Transcatheter Aortic Valve Replacement (TAVR): Getting it right with echo
No conflict
Aortic Stenosis Prevalence Increasing

Over 40 million people in the United States over the age of 65

- Up to 7% of the population over the age of 65 has AS
- Between 1990 and 2020, the population aged from 65-74 years will increase 74%

Population: 1960 to 2050 (in Millions)

Elderly

Source: US Census Bureau


Severe aortic stenosis has a worse prognosis than many metastatic cancers

5-year survival of breast cancer, lung cancer, prostate cancer, ovarian cancer and severe inoperable aortic stenosis

*Using constant hazard ratio. Data on file, Edwards Lifesciences LLC. Analysis courtesy of Murat Tuczu, MD, Cleveland Clinic

Courtesy of Dr. Ihab Alomari
Severe aortic stenosis is life threatening and treatment is critical\textsuperscript{5}

After the onset of symptoms, patients with severe aortic stenosis have a survival rate as low as 50% at 2 years and 20% at 5 years without aortic valve replacement

Echocardiographic Guidelines are the Gold Standard in Assessing Severe Aortic Stenosis\textsuperscript{6}

### Grading the Severity of Aortic Stenosis per the ACC/AHA Guidelines

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jet velocity (m/s)</td>
<td>&lt; 3.0</td>
<td>3.0 - 4.0</td>
<td>&gt; 4.0</td>
</tr>
<tr>
<td>Mean gradient (mmHg)</td>
<td>&lt; 25</td>
<td>25 - 40</td>
<td>&gt; 40</td>
</tr>
<tr>
<td>Valve area (cm(^2))</td>
<td>&gt; 1.5</td>
<td>1.0 – 1.5</td>
<td>&lt; 1.0</td>
</tr>
<tr>
<td>Valve area index (cm(^2)/m(^2))</td>
<td>N/A</td>
<td>N/A</td>
<td>&lt; 0.6</td>
</tr>
</tbody>
</table>

- According to the 2014 ACC/AHA guidelines, severe aortic stenosis is defined as:
  - Aortic valve area (AVA) less than 1.0 cm\(^2\)
  - Mean gradient greater than 40 mmHg or jet velocity greater than 4.0 m/s
New Classification of Aortic Stenosis

- **Four stages** based on symptoms, leaflet anatomy, valve hemodynamics, and LVEF
  - **Stage A**
    - At risk of developing AS with normal leaflet opening (bicuspid aortic valve, aortic sclerosis)
  - **Stage B**
    - Progressive leaflet calcification and thickening with mild to moderate valve obstruction
  - **Stage C**
    - C1: Asymptomatic patients with reduced systolic opening of aortic valve and antegrade velocity across the valve $\geq 4.0$ m/s equivalent to a mean transaortic gradient of 40 mm Hg or higher and LVEF $\geq 50$
    - C2: C1 with LVEF $\leq 50$
  - **Stage D**
    - D1: Symptomatic severe AS, high gradient
    - D2: Symptomatic severe with low flow/low gradient
    - D3: Symptomatic severe low gradient AS with normal LVEF

AS, aortic stenosis; LVEF, left ventricular ejection fraction.
AHA/ACC guidelines for aortic valve replacement in patients with aortic stenosis

**Aortic stenosis**

**Severe high gradient**
- AVA typically \(\leq 1.0 \text{ cm}^2\)
  - \(V_{\text{max}} \geq 4 \text{ m/s}\) or
  - \(\Delta p \text{ mean} \geq 40 \text{ mmHg}\)
- Symptomatic (stage D1)
  - **Yes**
    - Exercise test demonstrating decreased exercise tolerance or a fall in systolic BP
    - Should be recommended for valve replacement
  - **No**
    - Reasonable to recommend for valve replacement

**Severe low flow / low gradient**
- AVA typically \(\leq 1.0 \text{ cm}^2\)
  - resting aortic \(V_{\text{max}} < 4 \text{ m/s}\) or
  - \(\Delta p \text{ mean} < 40 \text{ mmHg}\)
- Symptomatic
  - **Yes**
    - Dobutamine stress echo (DSE) with AVA \(\leq 1 \text{ cm}^2\) and
    - \(V_{\text{max}} \geq 4 \text{ m/s}\) (stage D2)
  - **No**
    - Reasonable to recommend for valve replacement

**At risk / progressive**
- AVA typically \(\geq 1.0 \text{ cm}^2\)
  - \(V_{\text{max}} \leq 4 \text{ m/s}\)
- LVEF < 50%
  - Repeat echo every 6-12 months

**Worsening signs or symptoms**
- Consider for severe aortic stenosis evaluation

**Increased flow restrictions**
- AVA \(\leq 1.0 \text{ cm}^2\) and
- \(V_{\text{max}} \geq 4 \text{ m/s}\)

---

*AVR should be considered with stage D3 AS only if valve obstruction is the most likely cause of symptoms, stroke volume index is \(< 35 \text{ mL/m}^2\), indexed AVA is \(\leq 0.6 \text{ cm}^2/\text{m}^2\) and data are recorded when the patient is normotensive (systolic BP \(< 140 \text{ mm Hg}\)).
Operative Rates for Severe Aortic Stenosis

In clinical practice, > 30% of patients with severe symptomatic AS do not undergo AVR

AS, aortic stenosis; AVR, aortic valve replacement.

Courtesy of Dr. Ihab Alomari
TAVR: Transcatheter Aortic Valve Replacement

- An aortic valve replacement as an alternative to traditional thoracotomy.
- Less invasive than traditional thoracotomy for patients considered too high risk for traditional surgery.
2017 AHA/ACC Focused Update of the 2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease
TAVR Systems

Edwards Sapien 3

Medtronic CoreValve

J Am Coll Cardiol 2016;67:1472–87
Differences in Valve Seating

**SAPIEN XT**
- Contact only at annulus
- Remains easy engage coronaries

**CoreValve**
- Contact at ascending aorta, annulus, and left ventricular outflow tract
- Contact at left ventricular outflow tract increases pacemaker
- Engagement of coronaries more difficult

Courtesy of Dr. Ihab Alomari
Role of Echo in TAVR

- Patient selection
- Intra-procedural guidance
- Post-procedural evaluation

https://www.wakemed.org/heart-vascular-tavr
Role of Echo in TAVR

- Assess AV area, MG, peak V
- Assess EF
- Assess degree of AR and MR
- Assess AV annulus
- Assess degree and location of AV leaflet calcification
- Assess sinuses of Valsalva, STJ
- Assess LVOT diameter
- Assess septal buldge
- Confirm appropriate size transcatheter valve
- Aid in valve positioning
- Assess PV leak and central leak
- Assess coronary flow and post-implant EF
- Measure post-implant pressures
- Assess potential post-procedure complications
  - Pericardial effusion
  - Aorta, MV function

Department Name | Month X, 201X
Patient selection

- **TTE** is the first test to confirm if a patient is eligible for TAVR
  - Accurate severity of AS:
    \[
    AVA = \frac{CSA_{LVOT} \times VTI_{LVOT}}{VTI_{AV}}
    \]

LVOT diameter is measured in
- zoomed PLX view
- in mid-systole
- from the white–black interface of the septal endocardium to the anterior mitral leaflet
- parallel to the AV plane
- within 0.5–1.0 cm of the valve orifice.
Accurate severity of AS:

- LVOT velocity is measured
  - from the apical approach
  - the sample volume length (or gate) of 3–5 mm
  - positioned just proximal to the region of flow acceleration into the jet.
- The VTI is measured by tracing the modal velocity (middle of the dense signal) for use in the continuity equation or calculation of stroke volume

\[
AVA = \frac{CSA_{LVOT} \times VTI_{LVOT}}{VTI_{AV}}
\]

\[
CSA_{LVOT} = \pi \left( \frac{D}{2} \right)^2
\]
Patient selection

- Accurate severity of AS:

\[
AVA = \frac{CSA_{LVOT} \times VTI_{LVOT}}{VTI_{AV}}
\]

\[
CSA_{LVOT} = \pi \left(\frac{D}{2}\right)^2
\]

- A common source of error for gradient measurement is misalignment of the beam → important to use multiple acoustic windows for the CW Doppler assessment of AS to get the best alignment between Doppler signal and AV flow.
Patient selection

• Accurate severity of AS:

\[ AVA = \frac{CSA_{LVOT} \times VTI_{LVOT}}{VTI_{AV}} \]

• A dense outer edge of the smooth velocity curve with a and clear maximum velocity should be recorded.

• Vm is measured at the outer edge of the dark signal; fine linear signals should not be included in measurements.
Patient selection

- Accurate severity of AS:

\[ AVA = \frac{CSA_{LVOT} \times VTI_{LVOT}}{VTI_{AV}} \]

- Average \( \geq 5 \) consecutive beats if irregular rhythm.
- Avoid post-extrasystolic beats.

Mean gradient of 77 mmHg

Asecho.org
Patient selection

- Importance of EF and dobutamine stress echocardiography in definition of severe AS D2

\[
\begin{align*}
\text{AVA} & \leq 1.0 \text{ cm}^2 (\text{AVAi} \leq 0.6 \text{ cm}^2/\text{m}^2) \\
V_{\text{max}} & \geq 4 \text{ m/s or mean } \Delta P \geq 40 \text{ mm Hg}
\end{align*}
\]

- Low gradient AS

\[
\begin{align*}
\text{AVA} & \leq 1.0 \text{ cm}^2 (\text{AVAi} \leq 0.6 \text{ cm}^2/\text{m}^2) \\
V_{\text{max}} & < 4 \text{ m/s or mean } \Delta P < 40 \text{ mm Hg}
\end{align*}
\]

- Low LV EF < 50%

- Normal LVEF > 50%

- Stroke volume index < 35 mL/m²

- D1: Severe AS

- D2: Severe AS

- D3: Severe AS

DSE →

AVA ≤ 1.0 cm² with \( V_{\text{max}} \geq 4 \text{ m/s} \)
Patient selection

- Importance of accurate LVEF assessment in D2 vs D3 AS
  - ASE guideline recommends 3D if available and 2D EF by Simpson’s
  - EF by Biplane disk summation
  - EF by 3D volume data set
Patient selection

- Importance of EF and dobutamine stress echocardiography in definition of severe AS D2
  - low-flow/low-gradient AS with reduced LVEF

\[
\begin{align*}
\text{AVA} & \leq 1.0 \text{ cm}^2 (\text{AVA}_i \leq 0.6 \text{ cm}^2/\text{m}^2) \\
V_{\text{max}} & \geq 4 \text{ m/s or mean } \Delta P \geq 40 \text{ mm Hg}
\end{align*}
\]

D1
Severe AS

\[
\begin{align*}
\text{AVA} & \leq 1.0 \text{ cm}^2 (\text{AVA}_i \leq 0.6 \text{ cm}^2/\text{m}^2) \\
V_{\text{max}} & < 4 \text{ m/s or mean } \Delta P < 40 \text{ mm Hg}
\end{align*}
\]

D2
Severe AS

DSE \rightarrow
AVA \leq 1.0 \text{ cm}^2 \text{ with } V_{\text{max}} \geq 4 \text{ m/s}

D3
Severe AS

\[
\begin{align*}
\text{EF} & < 50 \% \\
\text{Stroke volume index} & < 35 \text{ mL/m}^2
\end{align*}
\]

Low gradient AS

\[
\begin{align*}
\text{EF} & > 50 \% \\
\text{Stroke volume index} & < 35 \text{ mL/m}^2
\end{align*}
\]
Patient selection

• Dob stress echo for low flow low gradient AS:
  • Start dob @ 2.5 – 5 to max 10 – 20 mg/kg/min
  • Stop infusion when
    – Positive result: AVA ≤ 1.0 cm² with V_{max} ≥ 4 m/s at any flow rate
    – HR 10 – 20 BPM over baseline
    – > 100 BPM
    – ↓BP
    – +Sx
    – + significant arrhythmia

• Doppler data recorded at each state

• LVOT diameter from baseline used for each stage
Patient selection

• Results from Low Dose Dobutamine Echo
  • An increase in effective AVA > 1.0 cm² → Not severe AS
  • AS jet velocity ≥ 4.0 m/s or MG > 30-40 mmHg and AVA < 1.0 cm² at any flow rate → severe AS
  • Absence of contractile reserve (failure to increase SV by 20%) is a predictor of high surgical mortality and poor long-term outcome
Patient selection

- Importance of stroke volume index in definition of severe AS D3
  - low-gradient AS with normal LVEF
  - paradoxical low-flow severe AS

AVA ≤ 1.0 cm² (AVAi ≤ 0.6 cm²/m²)
Vₘₐₓ ≥ 4 m/s or mean ΔP ≥ 40 mm Hg

Low gradient AS

AVA ≤ 1.0 cm² (AVAi ≤ 0.6 cm²/m²)
Vₘₐₓ < 4 m/s or mean ΔP < 40 mm Hg

EF < 50 %

EF > 50 %

DSE → AVA ≤ 1.0 cm² with Vₘₐₓ ≥ 4 m/s

Stroke volume index < 35 mL/m²

D1
Severe AS

D2
Severe AS

D3
Severe AS
Patient selection

- Stoke volume by echo
  - LVOT area × LVOT VIT

- EDV – ESV (by Simpson’s disk summation or by 3D)

- Stroke volume index = SV ÷ body surface area
Intra-procedural Guidance

- Evolution of Anesthesia & Echo Imaging for TAVR

<table>
<thead>
<tr>
<th>INITIAL TAVR EXPERIENCE</th>
<th>SUBSEQUENT TAVR EXPERIENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>General anesthesia</td>
<td>Moderate sedation</td>
</tr>
<tr>
<td>Endotracheal intubation</td>
<td>No endotracheal intubation</td>
</tr>
<tr>
<td>TEE guidance</td>
<td>TTE guidance</td>
</tr>
</tbody>
</table>
Intra-procedural Guidance

• TEE used
  • Supplement to pre-procedure CT data
  • Inadequate CT quality
  • CT not tolerated or contraindicated

• What to look for during TAVR on echo?
  • Guide position of transcatheter valve
  • TAVR Valve Function
  • Paravalvular Leak
  • Complications
## Summary of Intraprocedural Imaging Guidance

<table>
<thead>
<tr>
<th>Procedural Step</th>
<th>Imaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pacing wire position</td>
<td>1. Confirm wire in RV</td>
</tr>
<tr>
<td></td>
<td>2. Exclude perforation and PCE</td>
</tr>
<tr>
<td>Stiff wire position</td>
<td>1. Imaging wire position</td>
</tr>
<tr>
<td></td>
<td>2. Monitor mitral apparatus or possible worsening MR</td>
</tr>
<tr>
<td></td>
<td>3. Exclude perforation and PCE</td>
</tr>
<tr>
<td>BAV</td>
<td>1. Image during and immediately following BAV for aortic leaflet motion and AR</td>
</tr>
<tr>
<td></td>
<td>2. Image the coronary arteries (particularly the left main) for obstruction by the calcified leaflets.</td>
</tr>
<tr>
<td></td>
<td>3. Image the location of the displaced calcified leaflets for possible deformation of the aortic wall or risk for annular rupture.</td>
</tr>
<tr>
<td>Positioning transcatheter valve</td>
<td>1. Third generation balloon-expandable valve: outflow (i.e. distal or aortic) edge of the THV should cover the native leaflets while being below the STJ. Optimal final position covers the native leaflets.</td>
</tr>
<tr>
<td>Post-deployment</td>
<td>1. Assess stent positioning, shape, and leaflet motion; perform comprehensive hemodynamic measurements including effective orifice area.</td>
</tr>
<tr>
<td></td>
<td>a. New LVOT diameter can be the outer-to-outer stent diameter at the inflow edge if well positioned, or inner-to-inner stent diameter at the level of the leaflets if THV is too low.</td>
</tr>
<tr>
<td></td>
<td>b. Match the velocity-time integral for the location of the LVOT diameter measurement.</td>
</tr>
<tr>
<td></td>
<td>2. Assess paravalvular regurgitation relying on short-axis images of the LVOT just apical to the inflow edge of the THV (and gastric views for confirmation).</td>
</tr>
<tr>
<td></td>
<td>3. Assess coronary artery patency and ventricular function; confirm ventricular size and function are similar to baseline or improved.</td>
</tr>
<tr>
<td></td>
<td>5. Assess TR velocities and estimate pulmonary artery pressures.</td>
</tr>
<tr>
<td></td>
<td>6. Exclude perforation and pericardial effusion.</td>
</tr>
</tbody>
</table>

Adapted from  *J Am Coll Cardiol Img* 2015;8:261–87
Intraprocedural Guidance

• TEE to define anatomy
  • Confirm AS at valvular level
  • AV annulus area
  • Coronary ostium heights
  • Surrounding Ca^{2+}
Intraprocedural Guidance

- **AV annulus area**
  - Important for valve sizing
  - Automated 3D or multi-planar tracing
Intraprocedural Guidance

- **Coronary heights**
  - Automated 3D detection
  - SC2000 from Siemens
  - Off-axis 2D view
Intraprocedural Guidance

- Coronary ostia can be seen by withdrawing the probe above the AV leaflet level and appropriate angulation (yellow arrows)
- Biplane imaging to visualize long axis view

Adapted from J Am Coll Cardiol Img 2015;8:261–87
Balloon aortic valvuloplasty

- Performed before TAVR to increase cusp excursion and ensure adequate cardiac output during valve positioning
- After implant to expand the valve to reduce PVL
  - Capture balloon inflation by increasing the loop capture
  - Assess for potential complication
    - acute coronary occlusion, severe AR, and tamponade
  - Document that mobility of the cusps increased enough to facilitate valve positioning
Intraprocedural Guidance

- TEE helps guide position of the valve before deployment
  - Optimal position - the distal end of the crimped valve should cover the native leaflets but remain 1 to 2 mm below the sinotubular junction

- Capture deployment of the balloon-expandable valve
Post-implant Assessment

• Assess
  • valve position & shape
  • leaflet motion
  • gradients

• Color Doppler imaging -
  • presence, location, and severity of AR
  • coronary patency
  • mitral valve function

• In the setting of hemodynamic compromise –
  • LV/RV dysfunction
  • aortic root catastrophe
Post-implant Assessment

- Assessing transcatheter valve function
  - Assess position, shape, leaflet motion
  - Optimal circular shape
  - No excessive protrusion into LVOT
  - Assess and document normalized AV gradient
    - Typically via deep gastric view
- Assessing PVL
  - color Doppler imaging
    - Primary view: long-axis
    - Bi-plane to include short-axis views
    - Sweep LVOT to leaflet level in biplane
  - Look for paravalvular leak (PVL) just below the level of the stent and within the LVOT
Post-implant Assessment

- Small paravalvular jets following TAVR may spontaneously regress over 10 to 15 min and require no further intervention.
Moderate PVL is associated with increased mortality

- Moderate or severe paravalvular aortic regurgitation at 30 days had higher mortality during 2 years of follow-up than did patients who had no or trace or mild regurgitation (P<0.001)
Assessment of Paravalvular Regurgitation Following TAVR
A Proposal of Unifying Grading Scheme

Philippe Pibarot, DVM, PhD,* Rebecca T. Hahn, MD,† Neil J. Weissman, MD,‡ Mark J. Monaghan, PhD§
| TABLE 1: Scheme, Modalities, Parameters, and Criteria for Grading the Severity of PVR |
|---|---|---|---|---|---|---|---|
| 3-Class Grading Scheme | Trace | Mild | Mild-to-Moderate | Moderate | Moderate-to-Severe | Severe |
| Unifying 3-Class Grading Scheme | Trace | Mild | Mild-to-Moderate | Moderate | Moderate-to-Severe | Severe |
| Cretinography | Grade 1 | Grade 1 | Grade 1 | Grade 2 | Grade 3 | Grade 4 |
| Invasive hemodynamics | | | | | | |
| Aortic regurgitation index* | >25 | >25 | >25 | 10-25 | 10-25 | <10 |
| Doppler echocardiography | Structural parameters | Valve silent | Usually normal | Usually normal | Normal/abnormal | Usually abnormal | Usually abnormal |
| LV size | Normal | Normal | Normal/mildly dilated | Mildly/moderately dilated | Moderately/severely dilated |
| Doppler parameters (qualitative or semiquantitative) | Jet features | Absent | Absent | Absent | Absent | Absent | Absent |
| Multiple jets | Possible | Possible | Often present | Often present | Usually present | Usually present |
| Jet path visible along the aorta | Absent | Absent | Possible | Possible | Often present | Often present |
| Proximal flow convergence visible | Absent | Absent | Possible | Possible | (often present) | Often present |
| Ventral contracts width (mm): color Doppler | <2 | <2 | 2-4 | 4-5 | 5-6 | >6 |
| Ventral contracts area (mm²): 2D/3D color Doppler† | <5 | 5-10 | 10-20 | 20-30 | 30-40 | >40 |
| Jet width at its origin (%LVOT diameter) | Narrow (<5) | Narrow (5-15) | Intermediate (15-30) | Intermediate (30-45) | Large (45-60) | Large (>60) |
| color Doppler | | | | | | |
| Jet density: CW Doppler | Incomplete or faint | Incomplete or faint | Variable | Dense | Variable (200-500) | Dense |
| Decleration rate (PHT, mm): CW Doppler‡ | Slow (<50%) | Slow (<50%) | Variable (50-200) | Dense | Variable (200-500) | Dense |
| Diastolic flow reversal in the descending aorta: PW Doppler‡ | Absent | Absent or brief early diastolic | Intermediate | Dense | Holodiastolic (end-diast. Vel. >20 cm/s) | Holodiastolic (end-diast. Vel. >25 cm/s) |
| Circumferential extent of PVR (%): color Doppler | <10 | <10 | 10-20 | 20-30 | >30 | >30 |
| Doppler parameters (quantitative) | Regurgitant volume (mL/bst)* | <15 | <15 | 15-30 | 30-45 | 45-60 | >60 |
| Regurgitant fraction (%) | <15 | <15 | 15-30 | 30-45 | 45-60 | >60 |
| Effective regurgitant orifice area (mm²)** | <5 | <5 | 5-10 | 10-20 | 20-30 | >20 |
| Cardiac magnetic resonance imaging | Regurgitant fraction (%) | <10 | <10 | 10-20 | 20-30 | 25-50 | >50 |

* Parameters that are less often applicable due to pitfalls in the feasibility of the measurements and/or to the interaction with other factors. Online Values 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36 provide Doppler color images (parasternal short- and long-axis, apical 4-chamber view) of representative cases for each class (except none and severe PVR) of the unifying 3-class grading scheme proposed in this table. These parameters are influenced by LV and aortic compliance. In particular, low transvalvular and diastolic aorta to LV pressure gradient gradients and LV diastolic dysfunction may lead to false-positive results. The high dependency of diastolic flow reversal on aortic compliance considerably limits the utility of this parameter in the elderly population undergoing TAVR. These parameters are also influenced by echocardiography. Abnormalities of sinotubular position (too low or too high), deployment, and outflow tract. Mapping to chronic PVR but is less reliable for periprosthetic or early post-prosthetic assessment. (See Figure B for illustrative images. These parameters are generally assessed visually. The ventral contract area is measured by planimetry of the ventral contract area of the jets) on 2D or 3D color Doppler images in the short-axis view (Figure B). Regurgitant volume is calculated as the difference of stroke volume measured in the LV outflow tract minus the stroke volume measured in the right ventricular outflow tract (see Figure 10). The effective regurgitant orifice area is calculated by dividing the regurgitant volume by the time-volume integral of the AV flow by CW Doppler. There are important variations in the contour values of regurgitant fraction and volume reported in the published studies due to grade AV by cardiac magnetic resonance imaging.

**"2D" = 2-dimensional; "1D" = 1-dimensional; "AR" = aortic regurgitation; "CW" = continuous wave; end-vent. vel. = end-diastolic velocity; LV = left ventricular; LVOT = left ventricular outflow tract; PHT = pressure half-time; PVR = paravalvular regurgitation; PW = pulsed wave; RV = right ventricular; TAVR = transcatheter aortic valve replacement.
## TEE Color Doppler Views for the Assessment of PVR

<table>
<thead>
<tr>
<th>Circumferential extent of PVR (%)</th>
<th>Trace</th>
<th>Mild</th>
<th>Mild-to-Moderate</th>
<th>Moderate</th>
<th>Moderate-to-Severe</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Color Doppler</td>
<td>&lt;10</td>
<td>&lt;10</td>
<td>10–20</td>
<td>20–30</td>
<td>&gt;30</td>
<td>&gt;30</td>
</tr>
</tbody>
</table>

---

*J Am Coll Cardiol Img 2015;8:340–60*
Circumferential Extent of PVR Severity by TTE

**Figure 6** Circumferential Extent of the PVR for Assessment of Regurgitation Severity

- **A** Trace
- **B** Mild
- **C** Mild to Moderate
- **D** Mild to Moderate
- **E** Moderate
- **F** Moderate to severe

J Am Coll Cardiol Img 2015;8:340–60
Cineangiography/TEE/TTE after THV Deployment

- No AR
  - Trace
  - Mild
  - Mild-to-Moderate
    - Presence of vulnerability factors to AR†
    - Absence of high risk features/ low likelihood of success with corrective procedures‡
      - No More Procedures
      - Yes: Corrective Procedures
        - Balloon post-dilation
        - Valve-in-valve
        - Closure of the leak with a plug
      - Reassess
  - Moderate
    - Corrective Procedures
  - Moderate-to-Severe
    - Corrective Procedures
  - Severe
    - Corrective Procedures
Any Degree of AR

J Am Coll Cardiol Img 2015;8:340–60
Post-implant Assessment

• Complications of TAVR
  • Acute changes in BP or increase in PAPs
  • Check for AR, MR, LV function, PCE
  • Major bleeding → underfilling of the ventricle
  • Pericardial effusions
    • may indicate localized bleeding, aortic catastrophe or RV perforation by the temporary pacing wire
    • Many TAVR patients have small, hypertrophied, and “stiff” ventricles → even small effusions tolerated poorly
Summary

• Appropriate patient selection
  • Be accurate about determining AS severity
  • D2 AS: LFLG AS w reduced EF → dob echo
  • D3 AS: LFLG AS w normal EF → SVI ≤ 34 ml/m²

• Pre-procedure planning
  • Associated unfavorable anatomy
  • Valve sizing: AV annulus area (TEE)

• Intraprocedural guidance by TEE
  • Positioning of valve
  • Assessing for potential complications and/or hemodynamic changes
    • MV function
    • PCE

• PVL assessment - Circumferential extent of PVR less than 20 %
Thank you for your attention!