implantation
CoreValve Hemodynamic Effect

ASA (cm$^2$)
1.77 ±0.40 [1.1-2.6]
Global CoreValve procedures performed
## TAVI–The Technology Today

<table>
<thead>
<tr>
<th>Frame + Tissue</th>
<th>Size</th>
<th>Annulus</th>
<th>Delivery (internal)</th>
<th>Femoral Artery</th>
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<tbody>
<tr>
<td><strong>Edward SAPIEN™</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Stainless steel, Bovine pericardium</td>
<td>23 x 14.5 mm</td>
<td>18-22 mm</td>
<td>22F</td>
<td>≥8 mm</td>
</tr>
<tr>
<td></td>
<td>26 x 16 mm</td>
<td>21-25 mm</td>
<td>24F</td>
<td>≥ 9 mm</td>
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</table>

*18 French system was already introduced

<table>
<thead>
<tr>
<th>Frame + Tissue</th>
<th>Size</th>
<th>Annulus</th>
<th>Delivery (internal)</th>
<th>Femoral artery</th>
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<tbody>
<tr>
<td><strong>CoreValve Revalving™</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Nitinol, Porcine pericardium</td>
<td>26 x 53 mm</td>
<td>20-23 mm</td>
<td>18 F</td>
<td>≥ 6 mm</td>
</tr>
<tr>
<td></td>
<td>29 x 55 mm</td>
<td>23-27 mm</td>
<td></td>
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## TAVI: Contemporary European data

<table>
<thead>
<tr>
<th>System</th>
<th>Source Registry</th>
<th>18-F Expanded Registry</th>
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</thead>
<tbody>
<tr>
<td><strong>CoreValve</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Edwards-Sapien</strong></td>
<td><strong>n=505</strong></td>
<td><strong>n=1243</strong></td>
</tr>
<tr>
<td>Age (yrs)</td>
<td>81.8</td>
<td>81.0</td>
</tr>
<tr>
<td>Logistic EurosScore (%)</td>
<td>26.4</td>
<td>22.9</td>
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<tr>
<td>NYHC III/IV</td>
<td>9.27</td>
<td>8.4</td>
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<tr>
<td>AVA (before cm²)</td>
<td>0.59</td>
<td>0.64</td>
</tr>
<tr>
<td>AVA (after cm²)</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Mean gradient (before mm Hg)</td>
<td>53.5</td>
<td>49.6</td>
</tr>
<tr>
<td>Mean gradient (after mm Hg)</td>
<td>4</td>
<td>9.1</td>
</tr>
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Cribier et al. JACC Int 2009
## TAVI: Contemporary European data

<table>
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<tr>
<th>System</th>
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<th>18-F Expanded Registry</th>
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<tbody>
<tr>
<td></td>
<td>Edwards-Sapien</td>
<td>CoreValve</td>
</tr>
<tr>
<td></td>
<td>(N=505)</td>
<td>(1243)</td>
</tr>
<tr>
<td>Procedural success (%)</td>
<td>95</td>
<td>98</td>
</tr>
<tr>
<td>30-d mortality (%)</td>
<td>6.4</td>
<td>6.7</td>
</tr>
<tr>
<td>Stroke (%)</td>
<td>3.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Myocardial infarction (%)</td>
<td>1.0</td>
<td>3.9</td>
</tr>
<tr>
<td>Perforation-tamponade (%)</td>
<td>0.7</td>
<td>2.3</td>
</tr>
<tr>
<td>Vascular complications (%)</td>
<td>7.4</td>
<td>6.2</td>
</tr>
<tr>
<td>Need for pacemaker (immediate→30 days %)</td>
<td>1.5%</td>
<td>22%</td>
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Source Registry: 18-F Expanded Registry

Cribier et al. JACC Int 2009

TAVI: Contemporary European data
TAVI: Contemporary European data

Event (%)

<table>
<thead>
<tr>
<th>Event</th>
<th>Edwards-Sapien</th>
<th>CoreValve</th>
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<tbody>
<tr>
<td>Mortality (30d)</td>
<td>6.4</td>
<td>6.7</td>
</tr>
<tr>
<td>Stroke</td>
<td>3.4</td>
<td>3.9</td>
</tr>
<tr>
<td>MI</td>
<td>1.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Perforation</td>
<td>1.0</td>
<td>2.3</td>
</tr>
<tr>
<td>Vascular</td>
<td>6.2</td>
<td>6.2</td>
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<tr>
<td>complications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pacemaker</td>
<td>12</td>
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</tbody>
</table>
Conduction disturbances after TAVI

Cause of Complete Atrioventricular Block After Percutaneous Aortic Valve Implantation
Insights From a Necropsy Study

Raul Moreno, MD; David Doburro, MD; Esteban Lopez de Sis, MD; Mario Prieto, MD; Carmen Morales, MD; Luis Calvo Orbe, MD; Isidro Moreno-Gomez, MD; David Filgueiras, MD; Angel Fernandez-Royuela, MD; Guillermo Colunga, MD; Santiago Janénez

Circulation 2009;120(5):e29-30
Risk and Fate of Cerebral Embolism After Transfemoral Aortic Valve Implantation

A Prospective Pilot Study With Diffusion-Weighted Magnetic Resonance Imaging

Alexandra Chassani, MD,* Andreas Müller, MD;† Claus P. Näcke, MD;‡ Jürgen Knorr, MD,*
Peter Wernert, MD,† Christoph Hanselklang, MD,* Hans H. Schüle, MD,*
Jörg O. Schwab, MD, PhD,* Fritz Möllert, MD,‡ Rolf Pinnert, MD,‡ George
Daniel Thomas, MD*

*Erasmus, Germany
Emerging AVR Technology

Development Stage

Preclinical

Awaiting FHU

Clinical

Percutaneous

Min-invasive surgery

CoreValve (Edwards Lifesciences)

Also developing MIS method

AorTx

Sadra Medical

Direct Flow Medical Inc.

AorTech

3F Valves

ETR

DAT

Arbor Surgical Technologies

Heart Leaflet Technologies

Ventor

EndoCor

Emerging AVR Technology

Aortic Valve Xchange

1st implant is open, replacement/exchange done MIS or percutaneous

Awaiting substantial clinical data

Pivotal DAT

ETFHU

Substantial clinical data
Self-expandable transcatheter valve to optimize placement and physiology

Ehud Schwamenthal, MD, TCT2008
Ventor near $320 million acquisition by Medtronic

Investors in the medical device start-up can see a return of over 12 times their original investment.

Gali Weinreb 17 Feb 09

Sources inform "Globes" that medical device start-up Ventor Technologies Ltd. is in advanced negotiations to be acquired by Medtronic (NYSE: MDT) for about $300 million.

Ventor and existing investors Pitango Venture Capital, Medica, and co-founder Dr. Shimon Eckhouse all denied that the firm was in talks to be sold. Medtronic did not respond.
Heart Valve Market Forecast

% Procedures

2007
- PHVT 0.2%
- Repair 17.4%
- Mechanical 32.3%
- Tissue 50.1%

2012
- PHVT 41.1%
- Repair 12.4%
- Mechanical 12.7%
- Tissue 33.8%

Source: Millennium Research Group 2008
Partner US Pivotal Trial

- **Operable Assessment**
  - Yes → **Cohort A**
    - Femoral Access Evaluation Y/N
      - Yes → 1:1 Randomization
        - Trans femoral vs AVR Control
      - No → Trans apical vs AVR Control
  - No → **Cohort B**
    - Femoral Access Evaluation Y/N
      - Yes → 1:1 Randomization
        - Trans femoral vs Medical Management Control
      - No → Not in Study

- **Number of Patients**
  - Cohort A: ~650 pts
  - Cohort B: ~350 pts
Screening patients for TAVI
Screening patients for TAVI

- Does the patient have severe AS?
- Is it symptomatic AS?
- Is he “high risk” for conventional surgery?
Who are the “High Surgical Risk” Aortic-Stenosis Patients?

- Octogenarians with multiple co-morbidities (LV dysf., previous cardiac surgery, …).
- Impaired rehabilitation capacity.
- High “frailty” index.
- Neurocognitive dysfunction.
- Porcelain aorta.
- Cirrhosis with portal hypertension.
- End-stage Lung disease.
- Chest wall deformities (severe).
- Radiation chest wall / heart disease.

- STS Predicted Risk >10%.
- Logistic EuroSCORE > 20%
# EuroSCORE evaluation

<table>
<thead>
<tr>
<th>Patient-related factors</th>
<th>Cardiac-related factors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (years)</strong></td>
<td>82</td>
</tr>
<tr>
<td><strong>Gender</strong></td>
<td>Female</td>
</tr>
<tr>
<td><strong>Chronic pulmonary disease</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Extracardiac arteriopathy</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Neurological dysfunction</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Previous Cardiac Surgery</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Creatinine &gt; 200 μmol/L</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Active endocarditis</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Critical preoperative state</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Unstable angina</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>LV function</strong></td>
<td>Good</td>
</tr>
<tr>
<td><strong>Recent MI</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Pulmonary hypertension</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Operation-related factors</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Emergency</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Other than isolated CABG</strong></td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Surgery on thoracic aorta</strong></td>
<td>No</td>
</tr>
<tr>
<td><strong>Post infarct septal rupture</strong></td>
<td>No</td>
</tr>
</tbody>
</table>

**Logistic EuroSCORE:** 21.16%
Overestimation of aortic valve replacement risk by EuroSCORE: implications for percutaneous valve replacement

Brigitte R. Osswald¹, Vassil Gegouskov², Dominika Badowski-Zyla², Ursula Tochtermann³, Gisela Thomas³, Siegfried Hagle³, and Eugene H. Blackstone³,⁴
Difficult to quantify frailty?

- Both are 90 y/o and have EuroScore of 12%.
- One passes the “eyeball test”; one doesn’t.
A need for thorough screening process

Iliac rupture

“artery on a stick”
### Medtronic CoreValve Patient Evaluation Criteria

#### Diagnostic Findings

<table>
<thead>
<tr>
<th>Non-Invasive</th>
<th>Angiography</th>
<th>Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echocardiogram</td>
<td>CT/MRI</td>
<td>LV</td>
</tr>
<tr>
<td>Aortic Valve Stenosis</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Mitral Valve Stenosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aortic Valve Regurgitation</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Mitral Valve Regurgitation</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Aortic and Vascular Disease</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Anatomical Considerations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Indications For 26 mm CoreValve Device

<table>
<thead>
<tr>
<th>Anatomical Considerations</th>
<th>Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annulus Diameter</td>
<td>26-27mm</td>
</tr>
<tr>
<td>Ascending Aorta Diameter</td>
<td>&gt;= 40mm</td>
</tr>
</tbody>
</table>

#### Anatomical Considerations For 26 mm CoreValve Device

<table>
<thead>
<tr>
<th>Anatomical Considerations</th>
<th>Selection Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sinus of Valsalva Width</td>
<td>&gt;= 27mm</td>
</tr>
<tr>
<td>Sinus of Valsalva Height</td>
<td>&gt;= 15mm</td>
</tr>
<tr>
<td>Sinus of Valsalva Width</td>
<td>&gt;= 29mm</td>
</tr>
</tbody>
</table>

#### General Medical Guidance For Use Of CoreValve*

* General medical guidance reflects the experience to date with the product, but the judgment remains with the implanting physician.

#### Anatomical Considerations For 26 mm CoreValve Device

* Consult with a certified provider to determine if your patient is Moderate-High Risk.

---

Note the position of any SVEs:

- A: Annulus Diameter
- B: Sinus of Valsalva Width
- C: Sinus of Valsalva Height
- D: Sinus of Valsalva Width
- E: Frame Height (± 5mm)
Echo: Parasternal Long Axis

Aorta root measurements
Echo: Parasternal Long Axis

Annulus – LVOT measurement
Echo-annulus measurements

In the middle of calcification

Transmission AML to annulus

AO root

LVOT
Echo: Parasternal Short Axis

Tricuspid aortic-valve
Parasternal Long Axis View

mitral regurgitation
Coronary & bypass vessels angio
Aorta and Peripheral Angiography

- Iliacs > 8mm bilaterally
- Annular and arch examined
Angio: Aortic Root

- 5 cm
- Ascending AO
- STJ
- sinus
- Sinus height
Angio: Aortic Arch
Angio: Abdominal Aorta

Graduated Pigtail
Angio: iliacs bifurcation
Angio: femoral arteries

Femoral diameter

Puncture site
CT angio: aortic root

- Ascending AO
- 5 cm
- STJ
- sinus
- height
- ANNULUS
CT angio
Extracardiac findings per CT
Peripheral arteries are large enough:
Rt & Lt common iliac ~ 1.0cm.
CT angio
CT angio
CT angio
CT- evaluation of calcification

Calcifications are clearly visible
Rejection d/t Narrow Peripheral Vessels

Rt ext iliac

Lt ext iliac
Rejection d/t
Severe Peripheral Vessel Tortuosity
Rejection d/t
Severe Peripheral Vessel Tortuosity

Tortuosity & Calcification
Worst!
Protruding Aortic Atheroma
High angulation between Aorta & Aortic-Valve
“Horizontal Heart”
High angulation between Aorta & Aortic-Valve

“Horizontal Heart”
Evaluating the distance between Aortic-Valve and Coronary Ostia
Blocking The Coronary Ostia
Rejection d/t Calcified Tissue near Coronary Ostia
Paravalvular Leak

RCA

Paravalvular leak

LM

Above

Below
Failed Implantation
Failed Implantation
Rejection d/t
Inadequate Annulus size

- Edwards: 18-25mm
- CoreValve: 20-27mm
Bicuspid Aortic-Valve
Bicuspid Aortic-Valve

Figure 1: Different Shapes of Stent Deployment Encountered

Circle (A), triangle (B), and elliptical (C and D). Note the round calcifications crossing the stent frame.

Table 3: Stent Shape After Deployment According to Aortic Valve Pathology

<table>
<thead>
<tr>
<th>Stent Shape</th>
<th>Tricuspid (n = 18)</th>
<th>Bicuspid (n = 14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circular, n (%)</td>
<td>13 (68)</td>
<td>2 (14)</td>
</tr>
<tr>
<td>Elliptic, n (%)</td>
<td>2 (11)</td>
<td>11 (79)</td>
</tr>
<tr>
<td>Triangular, n (%)</td>
<td>4 (21)</td>
<td>1 (7)</td>
</tr>
</tbody>
</table>
Basal Septum Hypertrophy
Rapid Pacing During Implantation
Is it safe to perform the rapid pacing in this patient?

- Mod-severe LV dysfunction
- RV dysfunction
- Mod-Severe MR
- Severe Pulmonary HTN
Is it safe to perform the rapid pacing in this patient?

Three-Vessel Disease
Left Main Disease
Suggested PCI Strategy in TAVI Candidates

Significant coronary stenosis

Evaluate lesion complexity and/or PCI risk

No significant coronary stenosis

TAVI

Anticipated non-complex PCI

Single-stage

PCI immediately followed by TAVI

Scheduled follow up: reassess need for TAVI

TAVI

Anticipated Complex PCI

Multistage

PCI

Re-assess the risk of cardiac surgery

Reasonable surgical risk

Coronary bypass & AVR surgery (consider “off-pump” bypass surgery & TAVI)

High surgical risk

PCI (complete or partial) followed by balloon valvuloplasty / TAVI

Dvir D. et al. J Invasive Cardiol 2009
TAVI experience in Israel

PAVI was included in the “health basket” in January 2010
## Sapien PAVI: Israeli data

<table>
<thead>
<tr>
<th></th>
<th>Patients data (N=41)</th>
<th>Procedures (N=42)*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age (yrs)</strong></td>
<td></td>
<td>82.6±5.3 (65-91)</td>
</tr>
<tr>
<td><strong>Age &gt;80 yrs (%)</strong></td>
<td></td>
<td>76</td>
</tr>
<tr>
<td><strong>Men/women (%)</strong></td>
<td></td>
<td>40/60</td>
</tr>
<tr>
<td><strong>Logistic EuroScore (%)</strong></td>
<td></td>
<td>23.1±13.9</td>
</tr>
<tr>
<td><strong>NYHC III/IV (%)</strong></td>
<td></td>
<td>93</td>
</tr>
<tr>
<td><strong>Diabetes mellitus (%)</strong></td>
<td></td>
<td>37</td>
</tr>
<tr>
<td><strong>Post sternotomy</strong></td>
<td></td>
<td>37</td>
</tr>
<tr>
<td><strong>Renal insufficiency (creat.≥1.4 mg%)</strong></td>
<td></td>
<td>40</td>
</tr>
<tr>
<td><strong>Pulmonary disease (%)</strong></td>
<td></td>
<td>22</td>
</tr>
</tbody>
</table>

*in one case the procedure was converted from TF->TA
## Sapien PAVI: Israeli data

<table>
<thead>
<tr>
<th></th>
<th>Patients data (N=41)</th>
<th>Procedures (N=42)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>23 mm valve utilized</td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>26 mm valve utilized</td>
<td></td>
<td>21</td>
</tr>
<tr>
<td>AVA (before cm²)</td>
<td></td>
<td>0.57±0.13</td>
</tr>
<tr>
<td>AVA (after cm²)</td>
<td></td>
<td>1.67±0.25</td>
</tr>
<tr>
<td>Peak/Mean gradient (before mm Hg)</td>
<td></td>
<td>89/52</td>
</tr>
<tr>
<td>Peak/Mean gradient (after mm Hg)</td>
<td></td>
<td>17/9</td>
</tr>
</tbody>
</table>

*in one case the procedure was converted from TF->TA
# Sapien PAVI: Israeli data

<table>
<thead>
<tr>
<th>System</th>
<th>Patients data (N=41) Procedures (N=42)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall procedural success (%)</td>
<td>92.8% (39/42)</td>
</tr>
<tr>
<td>Trans-femoral procedural success (%)*</td>
<td>95.4% (21/22)</td>
</tr>
<tr>
<td>Trans-apical procedural success (%)**</td>
<td>85.0 (17/20)</td>
</tr>
<tr>
<td>Overall in-hosp. patients mortality (%)</td>
<td>4.9 (2/41)</td>
</tr>
<tr>
<td>Trans-femoral patients mortality (%)</td>
<td>0 (0/21)</td>
</tr>
<tr>
<td>Trans-apical patients mortality (%)</td>
<td>10.0 (2/20)</td>
</tr>
<tr>
<td>35 day patient survival (%)</td>
<td>92.1 (35/38)</td>
</tr>
</tbody>
</table>

*TF-in one case the procedure was converted from TF->TA  
**TA-in two cases in-lab fatal complications occurred and one additional case was converted into surgical AVR
Sapien PAVI: Israeli survival

Mortality (%)

Days

N=41  N=41  N=39  N=35  N=31  N=27
Mortality cases specified

- Case #1: Trans-apical, stiff wire related perforation, in-lab tamponade and death
- Case #2: Suspected annular rupture and severe AI, in-lab shock and death
- Case #3: Trans-femoral, in-lab vascular complication, vascular surgical repair, prolonged hospitalization, stroke and death @day 32 post TAVI.
# Sapien PAVI: Israeli complications

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Patients data (N=41) Procedures (N=42)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stroke (%)</td>
<td>4.9 (2/41)</td>
</tr>
<tr>
<td>-Major stroke (%)</td>
<td>2.4 (1/41)</td>
</tr>
<tr>
<td>-Minor stroke (%)</td>
<td>2.4 (1/41)</td>
</tr>
<tr>
<td>Myocardial infarction (%)</td>
<td>0 (0/41)</td>
</tr>
<tr>
<td>Perforation-tamponade (%)</td>
<td>4.9 (2/41)</td>
</tr>
<tr>
<td>-including PM related tamponade</td>
<td>2.4 (1/41)</td>
</tr>
<tr>
<td>Major vascular complications (%)</td>
<td>4.9 (2/41)</td>
</tr>
<tr>
<td>Valve migration (%)</td>
<td>2.4 (1/41)</td>
</tr>
<tr>
<td>Need for permanent pacemaker (%)</td>
<td>2.4 (1/41)</td>
</tr>
</tbody>
</table>

*median hospital stay=7 days (mean 13.7 days)
NYHA Class Response to TAVI

NYHA Class

Pre TAVI 30d post

(%)
# The Israeli CoreValve Registry

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>123</td>
</tr>
<tr>
<td>Age (years)</td>
<td>82.4 ± 5.9</td>
</tr>
<tr>
<td>Logistic EuroSCORE (%)</td>
<td>23.6 ± 13.1</td>
</tr>
<tr>
<td>Female</td>
<td>61%</td>
</tr>
<tr>
<td>NYHA</td>
<td>I-II: 3.2%</td>
</tr>
<tr>
<td></td>
<td>III-IV: 96.8%</td>
</tr>
<tr>
<td>Aortic Valve Area (cm²)</td>
<td>0.6 ± 0.1</td>
</tr>
<tr>
<td>Peak gradient (mm Hg)</td>
<td>81.3 ± 21.0</td>
</tr>
<tr>
<td>Mean gradient (mm Hg)</td>
<td>50.0 ± 12.9</td>
</tr>
<tr>
<td>P2P gradient (mm Hg)</td>
<td>70.5 ± 21.3</td>
</tr>
<tr>
<td>LVEF (%)</td>
<td>55.5 ± 9.2</td>
</tr>
</tbody>
</table>
# The Israeli CoreValve Registry (n=123)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>4.4% (5)</td>
</tr>
<tr>
<td>Aortic Dissection</td>
<td>0</td>
</tr>
<tr>
<td>Cardiac Tamponade</td>
<td>4.1% (5)</td>
</tr>
<tr>
<td>Cardiac Perforation</td>
<td>0.8% (1)</td>
</tr>
<tr>
<td>Access Site Complication</td>
<td>12.0% (15)</td>
</tr>
<tr>
<td>Major Bleeding</td>
<td>6.3% (5)</td>
</tr>
<tr>
<td>Conversion to Surgery</td>
<td>0</td>
</tr>
<tr>
<td>Myocardial Infarction</td>
<td>0</td>
</tr>
<tr>
<td>Major Arrhythmia</td>
<td>0.8% (1)</td>
</tr>
<tr>
<td>Aortic Regurg. 2/≥3</td>
<td>5%(4)/1.6% (2)</td>
</tr>
<tr>
<td>Pacemaker</td>
<td>30% (38)</td>
</tr>
<tr>
<td>Renal Failure</td>
<td>2.4% (3)</td>
</tr>
<tr>
<td>Stroke</td>
<td>1.6% (2) *</td>
</tr>
<tr>
<td>TIA</td>
<td>0.8% (1)</td>
</tr>
</tbody>
</table>

* hemorrhagic day 12
TAVI experience in Rabin Medical Center
The 1st patient 5/11/2008

- 87 year-old male
- Severe symptomatic AS – Functional Class III
- Very high risk d/t
  - previous cardiac surgery
  - porcelain aorta
  - pulmonary disease
- Calculated Euroscore- 20% predicted mortality.
The Moment of Truth...
Transfemoral Edwards 11/2008
Our first patient; 4 months after the procedure
Transfemoral CoreValve 9/2009

- A 76-year-old woman
- Obesity.
- Chronic hemodialysis tx.
- Deteriorating functional capacity.
Transfemoral CoreValve 9/2009
Transfemoral CoreValve 9/2009
Transfemoral CoreValve 9/2009
89 year old woman

Many comorbidities:
- Ischemic heart disease, s/p CABG
- Bilateral carotid stenosis
- Peripheral vascular disease

Logistic EuroSCORE 45.2%
Transapical Edwards 12/2009
Transapical Edwards 12/2009
Transapical Edwards 12/2009
Transaxillary CoreValve 3/2010

- 90 year-old woman
- Severe LV dysfunction
- Critical state
- Log EuroSCORE 47.5%
Transaxillary CoreValve 3/2010
Transaxillary CoreValve 3/2010
“Valve in Valve” 5/2010
first in Israel

- 81 year-old man
- s/p biologic AVR- Toronto stentless valve 29mm
- Severe aortic stenosis of the prosthetic valve
"Valve in Valve" 5/2010
first in Israel

No Balloon Valvuloplasty
Transaxillary CoreValve implantation
Screening Recruitment Rate

New patients per month

Cumulative # of patients

07/2008 01/2009 07/2009 01/2010
Treatment assignment

High-risk Severe AS Patients (n= 246)

Treatment Assigned (n= 178)

Under Active Screening (n= 68)

Conservative treatment (n= 70)

Aortic-Valve Replacement (n= 31)

Balloon Valvuloplasty (n= 32)

Transcatheter Aortic-Valve Implantation (n= 45)

TF/TAX CoreValve
n= 29

TF Edwards
n= 7

TA Edwards
n= 9
Cumulative TAVI Procedures

Total patients

0 10 20 30 40 50
11-2008 03-2009 07-2009 11-2009 03-2010 07-2010
Survival Analysis - 30 days

% survival

<table>
<thead>
<tr>
<th># at risk</th>
<th>0 days</th>
<th>30 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAVI</td>
<td>29</td>
<td>25</td>
</tr>
<tr>
<td>Conservative</td>
<td>61</td>
<td>55</td>
</tr>
<tr>
<td>Balloon</td>
<td>29</td>
<td>26</td>
</tr>
<tr>
<td>AVR</td>
<td>23</td>
<td>21</td>
</tr>
</tbody>
</table>
Survival Analysis- 30 days

% survival

Deaths 30 days:
- Conservative tx: sepsis, unknown, pulmonary edema & multiorgan failure.
- Balloon: pulmonary edema, sepsis.
- AVR: tamponade?, unknown.
## Clinical Profile

<table>
<thead>
<tr>
<th>Variable</th>
<th>TAVI (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>82.1±6.4</td>
</tr>
<tr>
<td>Male</td>
<td>33% (12)</td>
</tr>
<tr>
<td>STS score</td>
<td>7.4±5.8</td>
</tr>
<tr>
<td>Logistic EuroSCORE</td>
<td>22.8±10.4</td>
</tr>
<tr>
<td>New York Heart Association Class III / IV</td>
<td>100% (36)</td>
</tr>
</tbody>
</table>
## Clinical Profile

<table>
<thead>
<tr>
<th>Variable</th>
<th>TAVI (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes mellitus</td>
<td>25% (9)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>92% (33)</td>
</tr>
<tr>
<td>Hyperlipidemia</td>
<td>89% (32)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>62% (22)</td>
</tr>
<tr>
<td>Smoker</td>
<td>11% (4)</td>
</tr>
<tr>
<td>COPD</td>
<td>17% (6)</td>
</tr>
<tr>
<td>Renal failure</td>
<td>44% (16)</td>
</tr>
<tr>
<td>Prior CVA/TIA</td>
<td>17% (6)</td>
</tr>
<tr>
<td>Arrhythmia</td>
<td>33% (12)</td>
</tr>
<tr>
<td>PVD</td>
<td>31% (11)</td>
</tr>
<tr>
<td>Prior CABG</td>
<td>39% (14)</td>
</tr>
<tr>
<td>Prior PCI</td>
<td>53% (19)</td>
</tr>
</tbody>
</table>
## Echocardiographic Data

<table>
<thead>
<tr>
<th>Variable</th>
<th>TAVI (n=45)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ejection fraction (%)</td>
<td>44.7±14</td>
</tr>
<tr>
<td>Pulmonary artery systolic pressure (mmHg)</td>
<td>38.3±13.8</td>
</tr>
<tr>
<td>Aortic valve area (cm²)</td>
<td>0.55±0.11</td>
</tr>
<tr>
<td>Maximum velocity across aortic valve (m/sec)</td>
<td>4.1±0.8</td>
</tr>
<tr>
<td>Mean gradients across aortic valve (mmHg)</td>
<td>45.5±23.4</td>
</tr>
<tr>
<td>Peak gradients across aortic valve (mmHg)</td>
<td>71.7±34.2</td>
</tr>
<tr>
<td>Variable</td>
<td>TAVI (n=45)</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Before treatment</td>
<td></td>
</tr>
<tr>
<td>Mean gradients across aortic valve (mmHg)</td>
<td>45.5±23.4</td>
</tr>
<tr>
<td>Peak gradients across aortic valve (mmHg)</td>
<td>71.7±34.2</td>
</tr>
<tr>
<td>After treatment</td>
<td></td>
</tr>
<tr>
<td>Mean gradients across aortic valve (mmHg)</td>
<td>7.8±2.3</td>
</tr>
<tr>
<td>Peak gradients across aortic valve (mmHg)</td>
<td>15.6±5.5</td>
</tr>
</tbody>
</table>
Early Complications after TAVI- 30 days (n=45)

<table>
<thead>
<tr>
<th>Complication</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>0%</td>
</tr>
<tr>
<td>Vascular-minor</td>
<td>13.3% (6)</td>
</tr>
<tr>
<td>Vascular-major / Tamponade</td>
<td>2.2% (1)</td>
</tr>
<tr>
<td>Valve misplacement</td>
<td>0%</td>
</tr>
<tr>
<td>Perm Pacemaker implantation</td>
<td>15.6% (24% in CoreValve / 0% in Edwards)</td>
</tr>
<tr>
<td>VT / VF</td>
<td>2.2% (1) (8 days post procedure)</td>
</tr>
<tr>
<td>Blood transfusion</td>
<td>40% (18)</td>
</tr>
<tr>
<td>MI</td>
<td>0%</td>
</tr>
<tr>
<td>CHF</td>
<td>6.7% (3)</td>
</tr>
<tr>
<td>Acute Renal Failure</td>
<td>2.2% (1)</td>
</tr>
<tr>
<td>Significant AR (≥2)</td>
<td>2.2% (1)</td>
</tr>
<tr>
<td>CVA</td>
<td>4.4% (2)</td>
</tr>
<tr>
<td>Pulmonary Embolism</td>
<td>2.2% (1)</td>
</tr>
<tr>
<td>Surgical wound infection</td>
<td>2.2% (1)</td>
</tr>
<tr>
<td>Length of hospital stay</td>
<td>mean 6 days</td>
</tr>
</tbody>
</table>

Length of hospital stay mean 6 days
TAVI- Survival Analysis

<table>
<thead>
<tr>
<th># at risk</th>
<th>0 days</th>
<th>30 days</th>
<th>180 days</th>
<th>360 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAVI</td>
<td>45</td>
<td>38</td>
<td>18</td>
<td>4</td>
</tr>
</tbody>
</table>

* one patient died at day 35 from sepsis. No signs of endocarditis including on TEE evaluation.
SUMMARY

Treatment options for symptomatic aortic-stenosis patient:

- Medical tx only.
- Surgical AVR - the “treatment of choice”
- AV balloon valvuloplasty - as a “bridge” to AVR / TAVI.
- TAVI (transfemoral / transaxillary / transapical)
TAVI is an emerging technique with a rapid increase in world-wide experience, approaching 20,000 cases.

Current indications include only high-risk severe symptomatic aortic stenosis patients.

Patient selection is critical.

Preliminary studies show that TAVI is both feasible and effective in the short and medium term.
Thank You!