Valvular Heart Disease
Review and Update

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Cath Lab Director
Altru Health System

Overview

The new staging system of valvular heart disease
Aortic valve stenosis
Transcatheter aortic valve replacement (TAVR)
Mitral valve regurgitation
Transcatheter mitral valve repair (TMVR)

Overview

Valvular heart disease is increasing in prevalence due to the aging population
A detailed history and physical exam are essential in diagnosing, staging and treating valvular disease
There has been great change in the field with new surgical and interventional procedures and new guidelines

The New Staging System of Valvular Disease

<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 factors for the development of VHD</td>
</tr>
<tr>
<td>B</td>
<td>Progressive</td>
<td>Patients with progressive VHD (mild-to-moderate severity and asymptomatic)</td>
</tr>
</tbody>
</table>
| C     | Asymptomatic severe | Asymptomatic patients who have reached the criteria for severe VHD  
C1: Asymptomatic patients with severe VHD in whom the left or right ventricle remains compensated  
C2: Asymptomatic patients who have severe VHD, with decompensation of the left or right ventricle |
| D     | Symptomatic severe | Patients who have developed symptoms as a result of VHD |
Aortic Stenosis

The Normal Aortic valve
- Complex structure with remarkable durability
- 3 cusps of equal size, each surrounded by a sinus
- Cusps are crescent and open fully
- The free edges curve upward and at the tip form the Arantius nodules

Etiology
- Calcific aortic stenosis of a tricuspid valve
- Bicuspid or unicuspid valves
- Rheumatic valve disease
- Rare causes such as Fabry’s disease, Paget disease...

Calcific Aortic Stenosis
- Most common in the US
- Progresses from base to tip of the leaflet
- No commissural fusion
- Active disease process inflammation, lipid accumulation and calcification
- Similar to atherosclerosis with significant differences
- More often and earlier in ESRD
Bicuspid Aortic Valve

- Most common congenital heart anomaly (1-2% of the general population)
- Younger pts
- May be associated with aortic root pathology or aortic coarctation
- Usually normal function at birth and then causes AS or AR due to scarring and calcification

Rheumatic AS

- Not common in the US
- Most common etiology worldwide
- Commissural fusion with scarring and then calcification
- Almost always associated with MV disease

Symptoms

- Prolonged asymptomatic period
- Symptoms are rare until severe AS is present
- The classic triad is angina, syncope or dizziness, and heart failure or dyspnea
- SYMPTOMS SHOULD BE EXERTIONAL
- Even mild cardiac symptoms should trigger prompt intervention due to poor survival otherwise

Pathophysiology

Survival in Symptomatic Patients
Symptoms

- Exertional dyspnea is the most common symptom
  - Diastolic dysfunction
  - Inability to increase cardiac output
  - Overt heart failure is a late presentation

- Syncope reflects decreased cerebral perfusion with exertion

- Angina occurs in two-thirds of pts with severe AS
  - Half of them have CAD
  - Myocardial ischemia due to LVH and reduced coronary flow

- Sudden cardiac death
  - 0-5% in asymptomatic, 8-34% in symptomatic pts
  - Unclear etiology (possibly arrhythmic)
  - AVR reduces risk

- AF
  - Uncommon in isolated AS
  - May occur with HF
  - Not well tolerated in severe AS

- Bleeding tendency
due to acquired VW syndrome
  - Worse with severe AS

Physical Examination

- Pulsus parvus et tardus
  - Reduced in amplitude
  - Delayed

- S2 soft, single or paradoxically split

- S4 can be heard

- Systolic ejection murmur
  - Second right intercostal space
  - Radiates to the carotid arteries
  - A loud murmur is specific for severe AS
  - But not sensitive
  - Late-peaking murmur predicts severe AS

Echocardiography

- The gold standard for diagnosis and severity

- 2D, spectral Doppler and color Doppler

- Good leaflet movement on 2D virtually rules out significant AS

- Valve morphology, LVH, LA size, ascending aorta

- Color Doppler shows turbulence, associated AR

- Spectral Doppler measures flow velocity, gradients, and aortic valve area

- Pulmonary artery pressure

- May underestimate severity if not well done

Severity of Aortic Stenosis

<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>less than 3.0</td>
<td>3.0 – 4.0</td>
<td>greater than 4.0</td>
</tr>
<tr>
<td>Mean Gradient (mmHg)</td>
<td>less than 25</td>
<td>25 – 40</td>
<td>greater than 40</td>
</tr>
<tr>
<td>Valve area (cm²)</td>
<td>greater than 1.5</td>
<td>1.0 – 1.5</td>
<td>less than 1.0</td>
</tr>
<tr>
<td>Valve area index (cm² per m²)</td>
<td>less than 0.6</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AS During Cardiac Cath
### Aortic Stenosis: Diagnosis and Follow-Up

**Recommendations**

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Valve Anatomy</th>
<th>Valve Hemodynamics</th>
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<tbody>
<tr>
<td>A</td>
<td>AS risk</td>
<td>Bicuspid aortic valve (or other congenital anomaly)</td>
<td>Aortic V_max ≤ 2 m/s</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>B</td>
<td>Progressive AS</td>
<td>Valvular aortic stenosis or calcification of a bicuspid or trileaflet valve with some reduction in systolic motion or rheumatic valve changes with commissural fusion</td>
<td>Aortic V_max ≥ 2.0 m/s or mean AVP ≥ 40 mm Hg</td>
<td>Early LV diastolic dysfunction may be present</td>
<td>None</td>
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<tr>
<td>C</td>
<td>Symptomatic severe AS</td>
<td>Severe valvular aortic stenosis or calcification of severe AS with severely reduced leaflet motion</td>
<td>Aortic V_max ≥ 4.0 m/s or mean AVP ≥ 60 mm Hg</td>
<td>LV diastolic dysfunction may be present</td>
<td>None</td>
</tr>
</tbody>
</table>

**Consequences**

- **Hemodynamic**:
  - Stroke volume.
  - Indexed AVA.

- **Symptoms**:
  - None.

**Notes**

- Exercise testing should not be performed in symptomatic patients with AS when the aortic velocity is ≥ 4.0 m per second or greater or mean pressure gradient is ≥ 40 mm Hg or higher (stage D).

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### Stages of Valvular Aortic Stenosis

**Stages**

- **Stage A**: Risk of AS
  - Bicuspid aortic valve (or other congenital anomaly)
  - Aortic valve
  - Aortic V_max ≤ 2 m/s

- **Stage B**: Progressive AS
  - Valvular aortic stenosis or calcification of a bicuspid or trileaflet valve with some reduction in systolic motion or rheumatic valve changes with commissural fusion
  - Aortic V_max ≥ 2.0 m/s or mean AVP ≥ 40 mm Hg

- **Stage C**: Symptomatic severe AS
  - Severe valvular aortic stenosis or calcification of severe AS with severely reduced leaflet motion
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Surgical AVR

- Surgery improves symptoms and prolongs survival
- Average mortality risk of 3-5% for AVR alone and about 5-7% for AVR+CABG
- Reduces the risk of SCD
- Surgical outcomes are worse with low EF and in pts with several co-morbidities
- The timing of surgery in truly asymptomatic pts with severe AS is still controversial

Aortic Stenosis: Timing of Intervention

<table>
<thead>
<tr>
<th>Recommendations</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AVR is recommended with severe high-gradient AS who have symptoms by history or on exercise testing (stage D1)</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>AVR is recommended for asymptomatic patients with severe AS (stage C2) and LVEF &lt;50%</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>AVR is indicated for patients with severe AS (stage C or D) when undergoing other cardiac surgery</td>
<td>I</td>
<td>B</td>
</tr>
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</table>

Aortic Stenosis: Timing of Intervention (cont.)

<table>
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<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>AVR is reasonable for asymptomatic patients with very severe AS (stage C1, aortic velocity ≥5 m/s) and low surgical risk</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>AVR is reasonable in asymptomatic patients with severe AS and decreased exercise tolerance or an exercise fall in BP</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>AVR is reasonable in symptomatic patients with low-flow/low-gradient severe AS with reduced LVEF (stage D2) with a low-dose dobutamine stress study that shows an aortic velocity ≥4 m/s (or mean pressure gradient ≥40 mm Hg) with a valve area ≤1.0 cm² at any dobutamine dose</td>
<td>IIa</td>
<td>B</td>
</tr>
</tbody>
</table>

TAVR

- Extremely promising
- Developed to offer an option for pts with symptomatic severe AS who are not candidates for surgery
- Multiple approaches studied but most important are:
  - Transfemoral
  - Transapical
  - Subclavian
  - Direct aortic route
Balloon Expandable Valve

SAPIEN valve made by Edwards
Balloon expandable
FDA approved in November of 2011

The Procedure

Self-Expandable Valve

The CoreValve made by Medtronic
Self-expanding valve
FDA Approved
Has the potential for smaller catheter size and repositioning

The PARTNER Trial

- The pivotal clinical study in the US to gain FDA approval
- Randomized controlled multi-center study
- PARTNER cohort B compared TAVR using the SAPIEN valve vs medical therapy
- 358 patients were randomized in 25 centers

Partner Cohort B Outcomes
Partner Cohort A Trial Design

Challenges
- Exact placement of the valve is essential
- Vascular complications
- AV block requiring pacing
- Paravalvular leak and AR
- Peripheral vascular disease
- The risk of CVA

Aortic Stenosis: Choice of Surgical or Transcatheter Intervention

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<thead>
<tr>
<th>Recommendations</th>
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<th>LOE</th>
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</thead>
<tbody>
<tr>
<td>TAVR is recommended in patients who meet an indication for AVR (listed in Section 3.4) with low or intermediate surgical risk</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>For patients in whom TAVR or high-risk surgical AVR is being considered, members of a Heart Valve Team should collaborate closely to provide optimal patient care</td>
<td>I</td>
<td>C</td>
</tr>
<tr>
<td>TAVR is recommended in patients who meet an indication for AVR for AS who have a prohibitive surgical risk and a predicted post-TAVR survival &gt;12 months</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
</table>

In Conclusion
- Aortic stenosis is very common and is associated with high morbidity and mortality if not treated
- Close follow up of asymptomatic patients is essential to decide timing of surgery
- Echocardiography with Doppler is sufficient in most cases to diagnose and assess the severity of AS
- Surgical AVR is the most effective treatment and is still the gold standard for most patients
- TAVR is a promising treatment for the growing group of pts with severe symptomatic AS who are ineligible or very high risk for surgery
Mitral Regurgitation

Prevalence
- The second most common valvular lesion after AS
- Trivial "physiologic MR" can be detected by echo in up to 70% of healthy adults
- Moderate MR was present in 2%
- Severe MR present in 0.2% in the Strong Heart Study

Etiology
- Primary MR
  - Mitral valve prolapse
  - Rheumatic
  - Endocarditis
  - Congenital
- Secondary MR
  - Ischemic heart disease
  - Functional (secondary to dilated cardiomyopathy)
  - HOCM

Mitral Valve Prolapse
- Most common cause of primary MR
- Myxomatous valve (redundancy of leaflets and chordae)
- ≥2 mm of billowing above the mitral valve annulus
- Prevalence of 0.6-2.4%
- Increased incidence of chord rupture and flail leaflet

Ischemic Mitral Regurgitation
- Most common cause of secondary MR
- Occurs in patients with prior MI, especially inferior MI
- Gets worse with adverse LV remodeling and dilatation
- The mechanism is tethering or tenting of the leaflets caused by papillary muscle displacement
**Functional Mitral Regurgitation**

- Annular enlargement caused by LV dilatation
- Most pts with dilated cardiomyopathy have some degree of MR
- Severity is a predictor of mortality in pts with cardiomyopathy
- Contributes to symptoms in pts with cardiomyopathy

**Symptoms**

- Pts with mild or moderate MR are asymptomatic
- Many pts with severe MR are asymptomatic
- Symptoms are caused by LV dilatation and dysfunction, pulmonary hypertension, or atrial fibrillation
- Dyspnea and fatigue are most common
- Heart failure symptoms eventually develop
- Palpitations due to AF

**Physical Examination**

- Mostly holosystolic murmur at the apex (late systolic in MVP)
- Radiation can be to the axilla or the left sternal border depending on direction of the MR jet
- S1 can be diminished due to malcoaptation
- Widely split S2 can be present with pulmonary hypertension
- S3 can be heard with LV dilatation and failure

**Chronic Primary Mitral Regurgitation: Diagnosis and Follow-Up**

<table>
<thead>
<tr>
<th>Recommendations</th>
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<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTE is indicated to establish the anatomic basis for chronic primary MR (stages C and D) and to guide repair</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Exercise hemodynamics with either Doppler echocardiography or cardiac catheterization is reasonable in symptomatic patients with chronic primary MR where there is a discrepancy between symptoms and the severity of MR at rest (stages B and C)</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>Exercise treadmill testing can be useful in patients with chronic primary MR to establish symptom status and exercise tolerance (stages B and C)</td>
<td>IIa</td>
<td>C</td>
</tr>
</tbody>
</table>
### Stages of Primary Mitral Regurgitation

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Valve Anatomy</th>
<th>Valve Hemodynamics</th>
<th>Hemodynamic Consequences</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At-risk MR</td>
<td>Severe valve prolapse with basal coaptation</td>
<td>No MR jet or small jet</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>B</td>
<td>Progressive MR</td>
<td>Progressive valve prolapse with basal coaptation</td>
<td>Central jet MR 40% LA or 50% RV</td>
<td>Mitral valve enlargement</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rheumatic valve changes with leaflet restriction and loss of central coaptation</td>
<td>Regurgitant volume ≥400 ml</td>
<td>Pulmonary hypertension may be present at rest or with exercise</td>
<td>Mitral valve disease with LV dysfunction</td>
</tr>
</tbody>
</table>

### Stages of Primary Mitral Regurgitation (cont.)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
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</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Asymptomatic severe MR</td>
<td>Severe valve prolapse with basal coaptation</td>
<td>Central jet MR ≤40% LA or 50% RV</td>
<td>Mitral valve enlargement</td>
<td>Moderate mitral valve disease with LV dysfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rheumatic valve changes with leaflet restriction and loss of central coaptation</td>
<td>Regurgitant volume ≥400 ml</td>
<td>Pulmonary hypertension may be present at rest or with exercise</td>
<td>Mitral valve disease with LV dysfunction</td>
</tr>
</tbody>
</table>

### Stages of Secondary Mitral Regurgitation

<table>
<thead>
<tr>
<th>Stage</th>
<th>Definition</th>
<th>Valve Anatomy</th>
<th>Valve Hemodynamics</th>
<th>Associated Cardiac Findings</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>At-risk MR</td>
<td>Regional wall motion abnormalities with or without coaptation loss</td>
<td>ERO &lt;0.40 cm</td>
<td>Mitral valve annular dilatation</td>
<td>Mitral valve disease with LV dysfunction</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Regional wall motion abnormalities with severe loss of coaptation</td>
<td>ERO &lt;0.40 cm</td>
<td>Mitral valve annular dilatation</td>
<td>Mitral valve disease with LV dysfunction</td>
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<tr>
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<td>Mitral valve annular dilatation</td>
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### Symptoms of Mitral Regurgitation

- Exertional dyspnea
- Paroxysmal nocturnal dyspnea
- Orthopnea
- Cough
- Systolic murmur

### Associated Cardiac Findings

- Left atrial enlargement
- Mitral valve annular dilatation
- Mitral valve leaflet dysfunction

### Hemodynamic Consequences

- Mitral valve regurgitation
- Left ventricular systolic dysfunction
- Left atrial hypertension
**Chronic Primary Mitral Regurgitation: Intervention**

**Recommendations**

<table>
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<tr>
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<tbody>
<tr>
<td>MV surgery is recommended for symptomatic patients with chronic severe primary MR (stage D) and LVEF &gt;30%</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>MV surgery is recommended for asymptomatic patients with chronic severe primary MR and LV dysfunction (LVEF 30%–60% and/or LVESD ≥40 mm, stage C2)</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>MV repair is recommended in preference to MVR when surgical treatment is indicated for patients with chronic severe primary MR limited to the posterior leaflet</td>
<td>I</td>
<td>B</td>
</tr>
</tbody>
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**Chronic Primary Mitral Regurgitation: Intervention (cont.)**

**Recommendations**

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<tbody>
<tr>
<td>MV repair is recommended in preference to MVR when surgical treatment is indicated for patients with chronic severe primary MR involving the anterior leaflet or both leaflets when a successful and durable repair can be accomplished</td>
<td>I</td>
<td>B</td>
</tr>
<tr>
<td>Concomitant MV repair or replacement is indicated in patients with chronic severe primary MR undergoing other cardiac surgery</td>
<td>I</td>
<td>B</td>
</tr>
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<tr>
<td>MV repair is reasonable in asymptomatic patients with chronic severe nonrheumatic primary MR (stage C1) and preserved LV function in whom there is a high likelihood of a successful and durable repair with 1) new onset of AF or 2) resting pulmonary hypertension (PA systolic arterial pressure &gt;50 mm Hg)</td>
<td>IIa</td>
<td>B</td>
</tr>
<tr>
<td>Concomitant MV repair is reasonable in patients with chronic moderate primary MR (stage B) undergoing other cardiac surgery</td>
<td>IIa</td>
<td>C</td>
</tr>
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**Chronic Secondary Mitral Regurgitation: Medical Therapy**

**Recommendations**

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<tr>
<td>Patients with chronic secondary MR (stages B to D) and HF with reduced LVEF should receive standard GDMT therapy for HF, including ACE inhibitors, ARBs, beta blockers, and/or aldosterone antagonists as indicated</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Noninvasive imaging (stress nuclear/postron emission tomography, CMR, or stress echocardiography), cardiac CT angiography, or cardiac catheterization, including coronary angiography, is useful to establish etiology of chronic secondary MR (stages B to D) and/or to assess myocardial viability, which in turn may influence management of functional MR</td>
<td>I</td>
<td>A</td>
</tr>
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Chronic Severe Secondary Mitral Regurgitation: Intervention

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<tbody>
<tr>
<td>MV surgery is reasonable for patients with chronic severe secondary MR (stages C and D) who are undergoing CABG or AVR</td>
<td>IIa</td>
<td>C</td>
</tr>
<tr>
<td>MV surgery may be considered for severely symptomatic patients (NYHA class III-IV) with chronic severe secondary MR (stage D)</td>
<td>IIb</td>
<td>B</td>
</tr>
<tr>
<td>MV repair may be considered for patients with chronic moderate secondary MR (stage B) who are undergoing other cardiac surgery</td>
<td>IIb</td>
<td>C</td>
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Indications for Surgery for Mitral Regurgitation

Transcatheter Mitral Valve Repair
MitraClip System

Procedure
- Cath lab procedure done under fluoroscopic and TEE guidance
- Usually done under general anesthesia
- Access through the femoral vein
- Trans-septal puncture
- The catheter is then advanced into the LA and steered under TEE guidance to LV and then to grasp the leaflets
- Sometimes more than one clip is needed

Indication
- Severe symptomatic (NYHA Class III or IV) heart failure despite medical therapy
- Chronic severe primary MR
- Favorable anatomy for the repair procedure
- Reasonable life expectancy
- Prohibitive surgical risk due to comorbidities

Outcomes
The EVEREST II Trial
Results
- Similar mortality at 1 year between TMVR and MV surgery (6%)
- Similar rates of +3 or +4 MR at 1 year between the 2 groups (20 vs. 21%)
- Similar rates of mortality and significant MR at 4 years
- At 4 years, MTVR was associated with higher rates of surgery for MV dysfunction (24.8 vs. 5.5%)

Outcomes
- Other studies showed improvements in MR severity
- LV and LA volumes
- Quality of life
- Exercise capacity
- Observational studies suggest that TMVR can reduce MR and improve symptoms in pts with secondary MR

Conclusion
- MR is a common and very complex valvular lesion that can be a primary valve lesion or complicate CAD or dilated cardiomyopathy
- Secondary MR worsens ischemic and dilated cardiomyopathy and can be very difficult to treat
- TTE and TEE are the gold standards for diagnosis and evaluation of severity
- MV surgery, preferably repair is the most effective treatment for primary MR
- TMVR is a promising treatment for pts with primary or secondary MR who have appropriate anatomy and are deemed at high surgical risk

Thank you

Questions???