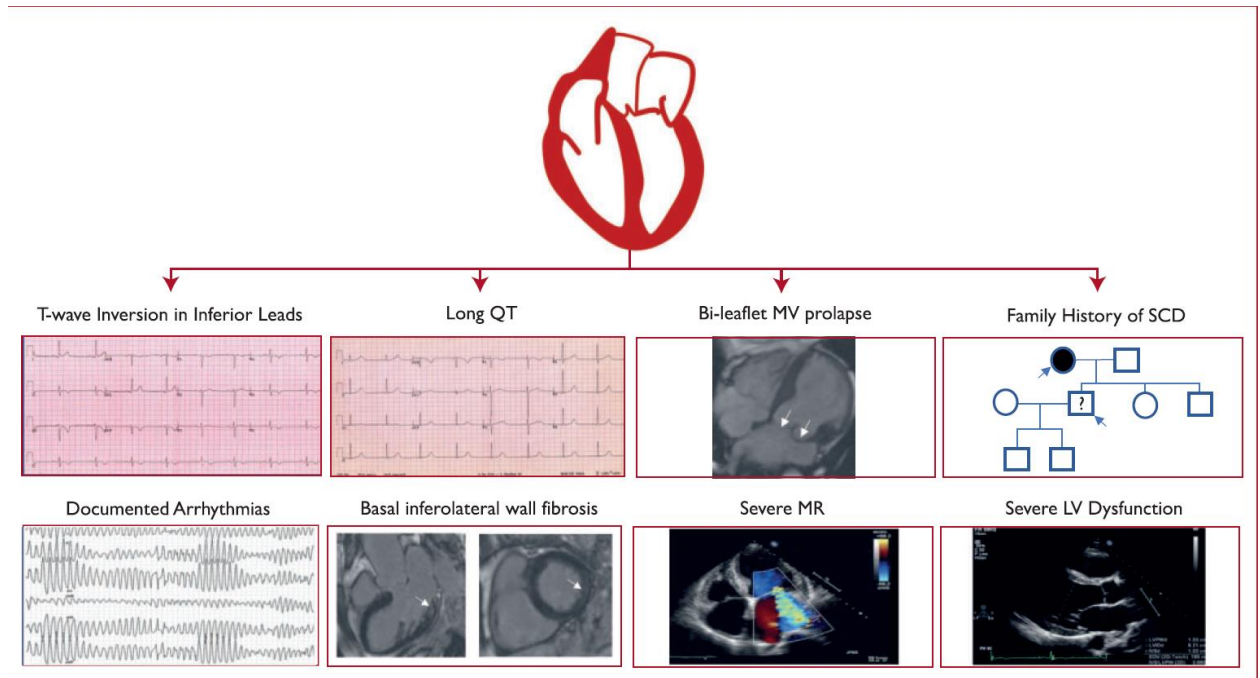




**Figure 1. ESC 2020 GL on Sports.** Specific markers of increased risk of sudden cardiac death (SCD) with mitral valve prolapse.

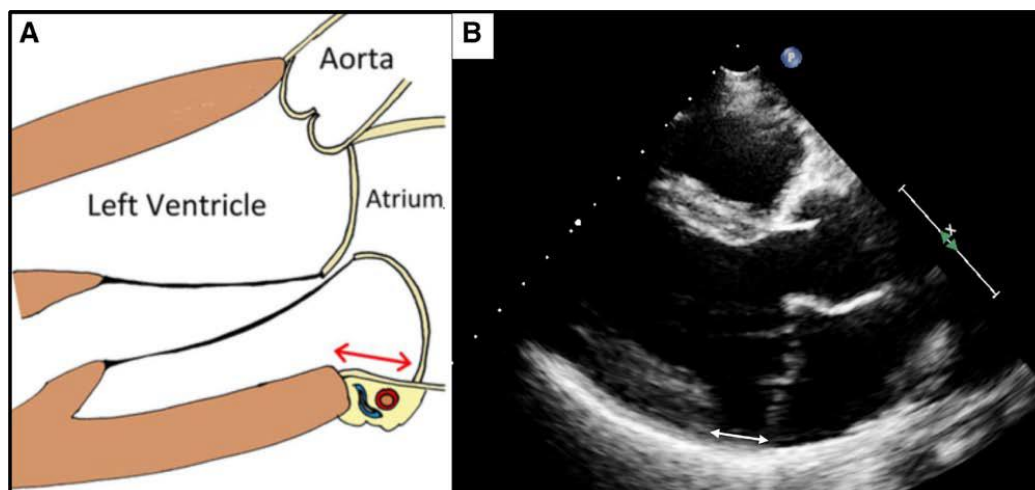
LV = left ventricular; MR = mitral regurgitation; MV = mitral valve

**Table 1. MIDA-Q Score Calculation**

| Characteristic                                                                            | No. of points |
|-------------------------------------------------------------------------------------------|---------------|
| Age $\geq 65$ y                                                                           | 3             |
| New York Heart Association $\geq$ III                                                     | 3             |
| Atrial fibrillation                                                                       | 1             |
| Left atrium volume index $\geq 60$ mL/m <sup>2</sup> or left atrial diameter $\geq 55$ mm | 1             |
| Systolic pulmonary artery pressure $\geq 50$ mm Hg                                        | 2             |
| Left ventricular end-systolic diameter $\geq 40$ mm                                       | 1             |
| Left ventricular ejection fraction $< 60\%$                                               | 1             |
| Effective regurgitant orifice, mm <sup>2</sup>                                            |               |
| <20                                                                                       | 0             |
| 20–40                                                                                     | 1             |
| 40–60                                                                                     | 2             |
| >60                                                                                       | 3             |

MIDA-Q indicates Mitral Regurgitation International Database Quantitative.

Essayagh B, et al. The MIDA-Q Mortality Risk Score: A Quantitative Prognostic Tool for the Mitral Valve Prolapse Spectrum. *Circulation*. 2023;147:798-811.



**Figure 2. Measurement of MAD.**

**A**, Schematic representation of transthoracic echocardiography, parasternal long axis view: the length of MAD is measured from the left atrial wall–MV posterior leaflet junction to the top of the LV posterior wall during end-systole (double-headed arrow).

**B**, Two-dimensional transthoracic echocardiography, parasternal long-axis view, showing a bileaflet MVP and posterior MAD (white line) measured during end-systole.

Basso C, et al. Mitral Valve Prolapse, Ventricular Arrhythmias, and Sudden Death. *Circulation*. 2019;140:952-964.

Table 2. ACC/AHA 2020 GL on VHD. Stages of Chronic MR

| Stage | Definition             | Valve Anatomy                                                                                                                                                                                                                                                                                   | Valve Hemodynamics *                                                                                                                                                                                                                                                                                   | Hemodynamic Consequences                                                                                                                                                                                                                                                     | Symptoms                                                                                                   |
|-------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| A     | At risk of MR          | <ul style="list-style-type: none"> <li>Mild mitral valve prolapse with normal coaptation</li> <li>Mild valve thickening and leaflet restriction</li> </ul>                                                                                                                                      | <ul style="list-style-type: none"> <li>No MR jet or small central jet area &lt;20% LA on Doppler</li> <li>Small vena contracta &lt;0.3 cm</li> </ul>                                                                                                                                                   | <ul style="list-style-type: none"> <li>None</li> </ul>                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>None</li> </ul>                                                     |
| B     | Progressive MR         | <ul style="list-style-type: none"> <li>Moderate to severe mitral valve prolapse with normal coaptation</li> <li>Rheumatic valve changes with leaflet restriction and loss of central coaptation</li> <li>Prior IE</li> </ul>                                                                    | <ul style="list-style-type: none"> <li>Central jet MR 20%-40% LA or late systolic eccentric jet MR</li> <li>Vena contracta &lt;0.7 cm</li> <li>Regurgitant volume &lt;60 mL</li> <li>Regurgitant fraction &lt;50%</li> <li>ERO &lt;0.40 cm<sup>2</sup></li> <li>Angiographic grade 1+ to 2+</li> </ul> | <ul style="list-style-type: none"> <li>Mild LA enlargement</li> <li>No LV enlargement</li> <li>Normal pulmonary pressure</li> </ul>                                                                                                                                          | <ul style="list-style-type: none"> <li>None</li> </ul>                                                     |
| C     | Asymptomatic severe MR | <ul style="list-style-type: none"> <li>Severe mitral valve prolapse with loss of coaptation or flail leaflet</li> <li>Rheumatic valve changes with leaflet restriction and loss of central coaptation</li> <li>Prior IE</li> <li>Thickening of leaflets with radiation heart disease</li> </ul> | <ul style="list-style-type: none"> <li>Central jet MR &gt;40% LA or holosystolic eccentric jet MR</li> <li>Vena contracta ≥0.7 cm</li> <li>Regurgitant volume ≥60 mL</li> <li>Regurgitant fraction ≥50%</li> <li>ERO ≥0.40 cm<sup>2</sup></li> <li>Angiographic grade 3+ to 4+</li> </ul>              | <ul style="list-style-type: none"> <li>Moderate or severe LA enlargement</li> <li>LV enlargement</li> <li>Pulmonary hypertension may be present at rest or with exercise</li> <li>C1: LVEF &gt;60% and LVESD &lt;40 mm</li> <li>C2: LVEF ≤60% and/or LVESD ≥40 mm</li> </ul> | <ul style="list-style-type: none"> <li>None</li> </ul>                                                     |
| D     | Symptomatic severe MR  | <ul style="list-style-type: none"> <li>Severe mitral valve prolapse with loss of coaptation or flail leaflet</li> <li>Rheumatic valve changes with leaflet restriction and loss of central coaptation</li> <li>Prior IE</li> <li>Thickening of leaflets with radiation heart disease</li> </ul> | <ul style="list-style-type: none"> <li>Central jet MR &gt;40% LA or holosystolic eccentric jet MR</li> <li>Vena contracta ≥0.7 cm</li> <li>Regurgitant volume ≥60 mL</li> <li>Regurgitant fraction ≥50%</li> <li>ERO ≥0.40 cm<sup>2</sup></li> <li>Angiographic grade 3+ to 4+</li> </ul>              | <ul style="list-style-type: none"> <li>Moderate or severe LA enlargement</li> <li>LV enlargement</li> <li>Pulmonary hypertension present</li> </ul>                                                                                                                          | <ul style="list-style-type: none"> <li>Decreased exercise tolerance</li> <li>Exertional dyspnea</li> </ul> |

\*Several valve hemodynamic criteria are provided for assessment of MR severity, but not all criteria for each category will be present in each patient. Categorization of MR severity as mild, moderate, or severe depends on data quality and integration of these parameters in conjunction with other clinical evidence.

ERO indicates effective regurgitant orifice; IE, infective endocarditis; LA, left atrium/atrial; LV, left ventricular; LVEF, left ventricular ejection fraction; LVESD; left ventricular endsystolic dimension; and MR, mitral regurgitation.

Table 3. ACC/AHA 2020 GL on VHD. Stages of Secondary MR

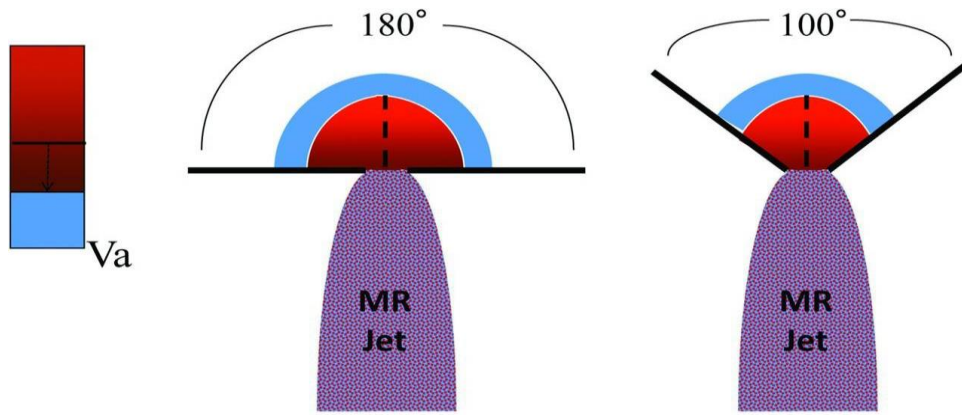
| Stage | Definition             | Valve Anatomy                                                                                                                                                                                                                           | Valve Hemodynamics*                                                                                                                                        | Associated Cardiac Findings                                                                                                                                                                                                                         | Symptoms                                                                                                                                                                                                                    |
|-------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A     | At risk of MR          | <ul style="list-style-type: none"> <li>Normal valve leaflets, chords, and annulus in a patient with CAD or cardiomyopathy</li> </ul>                                                                                                    | <ul style="list-style-type: none"> <li>No MR jet or small central jet area &lt;20% LA on Doppler</li> <li>Small vena contracta &lt;0.30 cm</li> </ul>      | <ul style="list-style-type: none"> <li>Normal or mildly dilated LV size with fixed (infarction) or inducible (ischemia) regional wall motion abnormalities</li> <li>Primary myocardial disease with LV dilation and systolic dysfunction</li> </ul> | <ul style="list-style-type: none"> <li>Symptoms attributable to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy</li> </ul>                                         |
| B     | Progressive MR         | <ul style="list-style-type: none"> <li>Regional wall motion abnormalities with mild tethering of mitral leaflet</li> <li>Annular dilation with mild loss of central coaptation of the mitral leaflets</li> </ul>                        | <ul style="list-style-type: none"> <li>ERO &lt;0.40 cm<sup>2</sup>†</li> <li>Regurgitant volume &lt;60 mL</li> <li>Regurgitant fraction &lt;50%</li> </ul> | <ul style="list-style-type: none"> <li>Regional wall motion abnormalities with reduced LV systolic function</li> <li>LV dilation and systolic dysfunction attributable to primary myocardial disease</li> </ul>                                     | <ul style="list-style-type: none"> <li>Symptoms attributable to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy</li> </ul>                                         |
| C     | Asymptomatic severe MR | <ul style="list-style-type: none"> <li>Regional wall motion abnormalities and/or LV dilation with severe tethering of mitral leaflet</li> <li>Annular dilation with severe loss of central coaptation of the mitral leaflets</li> </ul> | <ul style="list-style-type: none"> <li>ERO ≥0.40 cm<sup>2</sup>†</li> <li>Regurgitant volume ≥60 mL ‡</li> <li>Regurgitant fraction ≥50%</li> </ul>        | <ul style="list-style-type: none"> <li>Regional wall motion abnormalities with reduced LV systolic function</li> <li>LV dilation and systolic dysfunction attributable to primary myocardial disease</li> </ul>                                     | <ul style="list-style-type: none"> <li>Symptoms attributable to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy</li> </ul>                                         |
| D     | Symptomatic severe MR  | <ul style="list-style-type: none"> <li>Regional wall motion abnormalities and/or LV dilation with severe tethering of mitral leaflet</li> <li>Annular dilation with severe loss of central coaptation of the mitral leaflets</li> </ul> | <ul style="list-style-type: none"> <li>ERO ≥0.40 cm<sup>2</sup>†</li> <li>Regurgitant volume ≥60 mL ‡</li> <li>Regurgitant fraction ≥50%</li> </ul>        | <ul style="list-style-type: none"> <li>Regional wall motion abnormalities with reduced LV systolic function</li> <li>LV dilation and systolic dysfunction attributable to primary myocardial disease</li> </ul>                                     | <ul style="list-style-type: none"> <li>HF symptoms attributable to MR persist even after revascularization and optimization of medical therapy</li> <li>Decreased exercise tolerance</li> <li>Exertional dyspnea</li> </ul> |

\*Several valve hemodynamic criteria are provided for assessment of MR severity, but not all criteria for each category will be present in each patient. Categorization of MR severity as mild, moderate, or severe depends on data quality and integration of these parameters in conjunction with other clinical evidence.

†The measurement of the proximal isovelocity surface area by 2D TTE in patients with secondary MR underestimates the true ERO because of the crescentic shape of the proximal convergence.

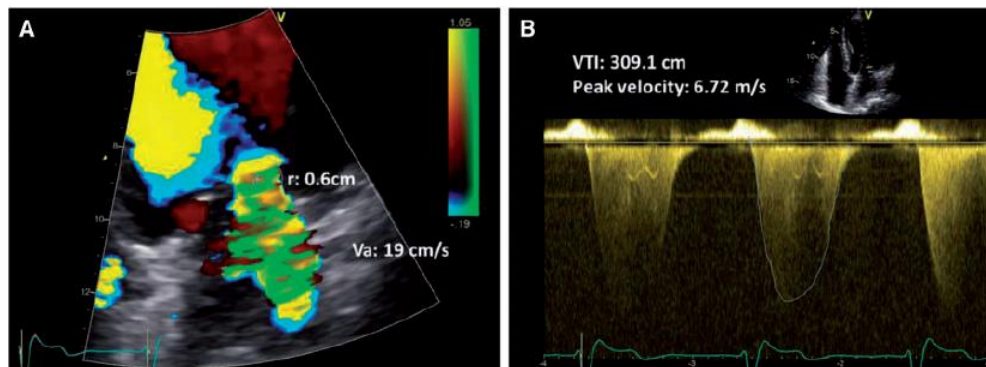
‡May be lower in low-flow states.

2D indicates 2-dimensional; CAD, coronary artery disease; ERO, effective regurgitant orifice; HF, heart failure; LA, left atrium; LV, left ventricular; MR, mitral regurgitation; and TTE, transthoracic echocardiogram.



$$\text{Peak MR Flow Rate} = 2\pi r^2 \times Va \times (\text{angle}/180^\circ)$$

$$\text{EROA} = \text{Peak MR Flow Rate} / \text{Peak Velocity of MR Jet}$$

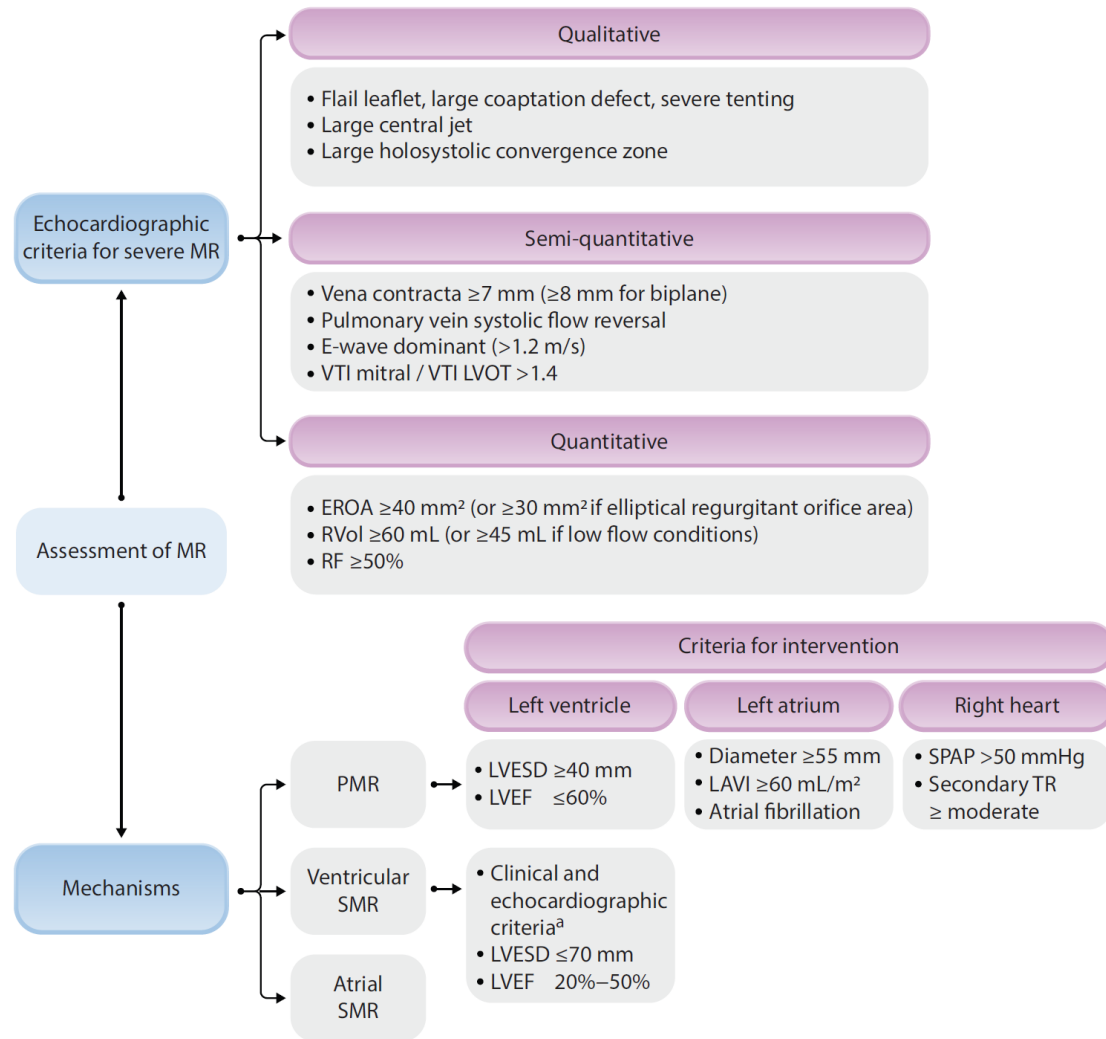


**Figure 3.**

**Upper Panel.** Schematic example of the proximal isovelocity surface area (PISA) method. Left, The color Doppler baseline is shifted downward (in the direction of the mitral regurgitation [MR] jet) until the proximal convergence zone (middle) appears hemispheric. The aliasing velocity ( $V_a$ ) is used to calculate peak regurgitant flow rate from the formula, where  $r$  is the radius from the blue-red alias line to the orifice. Note that this formula assumes that peak flow rate from the PISA radius occurs at the same time as peak velocity of the MR jet by continuous-wave Doppler. If the proximal flow convergence does not occur over a flat ( $180^\circ$ ) plane, angle correction must be used (right). It is important to shift the baseline in the direction of the MR jet, not to merely lower the aliasing velocity. It is also important to turn off variance, which makes the red-blue alias line easier to identify. EROA indicates effective regurgitant orifice area.

Grayburn PA, et al. Quantitation of mitral regurgitation. *Circulation*. 2012;126:2005-17.

**Lower Panel.** Assessment of the echocardiographic and the integrated regurgitant volume (RVol) of mitral regurgitation (MR). By echocardiography, the proximal isovelocity surface area method was used for the assessment of the effective regurgitant orifice area (EROA) of the MR. (A, B, F) The velocity time integral (VTI) of the MR jet was assessed on the continuous wave Doppler images (B). van Rosendaal PJ, et al. Integrated imaging of echocardiography and computed tomography to grade mitral regurgitation severity in patients undergoing transcatheter aortic valve implantation. *Eur Heart J*. 2017.



**Figure 4. ESC/EACTS 2025 GL on valvular heart disease. Severe mitral regurgitation criteria based on 2D echocardiography**

EROA, effective regurgitant orifice area; LAVI, left atrial volume index; LVEF, left ventricular ejection fraction; LVEDS, left ventricular end-systolic diameter; LVOT, left ventricular outflow tract; MR, mitral regurgitation; PMR, primary mitral regurgitation; RF, regurgitant fraction; RVol, regurgitant volume; SMR, secondary mitral regurgitation; SPAP, systolic pulmonary artery pressure; TR, tricuspid regurgitation; VTI, velocity time integral. <sup>a</sup>See Table on intervention for secondary MR or criteria predicting outcome improvement.

**Table 5. ACC/AHA 2020 GL on VHD. Diagnosis of Primary MR****Initial Diagnosis of Chronic MR**

TTE in patients with known or suspected primary MR, for baseline evaluation of LV size I-B-NR  
And function, RV function, LA size, pulmonary artery pressure, and the mechanism  
and severity of primary MR (Stages A to D).

TEE in patients with primary MR, when TTE provides insufficient or discordant I-C-EO  
information, for evaluation of the severity of MR, mechanism of MR, and status of  
LV function (Stages B to D).

In patients with primary MR, CMR to assess LV and RV volumes and function I-B-NR  
and may help with assessing MR severity when there is a discrepancy between  
the findings on clinical assessment and echocardiography.

In patients with severe primary MR undergoing mitral intervention, I-B-NR  
intraoperative TEE to establish the anatomic basis for primary MR (Stages C and D)  
and to guide repair.

**Changing Signs or Symptoms in Patients With Primary MR**

In patients with primary MR (Stages B to D) and new-onset or changing symptoms, I-B-NR  
TTE to evaluate the mitral valve apparatus and LV function

**Exercise Testing for Chronic Primary MR**

Hemodynamic exercise testing using Doppler echocardiography or cardiac catheterization IIa-B-NR  
or cardiopulmonary exercise testing, in patients with primary MR (Stages B and C)  
and symptoms that might be attributable to MR.

**Routine Follow-Up for Chronic Primary MR**

For asymptomatic patients with severe primary MR (Stages B and C1), I-B-NR  
TTE every 6 to 12 months for surveillance of LV function (estimated by LVEF,  
LVEDD, and LVESD) and assessment of pulmonary artery pressure.

In asymptomatic patients with severe primary MR (Stages B and C1), IIb-B-NR  
use of serum biomarkers and novel measurements of LV function, such as global  
longitudinal strain, as an adjunct to guide timing of intervention.

**Table 5. ACC/AHA 2020 GL on VHD.****Diagnosis of Secondary MR**

TTE in patients with chronic secondary MR (Stages B to D), to establish the etiology I-B-NR  
and to assess the extent of regional and global LV remodeling and systolic dysfunction,  
severity of MR, and magnitude of pulmonary hypertension.

Noninvasive imaging (stress nuclear/PET, CMR, or stress echocardiography), I-C-EO  
coronary CT angiography, or coronary arteriography

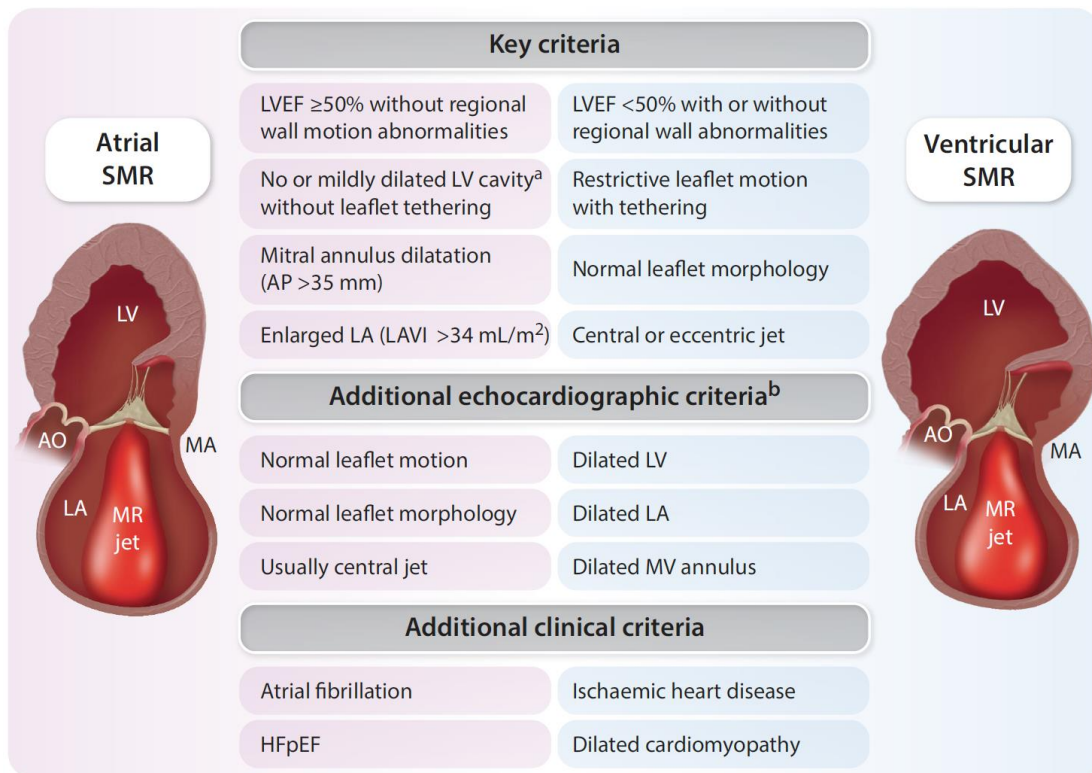
to establish etiology of MR and to assess myocardial viability.

|                                                                                                                                                                                                                          |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| TEE to determine suitability for the procedure in patients with chronic secondary MR with severe symptoms (Stage D) that are unresponsive to GDMT who are being considered for transcatheter mitral valve interventions, | I-B-NR |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|

|                                                                                                                             |        |
|-----------------------------------------------------------------------------------------------------------------------------|--------|
| Intraprocedural guidance with TEE in patients with chronic secondary MR undergoing transcatheter mitral valve intervention. | I-C-EO |
|-----------------------------------------------------------------------------------------------------------------------------|--------|

### **Management of CAD in Patients Undergoing Valve Surgery**

|                                                                                                                  |        |
|------------------------------------------------------------------------------------------------------------------|--------|
| Invasive coronary angiography before valve intervention as part of the evaluation in chronic severe secondary MR | I-C-LD |
|------------------------------------------------------------------------------------------------------------------|--------|



**Figure 5. ESC/EACTS 2025 GL on valvular heart disease. Most frequently used criteria for the diagnosis of atrial secondary mitral regurgitation.**

AO, aorta; AP, anteroposterior; HFpEF, heart failure with preserved ejection fraction; LA, left atrium/left atrial; LAVI, left atrial volume index; LV, left ventricle/left ventricular; LVEF, left ventricular ejection fraction; MA, mitral annulus; MR, mitral regurgitation; MV, mitral valve; SMR, secondary mitral regurgitation.

<sup>a</sup>LV end-diastolic dimension of  $< 56$  mm in females and  $< 63$  mm in males; indexed LV end-diastolic volume  $< 71$  mL/m<sup>2</sup> (in women) or  $< 79$  mL/m<sup>2</sup> (in men).

<sup>b</sup>Additional echocardiographic criteria for atrial SMR may no longer be fulfilled in advanced stages.

**Table 6. ACC/AHA 2020 GL on VHD.****Medical therapy for chronic primary MR**

|                                                                                                                                                                                                |          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| GDMT for systolic dysfunction in symptomatic or asymptomatic patients with severe primary MR and LV systolic dysfunction (Stages C2 and D) in whom surgery is not possible or must be delayed. | IIa-B-NR |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|

|                                                                                                                                                                  |                          |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|
| In asymptomatic patients with primary MR and normal LV systolic function (Stages B and C1), vasodilator therapy is not indicated if the patient is normotensive. | III-B-NR<br>(No benefit) |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|

**Medical therapy for secondary MR**

1. Patients should receive

|                                                                                                                                                                                                                                                           |     |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
| Standard GDMT for HF, including ACE inhibitors, ARBs, beta blockers, aldosterone antagonists, and/or sacubitril/valsartan, and biventricular pacing as indicated, in patients with chronic severe secondary MR (Stages C and D) and HF with reduced LVEF. | I-A |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|

|                                                                                                                                                                                                                                                              |        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| 2. In patients with chronic severe secondary MR and HF with reduced LVEF, a cardiologist expert in the management of patients with HF and LV systolic dysfunction should be the primary MDT member responsible for implementing and monitoring optimal GDMT. | I-C-EO |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------|

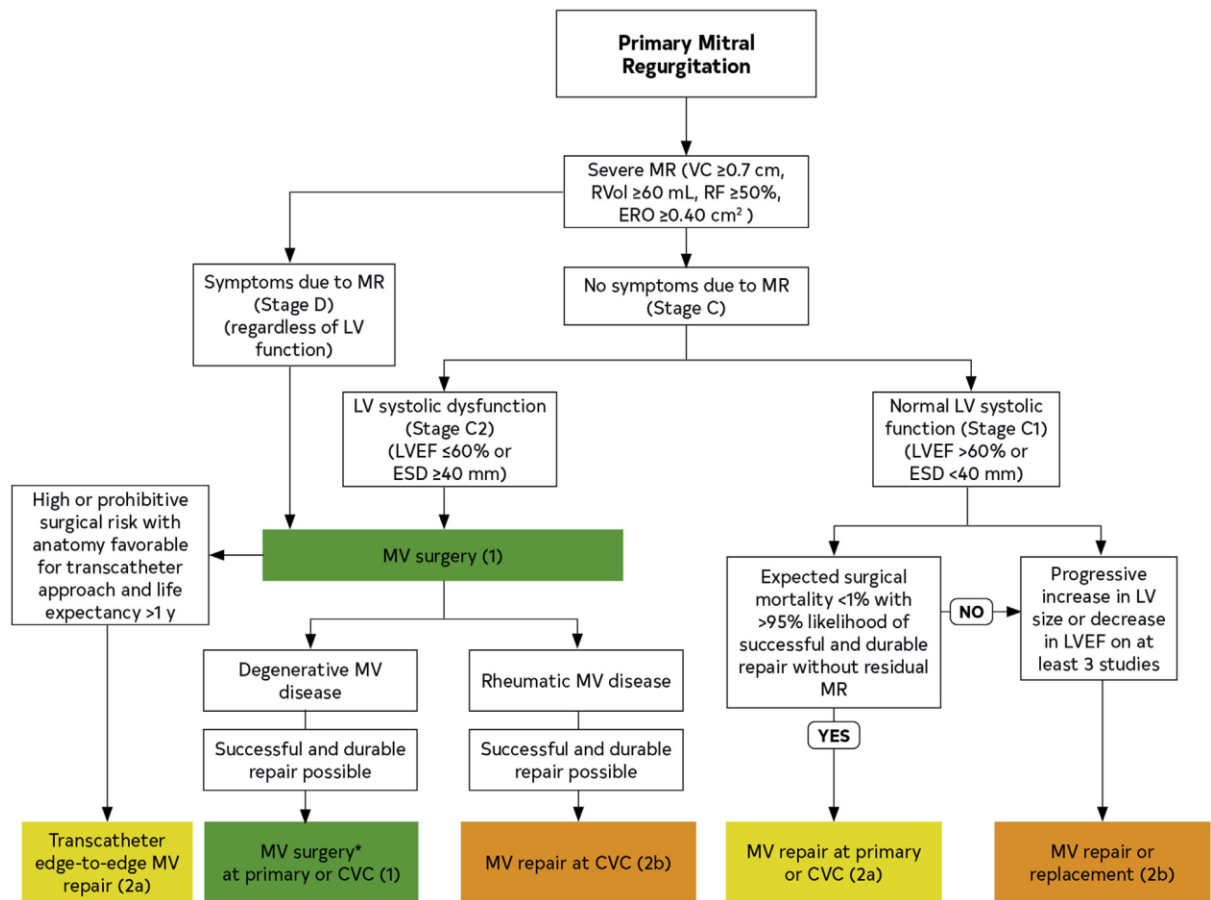
**Table 7. ESC/EACTS 2025 GL on valvular heart disease. Recommendations on indications for intervention in severe primary mitral regurgitation**

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |            |          |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------|
| MV repair is the recommended surgical technique to treat patients with severe PMR when the result is expected to be durable. <sup>26,532,533,559,560</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                      | <b>I</b>   | <b>B</b> |
| MV surgery is recommended in symptomatic patients with severe PMR considered operable by the Heart Team. <sup>26,532,533,561</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                              | <b>I</b>   | <b>B</b> |
| MV surgery is recommended in asymptomatic patients with severe PMR and LV dysfunction (LVESD $\geq 40$ mm or LVESDi $\geq 20$ mm/m <sup>2</sup> or LVEF $\leq 60\%$ ). <sup>522,544,545</sup>                                                                                                                                                                                                                                                                                                                                                                                                   | <b>I</b>   | <b>B</b> |
| Surgical MV repair is recommended in low-risk asymptomatic patients with severe PMR without LV dysfunction (LVESD $< 40$ mm, LVESDi $< 20$ mm/m <sup>2</sup> , and LVEF $> 60\%$ ) when a durable result is likely, if at least three of the following criteria are fulfilled: <sup>517,547,562–564</sup> <ul style="list-style-type: none"> <li>• AF</li> <li>• SPAP at rest <math>&gt; 50</math> mmHg</li> <li>• LA dilatation (LAVI <math>\geq 60</math> mL/m<sup>2</sup> or LA diameter <math>\geq 55</math> mm)</li> <li>• Concomitant secondary TR <math>\geq</math> moderate.</li> </ul> | <b>I</b>   | <b>B</b> |
| MV surgery should be considered in asymptomatic patients with severe PMR without LV dysfunction (LVESD $< 40$ mm, LVESDi $< 20$ mm/m <sup>2</sup> , and LVEF $> 60\%$ ) in the presence of PH (SPAP at rest $> 50$ mmHg), or AF secondary to MR. <sup>517,518,562,565</sup>                                                                                                                                                                                                                                                                                                                     | <b>IIa</b> | <b>B</b> |
| Surgical MV repair should be considered in low-risk asymptomatic patients with severe PMR without LV dysfunction (LVESD $< 40$ mm, LVESDi $< 20$ mm/m <sup>2</sup> , and LVEF $> 60\%$ ) in the presence of significant LA dilatation (LAVI $\geq 60$ mL/m <sup>2</sup> or LA diameter $\geq 55$ mm), when performed in a Heart Valve Centre and a durable repair is likely. <sup>517,565</sup>                                                                                                                                                                                                 | <b>IIa</b> | <b>B</b> |
| TEER should be considered in symptomatic patients with severe PMR who are anatomically suitable and at high surgical risk according to the Heart Team. <sup>538,540,566</sup>                                                                                                                                                                                                                                                                                                                                                                                                                   | <b>IIa</b> | <b>B</b> |
| Minimally invasive MV surgery may be considered at experienced centres to reduce the length of stay and accelerate recovery. <sup>557,567</sup>                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>IIb</b> | <b>B</b> |

AF, atrial fibrillation; LA, left atrium/left atrial; LAVI, left atrial volume index; LV, left ventricle/left ventricular; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; LVESDi, left ventricular end-systolic diameter indexed to body surface area; MR, mitral regurgitation; MV, mitral valve; PH, pulmonary hypertension; PMR, primary mitral regurgitation; SPAP, systolic pulmonary artery pressure; TEER, transcatheter edge-to-edge repair; TR, tricuspid regurgitation.

**Table 8. ACC/AHA 2020 GL on VHD. Intervention for chronic primary MR**

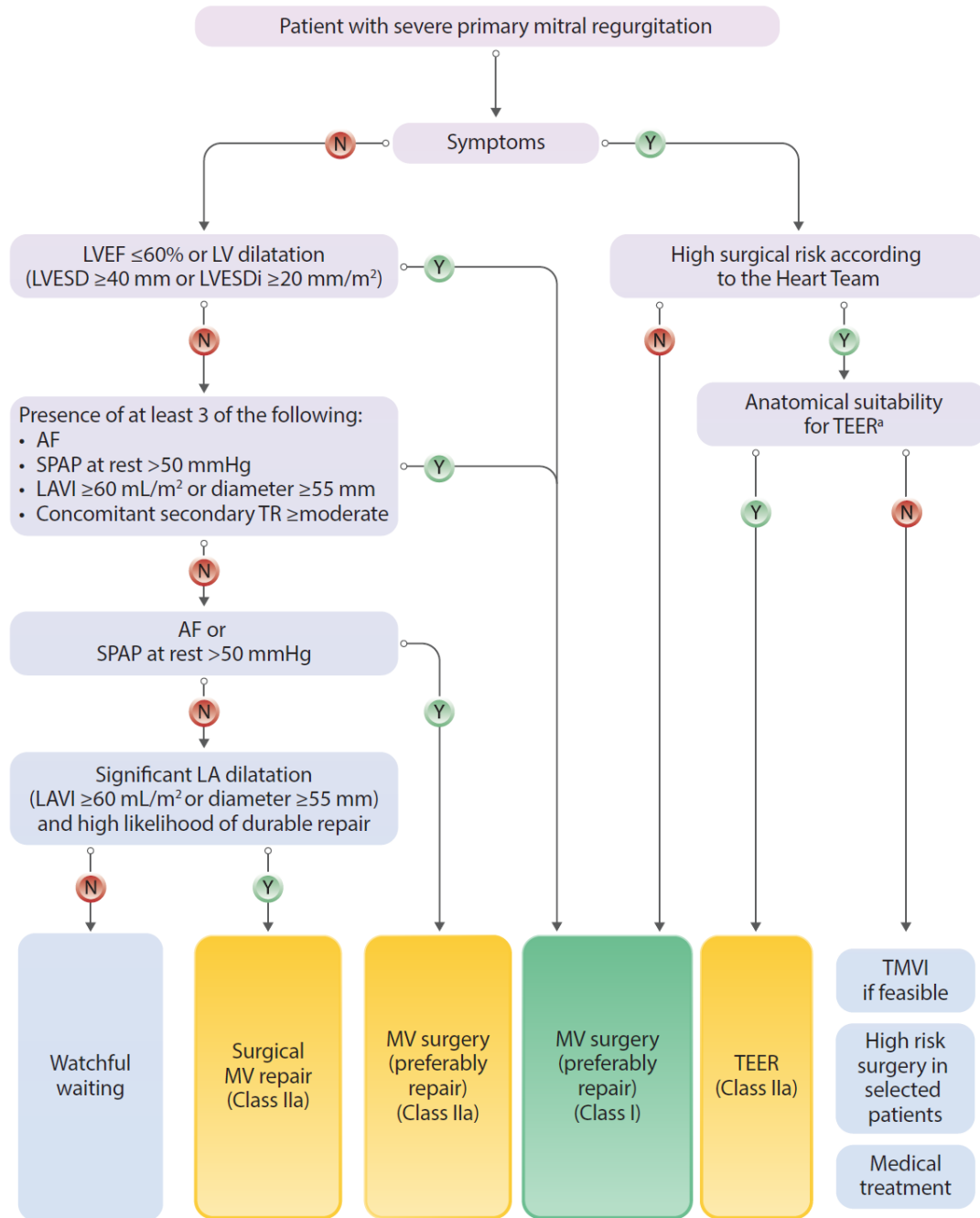
|                                                                                                                                                                                                                                                                                                                                                                |                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------|
| Mitral valve intervention in symptomatic patients with severe primary MR (Stage D), irrespective of LV systolic function.                                                                                                                                                                                                                                      | I-B-NR             |
| Mitral valve surgery in asymptomatic patients with severe primary MR and LV systolic dysfunction (LVEF $\leq$ 60%, LVESD $\geq$ 40 mm) (Stage C2).                                                                                                                                                                                                             | I-B-NR             |
| Mitral valve repair in preference to mitral valve replacement patients with severe primary MR when the anatomic cause of MR is degenerative disease, if a successful and durable repair is possible.                                                                                                                                                           | I-B-NR             |
| Mitral valve repair in asymptomatic patients with severe primary MR and normal LV systolic function (LVEF $\geq$ 60% and LVESD $\leq$ 40 mm) (Stage C1), when the likelihood of a successful and durable repair without residual MR is $>$ 95% with an expected mortality rate of $<$ 1%, when it can be performed at a Primary or Comprehensive Valve Center. | IIa-B-NR           |
| Mitral valve surgery irrespective of the probability of a successful and durable repair asymptomatic patients with severe primary MR and normal LV systolic function (LVEF $>$ 60% and LVESD $<$ 40 mm) (Stage C1) but with a progressive increase in LV size or decrease in EF on $\geq$ 3 serial imaging studies.                                            | IIb-C-LD           |
| Transcatheter edge-to-edge repair (TEER) if mitral valve anatomy is favorable for the repair procedure and patient life expectancy is at least 1 year, in severely symptomatic patients (NYHA class III or IV) with primary severe MR and high or prohibitive surgical risk.                                                                                   | IIa-B-NR           |
| Mitral valve repair at a Comprehensive Valve Center by an experienced team if a durable and successful repair is likely, in symptomatic patients with severe primary MR attributable to rheumatic valve disease.                                                                                                                                               | IIb-B-NR           |
| In patients with severe primary MR where leaflet pathology is limited to less than one half the posterior leaflet, mitral valve replacement should not be performed unless mitral valve has been attempted at a Primary or Comprehensive Valve Center and was unsuccessful.                                                                                    | III-B-NR<br>(Harm) |



**Figure 6. ACC/AHA 2020 GL on valvular heart disease. Primary MR**

\*See Prosthetic Valve section for choice of mitral valve replacement if mitral valve repair is not possible.

CVC indicates Comprehensive Valve Center; ERO, effective regurgitant orifice; ESD, end-systolic dimension; LVEF, ejection fraction; MR, mitral regurgitation; MV, mitral valve; MVR, mitral valve replacement; RF, regurgitant fraction; RVol, regurgitant volume; and VC, vena contracta.



**Figure 7. ESC/EACTS 2025 GL on valvular heart disease. Management of patients with severe primary mitral regurgitation.**

AF, atrial fibrillation; LA, left atrial; LAVI, left atrial volume index; LV, left ventricle/left ventricular; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; LVESDi, left ventricular end-systolic diameter indexed to BSA; MV, mitral valve; SPAP, systolic pulmonary artery pressure; TEER, transcatheter edge-to-edge repair; TMVI, transcatheter mitral valve implantation; TR, tricuspid regurgitation

**Table 9. ACC/AHA/HRS 2018 GL on bradycardia. Pacing After Mitral Valve Surgery**

|                                                                                                                                                                                                                                               |          |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| Permanent pacing before discharge in patients who have new postoperative SND or atrioventricular block associated with persistent symptoms or hemodynamic instability that does not resolve after mitral valve repair or replacement surgery, | I-B-NR   |
| Routine placement of temporary epicardial pacing wires in patients undergoing mitral valve surgery                                                                                                                                            | IIa-C-LD |
| Intraoperative placement of a permanent epicardial left ventricular lead in patients undergoing surgical mitral valve repair or replacement who will likely require future CRT or ventricular pacing                                          | IIb-C-EO |

**Table 10. Secondary MR.****ACC/AHA 2020 GL on VHD. Intervention for secondary MR**

|                                                                                                                                                                                                                                                                                                                                                              |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|
| In patients with chronic severe secondary MR related to LV systolic dysfunction (LVEF <50%) who have persistent symptoms (NYHA class II, III, or IV) while on optimal GDMT for HF (Stage D),<br>TEER in patients with appropriate anatomy as defined on TEE and with LVEF between 20% and 50%, LVESD ≤70 mm, and pulmonary artery systolic pressure ≤70 mmHg | IIa-B-R  |
| In patients with severe secondary MR (Stages C and D), mitral valve surgery when CABG is undertaken for the treatment of myocardial ischemia.                                                                                                                                                                                                                | IIa-B-NR |
| Mitral valve surgery in patients with chronic severe secondary MR from atrial annular dilation with preserved LV systolic function (LVEF ≥50%) who have severe persistent symptoms (NYHA class III or IV) despite therapy for HF and therapy for associated AF or other comorbidities (Stage D).                                                             | IIb-B-NR |
| Mitral valve surgery in patients with chronic severe secondary MR related to LV systolic dysfunction (LVEF <50%) who have persistent severe symptoms (NYHA class III or IV) while on optimal GDMT for HF (Stage D).                                                                                                                                          | IIb-B-NR |
| Chordal-sparing mitral valve replacement preferable to downsized annuloplasty repair in patients with CAD and chronic severe secondary MR related to LV systolic dysfunction (LVEF <50%) (Stage D) who are undergoing mitral valve surgery because of severe symptoms (NYHA class III or IV) that persist despite GDMT for HF.                               | IIb-B-R  |

**ACC/AHA/HFSA 2022 GL on HF. Valvular Heart Disease**

|                                                                                                                                                 |        |
|-------------------------------------------------------------------------------------------------------------------------------------------------|--------|
| In patients with chronic severe secondary MR and HFrEF, optimization of GDMT before any intervention for secondary MR related to LV dysfunction | I C-LD |
|-------------------------------------------------------------------------------------------------------------------------------------------------|--------|

**Table 11. Secondary MR****ESC/EACTS 2025 GL on valvular heart disease. Recommendations on indications for mitral valve intervention in chronic severe secondary mitral regurgitation**

| <b>Severe atrial secondary mitral regurgitation</b>                                                                                                                                                                                                                                                                                          |            |          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------|
| MV surgery, surgical AF ablation, if indicated, and LAAO should be considered in symptomatic patients with severe atrial SMR under optimal medical therapy. <sup>627–630,636,637</sup>                                                                                                                                                       | <b>IIa</b> | <b>B</b> |
| TEER may be considered in symptomatic patients with severe atrial SMR not eligible for surgery after optimization of medical therapy including rhythm control, when appropriate. <sup>588,590,638,639</sup>                                                                                                                                  | <b>IIb</b> | <b>B</b> |
| <b>Ventricular secondary mitral regurgitation and concomitant coronary artery disease</b>                                                                                                                                                                                                                                                    |            |          |
| MV surgery is recommended in patients with severe ventricular SMR undergoing CABG. <sup>640</sup>                                                                                                                                                                                                                                            | <b>I</b>   | <b>B</b> |
| MV surgery may be considered in patients with moderate SMR undergoing CABG. <sup>622–624,641,642</sup>                                                                                                                                                                                                                                       | <b>IIb</b> | <b>B</b> |
| PCI followed by TEER after re-evaluation of MR may be considered in symptomatic patients with chronic severe ventricular SMR and non-complex CAD. <sup>150</sup>                                                                                                                                                                             | <b>IIb</b> | <b>C</b> |
| <b>Severe ventricular secondary mitral regurgitation without concomitant coronary artery disease</b>                                                                                                                                                                                                                                         |            |          |
| TEER is recommended to reduce HF hospitalizations and improve quality of life in haemodynamically stable, symptomatic patients with impaired LVEF (<50%) and persistent severe ventricular SMR, despite optimized GDMT and CRT (if indicated), fulfilling specific clinical and echocardiographic criteria. <sup>c 583,584,606,608,643</sup> | <b>I</b>   | <b>A</b> |
| TEER may be considered for symptom improvement in selected symptomatic patients with severe ventricular SMR not fulfilling the specific clinical and echocardiographic criteria, <sup>c</sup> after careful evaluation of LVAD or HTx. <sup>203,608–610</sup>                                                                                | <b>IIb</b> | <b>B</b> |
| MV surgery may be considered in symptomatic patients with severe ventricular SMR without advanced HF who are not suitable for TEER. <sup>617</sup>                                                                                                                                                                                           | <b>IIb</b> | <b>C</b> |

AF, atrial fibrillation; CABG, coronary artery bypass grafting; CAD, coronary artery disease; CRT, cardiac resynchronization therapy; GDMT, guideline-directed medical therapy; HF, heart failure; HTx, heart transplantation; LAAO, left atrial appendage occlusion; LVAD, left ventricular assist device; LVEF, left ventricular ejection fraction; MR, mitral regurgitation; MV, mitral valve; PCI, percutaneous coronary intervention; SMR, secondary mitral regurgitation; TEER, transcatheter edge-to-edge repair.

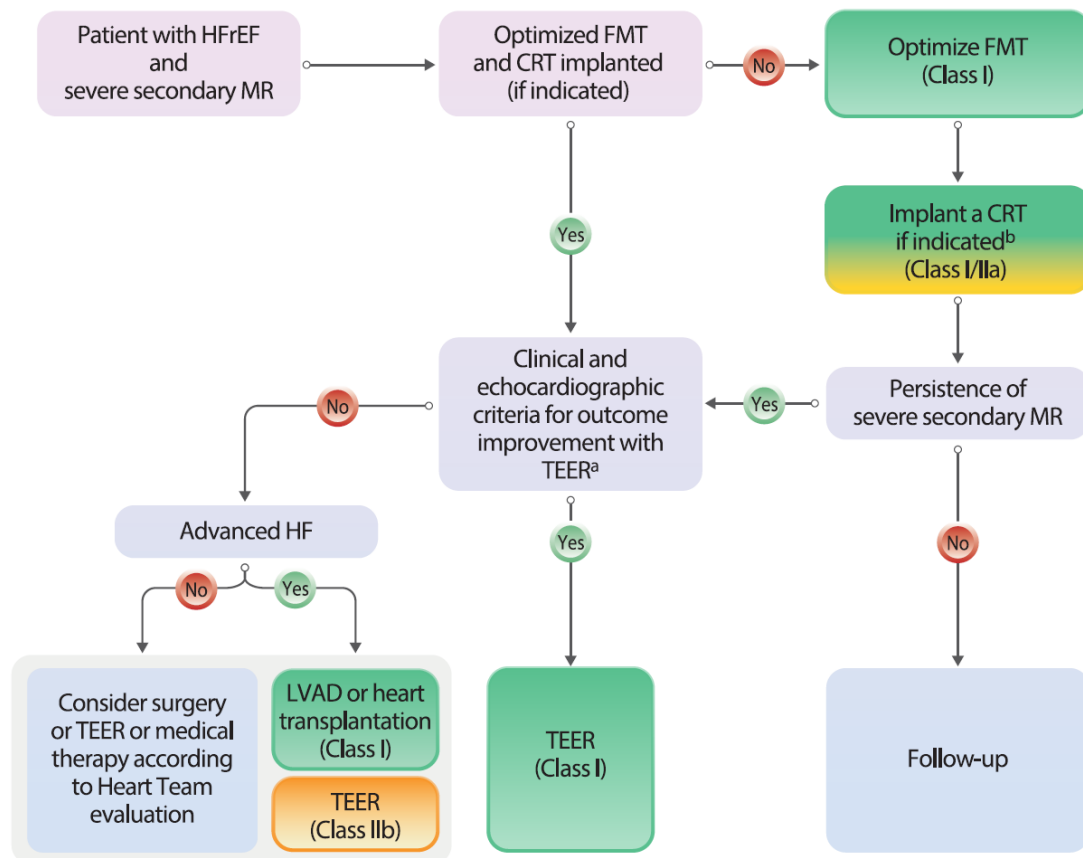
**Table 12. ESC 2026 GL on HF. Recommendations for valvular heart disease in patients with heart failure**

| Secondary mitral regurgitation                                                                                                                                                                                                                                                                                                                                                                                            |     |    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|----|
| Mitral transcatheter edge-to-edge repair is recommended in haemodynamically stable, symptomatic patients with HFrEF and persistent severe secondary mitral regurgitation despite optimized FMT and CRT if indicated, who fulfil specific clinical and echocardiographic criteria, <sup>d</sup> in order to reduce the risk of HFH and improve QoL. <sup>750-753</sup>                                                     | I   | B1 |
| Mitral transcatheter edge-to-edge repair may be considered in selected symptomatic patients with HFrEF and persistent severe secondary mitral regurgitation despite optimized FMT and CRT if indicated (after excluding the option of LVAD or heart transplantation) who do not fulfil the clinical and echocardiographic criteria for outcome improvement, <sup>d</sup> in order to improve symptoms. <sup>766-769</sup> | IIb | C  |

CRT, cardiac resynchronization therapy; FMT, foundational medical therapy; HF, heart failure; HFH, heart failure hospitalization; HFpEF, heart failure with preserved ejection fraction; HFrEF, heart failure with reduced ejection fraction; LVAD, left ventricular assist device; LVEF, left ventricular ejection fraction; QoL, quality of life; SAVR, surgical aortic valve replacement; TAVI, transcatheter aortic valve implantation.

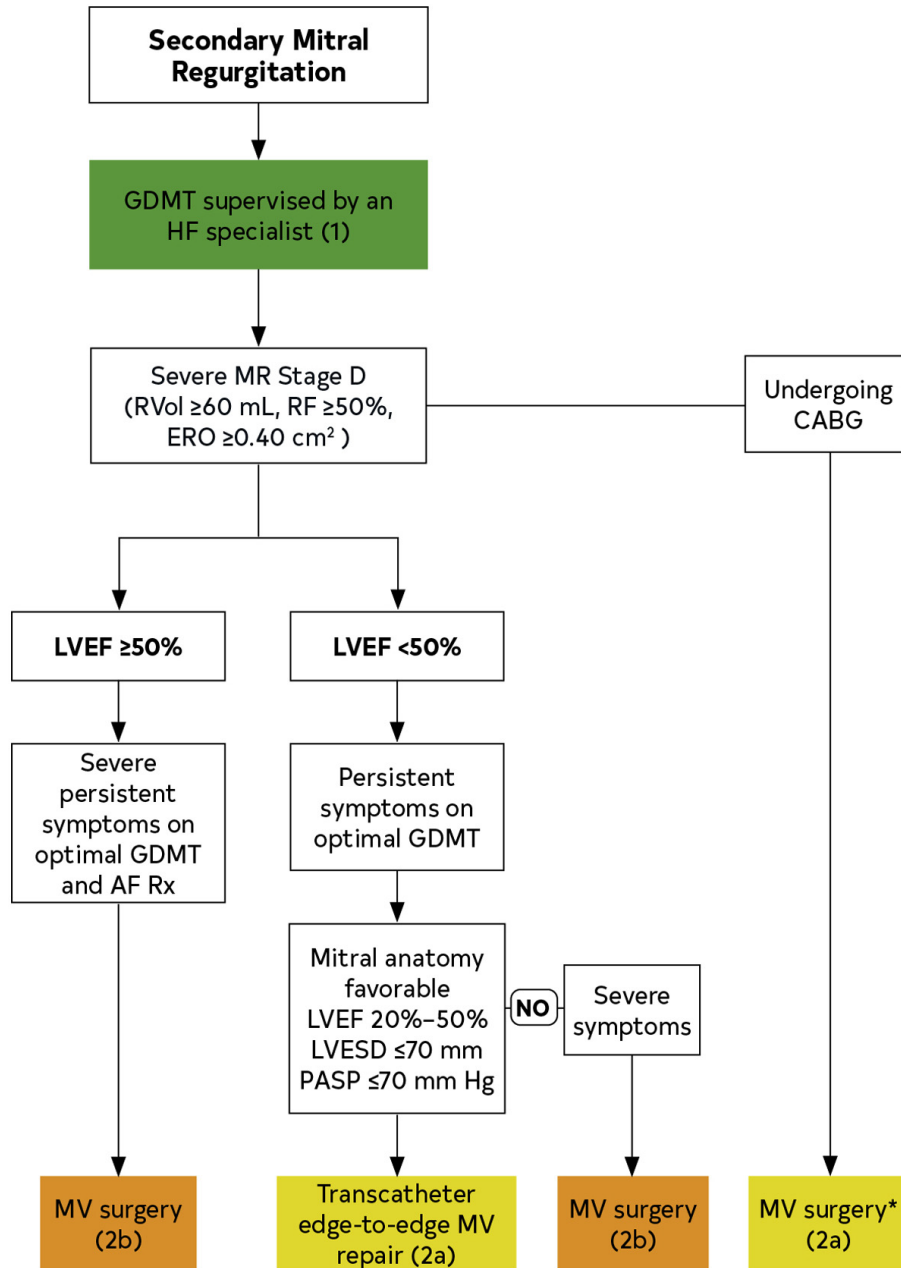
<sup>c</sup>This recommendation refers to patients with severe high gradient aortic stenosis regardless of LVEF and to patients with low-flow low-gradient aortic stenosis and HFrEF. For details regarding low-flow low-gradient aortic stenosis in HFpEF, we refer to the *2025 ESC/EACTS Guidelines for the management of valvular heart disease*.

<sup>d</sup>For clinical and echocardiographic criteria, see [Table 19](#).



**Figure 8. ESC 2026 GL on HF.** Management of secondary mitral regurgitation in patients with heart failure with reduced ejection fraction.

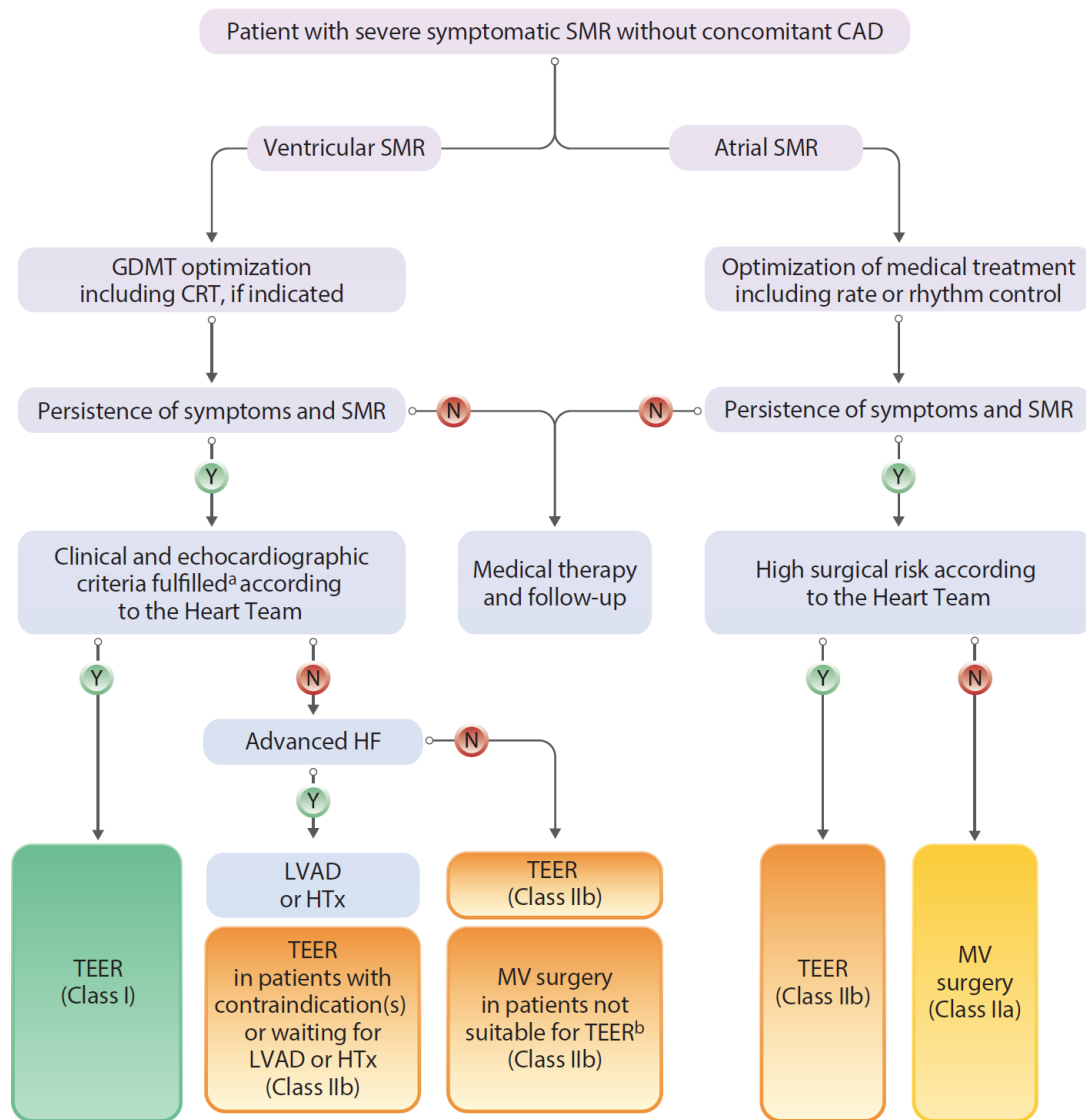
CRT, cardiac resynchronization therapy; FMT, foundational medical therapy; HF, heart failure; LVAD, left ventricular assist device; MR, mitral regurgitation; TEER, transcatheter edge-to-edge repair. Colours refer to class of recommendation



**Figure 9. ACC/AHA 2020 GL on valvular heart disease and ACC/AHA/HFSA 2022 GL on HF. Secondary MR**

\*Chordal-sparing MV replacement may be reasonable to choose over downsized annuloplasty repair.

AF indicates atrial fibrillation; CABG, coronary artery bypass graft; ERO, effective regurgitant orifice; GDMT, guideline-directed management and therapy; HF, heart failure; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic dimension; MR, mitral regurgitation; MV, mitral valve; PASP, pulmonary artery systolic pressure; RF, regurgitant fraction; RVol, regurgitant volume; and Rx, medication.



**Figure 10. ESC/EACTS 2025 GL on valvular heart disease.** Treatment of severe secondary mitral regurgitation without concomitant coronary artery disease.

CAD, coronary artery disease; CRT, cardiac resynchronization therapy; GDMT, guideline-directed medical therapy; HF, heart failure; HTx, heart transplantation; LVAD, left ventricular assist device; MV, mitral valve; SMR, secondary mitral regurgitation; TEER, transcatheter edge-to-edge repair. <sup>a</sup>See Table

**Table 13. ESC 2026 GL on HF. Selection criteria for mitral transcatheter edge-to-edge repair in heart failure with reduced ejection fraction**

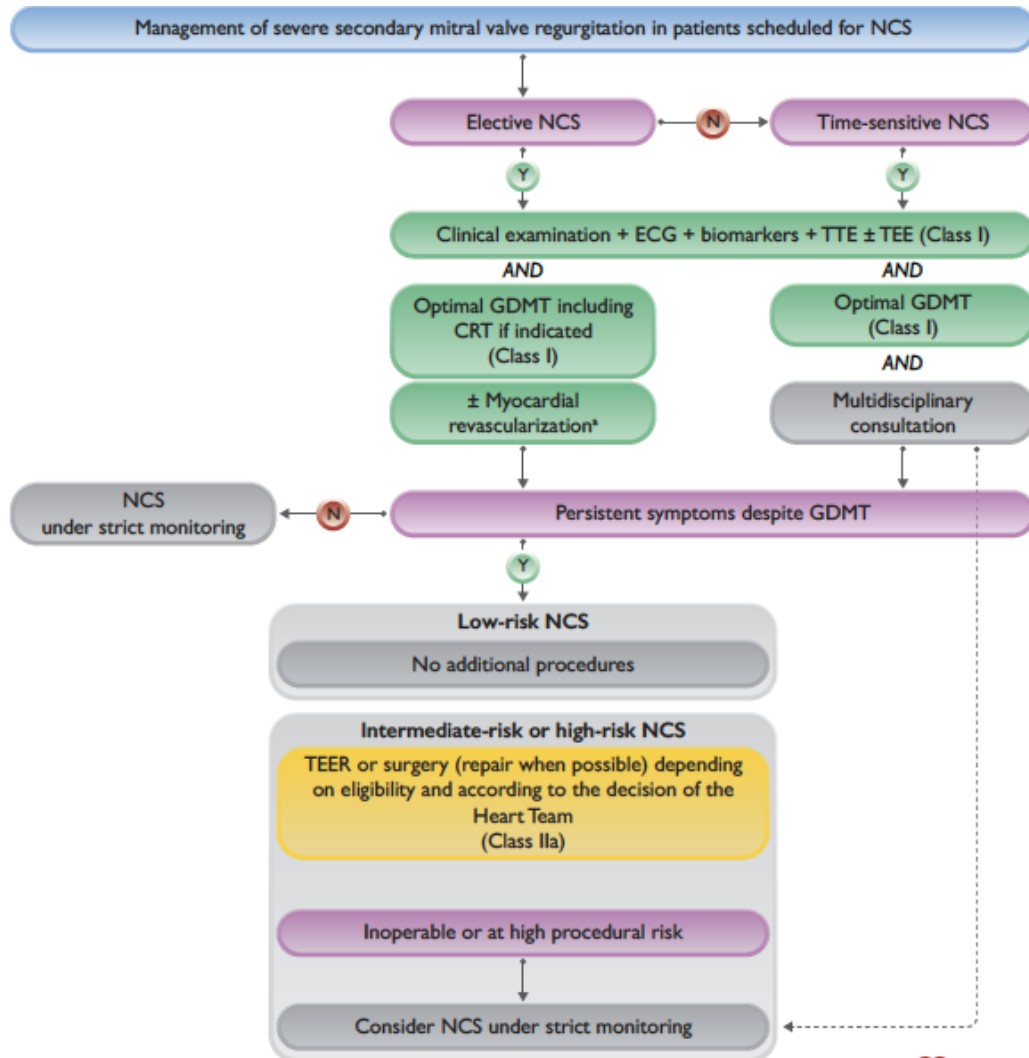
| Clinical and echocardiographic criteria                                                    |
|--------------------------------------------------------------------------------------------|
| Optimized FMT and other GDIT (i.e. CRT) if needed                                          |
| NYHA class $\geq$ II                                                                       |
| At least one HFH within the last year                                                      |
| OR                                                                                         |
| Increased natriuretic peptide levels (BNP $\geq$ 300 pg/mL or NT-proBNP $\geq$ 1000 pg/mL) |
| No stage D (advanced) HF                                                                   |
| No CAD requiring revascularization                                                         |
| No hypertrophic, restrictive, or infiltrative cardiomyopathies                             |
| LVEF 20%–50%                                                                               |
| LVESD $\leq$ 70 mm                                                                         |
| Anatomy deemed suitable for mitral TEER                                                    |
| sPAP $\leq$ 70 mmHg                                                                        |
| No severe RV dysfunction                                                                   |
| No severe aortic and/or tricuspid valve disease                                            |

BNP, B-type natriuretic peptide; CAD, coronary artery disease; CRT, cardiac resynchronization therapy; FMT, foundational medical therapy; GDIT, guideline-directed interventional therapy; HF, heart failure; HFH, heart failure hospitalization; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; TEER, transcatheter edge-to-edge repair; NT-proBNP, N-terminal pro-B-type natriuretic peptide; NYHA, New York Heart Association; RV, right ventricular; sPAP, systolic pulmonary artery pressure.

**Table 14. ESC/EACTS 2025 GL on valvular heart disease. Clinical and echocardiographic criteria predicting outcome improvement in patients with severe ventricular secondary mitral regurgitation undergoing mitral transcatheter edge-to-edge repair**

|                                                                                                                                                        |
|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| Anatomy deemed suitable for M-TEER                                                                                                                     |
| NYHA class $\geq$ II                                                                                                                                   |
| LVEF 20%–50%                                                                                                                                           |
| LVESD $\leq$ 70 mm                                                                                                                                     |
| At least one HF hospitalization within the previous year or increased natriuretic peptide levels (BNP $\geq$ 300 pg/mL or NT-proBNP $\geq$ 1000 pg/mL) |
| SPAP $\leq$ 70 mmHg                                                                                                                                    |
| No severe RV dysfunction                                                                                                                               |
| No Stage D or advanced HF                                                                                                                              |
| No CAD requiring revascularization                                                                                                                     |
| No severe AV and/or TV disease                                                                                                                         |
| No hypertrophic, restrictive, or infiltrative cardiomyopathies                                                                                         |

AV, aortic valve; BNP, brain natriuretic peptide; CAD, coronary artery disease; HF, heart failure; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; M-TEER, mitral transcatheter edge-to-edge repair; NT-proBNP, N-terminal pro-B-type natriuretic protein; NYHA, New York Heart Association; RV, right ventricle/ right ventricular; SPAP, systolic pulmonary artery pressure; TV, tricuspid valve.



**Figure 9. ESC 2022 GL on non-cardiac surgery.** Management of patients with secondary mitral valve regurgitation scheduled for non-cardiac surgery.

a Coronary angiography + PCI/CABG on a case-by-case according to the expert team.

ECG, electrocardiogram; GDMT, guideline-directed medical therapy; N, no; NCS, non-cardiac surgery; TTE, transthoracic echocardiography; TEE, transoesophageal echocardiography; TEER, transcatheter edge-to-edge repair. Y, yes;

**Table 15. Noncardiac Surgery****ESC 2022 GL on Noncardiac Surgery**

| <b>Mitral valve regurgitation</b>                                                                                                                                                                                                                                              |            |          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|----------|
| In patients with symptomatic severe primary MR or asymptomatic severe primary MR with LV dysfunction (LVESD $\geq$ 40 mm and/or LVEF $\leq$ 60%), valve intervention (surgical or transcatheter) should be considered prior to intermediate- or high-risk NCS, if time allows. | <b>IIa</b> | <b>C</b> |
| In patients with severe secondary MR who remain symptomatic despite guideline-directed medical therapy (including CRT if indicated), valve intervention (transcatheter or surgical) should be considered before NCS, in eligible patients with an acceptable procedural risk.  | <b>IIa</b> | <b>C</b> |

**AHA/ACC 2024 GL on Noncardiac Surgery**

|    |      |                                                                                                                                                                                              |
|----|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 2a | C-LD | 3. In asymptomatic patients with moderate or severe MR, normal LV systolic function, and estimated PA systolic pressure <50 mm Hg, it is reasonable to perform elective NCS.* <sup>4,5</sup> |
| 2a | C-EO | 2. For patients who undergo MV TEER, it is reasonable to perform NCS after the successful MV intervention as clinically indicated. <sup>4</sup>                                              |

**Table 16. ESC 2020 GL on Sports. Mitral Regurgitation****Recommendations for participation in recreational/leisure-time sports in asymptomatic individuals with mitral regurgitation\*****Mild**

Participation in all sports I C

**Moderate**

Participation in all recreational sports, if: IIa C

- LVEDD <60 mm or <35.3 mm/m<sup>2</sup> in men and <40 mm/m<sup>2</sup> in women
- LVEF  $\geq$  60%
- Resting sPAP <50 mmHg
- Normal exercise test

**Severe**

Participation in all recreational sports involving low and moderate intensity, if: IIb C

- LVEDD <60 mm or <35.3 mm/m<sup>2</sup> in men and <40 mm/m<sup>2</sup> in women
- LVEF  $\geq$  60%
- Resting sPAP <50 mmHg
- Normal exercise test

## Recommendations for participation in competitive sports in asymptomatic individuals with mitral regurgitation

### Mild

Participation in all competitive sports

I C

### Moderate

Participation in all competitive sports, if:

IIa C

- LVEDD < 60 mm or < 35.3 mm/m<sup>2</sup> in men and < 40 mm/m<sup>2</sup> in women
- LVEF > 60%
- Resting sPAP < 50 mmHg
- Normal exercise test

### Severe

Participation in competitive sports involving low exercise intensity, if:

IIb C

- LVEDD < 60 mm or < 35.3 mm/m<sup>2</sup> in men and < 40 mm/m<sup>2</sup> in women
- LVEF > 60%
- Resting sPAP < 50 mmHg
- Normal exercise test

Participation in competitive sports is not recommended in LVEF < 60%

III C

LVEDD = left ventricular end-diastolic diameter; LVEF = left ventricular ejection fraction;  
MR = mitral regurgitation; sPAP = systolic pulmonary artery pressure.

\* For mixed valvular disease, the recommendation for the predominant valve lesion should be followed. No collision or body contact sports if anticoagulated for atrial fibrillation.