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American
Heart
Association.

Guideline for the Management of Patients With Valvular Heart Disease

Mitral and Tricuspid Regurgitation

Derived From:

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Full-text guidelines available in both *Circulation* and *JACC*.



Note: The numbering of the following tables and figures may differ from that of the Clinical Practice Guideline.

Table 1. Evaluation of Patients With Known or Suspected VHD		
Reason	Test	Indication
Initial evaluation: All patients with known or suspected valve disease	TTE*	Establishes chamber size and function, valve morphology and severity, and effect on pulmonary and systemic circulation
	History and physical	Establishes symptom severity, comorbidities, valve disease presence and severity, and presence of HF
	ECG	Establishes rhythm, LV function, and presence or absence of hypertrophy
Further diagnostic testing: Information required for equivocal symptom status, discrepancy between examination and echocardiogram, further definition of valve disease, or assessing response of the ventricles and pulmonary circulation to load and to exercise	Chest x-ray	Important for the symptomatic patient; establishes heart size and presence or absence of pulmonary vascular congestion, intrinsic lung disease, and calcification of aorta and pericardium
	TEE	Provides high-quality assessment of mitral and prosthetic valve, including definition of intracardiac masses and possible associated abnormalities (e.g., intracardiac abscess, LA thrombus)
	CMR	Provides assessment of LV volumes and function, valve severity, and aortic disease
	PET CT	Aids in determination of active infection or inflammation
	Stress testing	Gives an objective measure of exercise capacity
	Catheterization	Provides measurement of intracardiac and pulmonary pressures, valve severity, and hemodynamic response to exercise and drugs

Table 1. Evaluation of Patients With Known or Suspected VHD (cont'd)

Reason	Test	Indication
Further risk stratification: Information on future risk of the valve disease, which is important for determination of timing of intervention	Biomarkers	Provide indirect assessment of filling pressures and myocardial damage
	TTE strain	Helps assess intrinsic myocardial performance
	CMR	Assesses fibrosis by gadolinium enhancement
	Stress testing	Provides prognostic markers
	Procedural risk	Quantified by STS (Predicted Risk of Mortality) and TAVI scores
Preprocedural testing: Testing required before valve intervention	Frailty score	Provides assessment of risk of procedure and chance of recovery of quality of life
	Dental examination	Rules out potential infection sources
	CT coronary angiogram or invasive coronary angiogram	Gives an assessment of coronary anatomy
	CT: peripheral	Assesses femoral access for TAVI and other transcatheter procedures
	CT: cardiac	Assesses suitability for TAVI and other transcatheter procedures

* TTE is the standard initial diagnostic test in the initial evaluation of patients with known or suspected VHD.

2.6. The Multidisciplinary Heart Valve Team and Heart Valve Centers

COR	LOE	Recommendations
1	C-EO	Patients with severe VHD should be evaluated by a Multidisciplinary Heart Valve Team (MDT) when intervention is considered.
2a	C-LD	Consultation with or referral to a Primary or Comprehensive Heart Valve Center is reasonable when treatment options are being discussed for 1) asymptomatic patients with severe VHD, 2) patients who may benefit from valve repair versus valve replacement, or 3) patients with multiple comorbidities for whom valve intervention is considered.

Stage	Definition	Description
A	At risk	Patients with risk factors for development of VHD
B	Progressive	Patients with progressive VHD (mild-to-moderate severity and asymptomatic)
C	Asymptomatic severe	Asymptomatic patients who meet the criteria for severe VHD: C1: Asymptomatic patients with severe VHD in whom the left or right ventricle remains compensated C2: Asymptomatic patients with severe VHD, with decompensation of the left or right ventricle
D	Symptomatic severe	Patients who have developed symptoms as a result of VHD

Stage	Valve Lesion			
	Aortic		Mitral	
	Aortic Stenosis*	Regurgitation	Mitral Stenosis	Regurgitation
Progressive (stage B)	Every 3–5 y (mild severity; V_{max} 2.0–2.9 m/s)	Every 3–5 y (mild severity)	Every 3–5 y (mitral valve area [MVA] >1.5 cm ²)	Every 3–5 y (mild severity)
	Every 1–2 y (moderate severity; V_{max} 3.0–3.9 m/s)	Every 1–2 y (moderate severity)		Every 1–2 y (moderate severity)
Severe asymptomatic (stage C1)	Every 6–12 mo (V_{max} ≥4 m/s)	Every 6–12 mo	Every 1–2 y (MVA 1.0–1.5 cm ²)	Every 6–12 mo
		Dilating LV: more frequently	Every year (MVA <1.0 cm ²)	Dilating LV: more frequently

Patients with mixed valve disease may require serial evaluations at intervals earlier than recommended for single-valve lesions. These intervals apply to most patients with each valve lesion and do not take into consideration the etiology of the valve disease.

* With normal stroke volume.

Criteria	Low-Risk SAVR (Must Meet ALL Criteria in This Column)	Low-Risk Surgical Mitral Valve Repair for Primary MR (Must Meet ALL Criteria in This Column)	High Surgical Risk (Any 1 Criterion in This Column)	Prohibitive Surgical Risk (Any 1 Criterion in This Column)
STS-predicted risk of death*	<3% AND	<1% AND	>8% OR	Predicted risk of death or major morbidity (all-cause) >50% at 30 d OR
Frailty [†]	None AND	None AND	≤1 Indices (moderate to severe) OR	≥2 Indices (moderate to severe) OR
Cardiac or other major organ system compromise not to be improved postoperatively [‡]	None AND	None AND	1 to 2 Organ systems OR	≥3 Organ systems OR
Procedure-specific impediment [§]	None	None	Possible procedure-specific impediment	Severe procedure-specific impediment

* Use of the STS Predicted Risk of Mortality (<http://riskcalc.sts.org/stswebriskcalc/#/>) to predict risk in a given institution with reasonable reliability is appropriate only if institutional outcomes are within 1 standard deviation of the STS average observed/expected mortality ratio for the procedure in question. The EUROSCORE II risk calculator may also be considered for use and is available at <http://www.euroscore.org/calc.html>.

[†] Seven frailty indices: Katz Activities of Daily Living (independence in feeding, bathing, dressing, transferring, toileting, and urinary continence) plus independence in ambulation (no walking aid or assistance required, or completion of a 5-m walk in <6 s). Other scoring systems can be applied to calculate no, mild, or moderate to severe frailty.

[‡] Examples of major organ system compromise include cardiac dysfunction (severe LV systolic or diastolic dysfunction or RV dysfunction, fixed pulmonary hypertension); kidney dysfunction (chronic kidney disease, stage 3 or worse); pulmonary dysfunction (FEV1 <50% or D_{LCO_2} <50% of predicted); central nervous system dysfunction (dementia, Alzheimer's disease, Parkinson's disease, cerebrovascular accident with persistent physical limitation); gastrointestinal dysfunction (Crohn's disease, ulcerative colitis, nutritional impairment, or serum albumin <3.0); cancer (active malignancy); and liver dysfunction (any history of cirrhosis, variceal bleeding, or elevated INR in the absence of VKA therapy).

[§] Examples of procedure-specific impediments include presence of tracheostomy, heavily calcified (porcelain) ascending aorta, chest malformation, arterial coronary graft adherent to posterior chest wall, and radiation damage.

Mitral Regurgitation

Table 5. Stages of Chronic Primary MR

Stage	Definition	Valve Anatomy	Valve Hemodynamics*	Hemodynamic Consequences	Symptoms
A	At risk of MR	<ul style="list-style-type: none"> Mild MV prolapse with normal coaptation Mild valve thickening and leaflet restriction 	<ul style="list-style-type: none"> No MR jet or small central jet area <20% LA on Doppler Small vena contracta <0.3 cm 	None	None
B	Progressive MR	<ul style="list-style-type: none"> Moderate to severe MV prolapse with normal coaptation Rheumatic valve changes with leaflet restriction and loss of central coaptation Prior IE 	<ul style="list-style-type: none"> Central jet MR 20%–40% LA or late systolic eccentric jet MR Vena contracta <0.7 cm RVol <60 mL RF <50% ERO <0.40 cm² Angiographic grade 1+ to 2+ 	<ul style="list-style-type: none"> Mild LA enlargement No LV enlargement Normal pulmonary pressure 	None
C	Asymptomatic severe MR	<ul style="list-style-type: none"> Severe MV prolapse with loss of coaptation or flail leaflet Rheumatic valve changes with leaflet restriction and loss of central coaptation Prior IE Thickening of leaflets with radiation heart disease 	<ul style="list-style-type: none"> Central jet MR >40% LA or holosystolic eccentric jet MR Vena contracta ≥0.7 cm RVol ≥60 mL RF ≥50% ERO ≥0.40 cm² Angiographic grade 3+ to 4+ 	<ul style="list-style-type: none"> Moderate or severe LA enlargement LV enlargement PHTN may be present at rest or with exercise C1: LVEF >60% and LVESD <40 mm C2: LVEF ≤60% and/or LVESD ≥40 mm 	None
D	Symptomatic severe MR	<ul style="list-style-type: none"> Severe MV prolapse with loss of coaptation or flail leaflet Rheumatic valve changes with leaflet restriction and loss of central coaptation Prior IE Thickening of leaflets with radiation heart disease 	<ul style="list-style-type: none"> Central jet MR >40% LA or holosystolic eccentric jet MR Vena contracta ≥0.7 cm RVol ≥60 mL RF ≥50% ERO ≥0.40 cm² Angiographic grade 3+ to 4+ 	<ul style="list-style-type: none"> Moderate or severe LA enlargement LV enlargement PHTN present 	<ul style="list-style-type: none"> Decreased exercise tolerance Exertional dyspnea

* 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.



7.2.2.1. Diagnostic Testing: Initial Diagnosis		
COR	LOE	Recommendations
1	B-NR	In patients with known or suspected primary MR, TTE is indicated for baseline evaluation of LV size and function, RV function, LA size, pulmonary artery pressure, and the mechanism and severity of primary MR (Stages A to D).
1	C-EO	In patients with primary MR, when TTE provides insufficient or discordant information, TEE is indicated for evaluation of the severity of MR, mechanism of MR, and status of LV function (Stages B to D).
1	B-NR	In patients with primary MR, CMR is indicated to assess LV and RV volumes and function and may help with assessing MR severity when there is a discrepancy between the findings on clinical assessment and echocardiography.
1	B-NR	In patients with severe primary MR undergoing mitral intervention, intraoperative TEE is indicated to establish the anatomic basis for primary MR (Stages C and D) and to guide repair.

7.2.2.2. Diagnostic Testing: Changing Signs or Symptoms		
COR	LOE	Recommendation
1	B-NR	In patients with primary MR (Stages B to D) and new-onset or changing symptoms, TTE is indicated to evaluate the mitral valve apparatus and LV function.

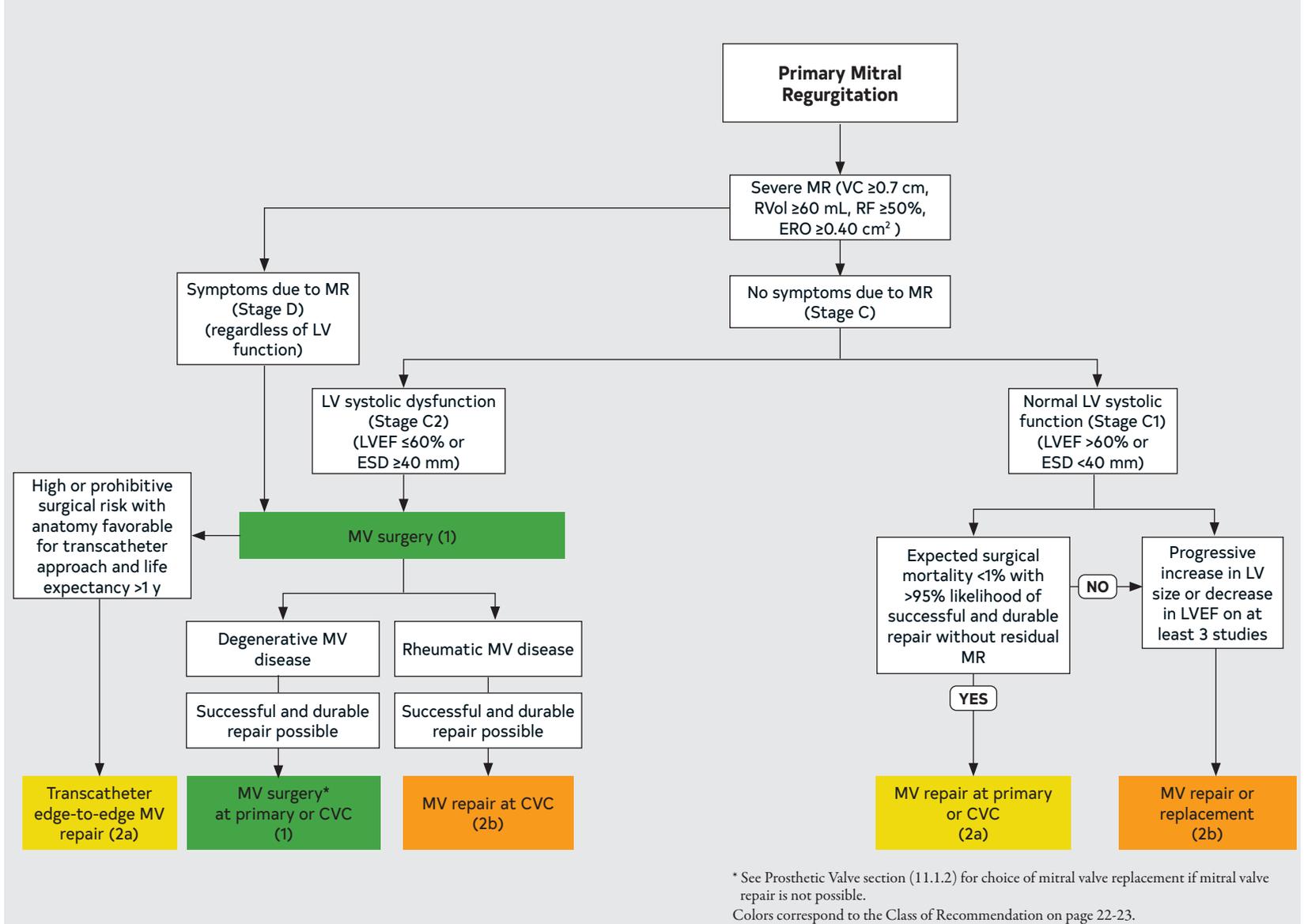
7.2.2.3. Diagnostic Testing: Routine Follow-Up		
COR	LOE	Recommendations
1	B-NR	For asymptomatic patients with severe primary MR (Stages B and C1), TTE is indicated every 6 to 12 months for surveillance of LV function (estimated by LVEF, LVESD, and LVESD) and assessment of pulmonary artery pressure.
2b	B-NR	In asymptomatic patients with severe primary MR (Stages B and C1), use of serum biomarkers and novel measurements of LV function, such as global longitudinal strain, may be considered as an adjunct to guide timing of intervention.

7.2.2.5. Diagnostic Testing: Exercise Testing		
COR	LOE	Recommendation
2a	B-NR	In patients with primary MR (Stages B and C) and symptoms that might be attributable to MR, hemodynamic exercise testing using Doppler echocardiography or cardiac catheterization or cardiopulmonary exercise testing is reasonable.

7.2.3. Medical Therapy		
COR	LOE	Recommendations
2a	B-NR	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, GDMT for systolic dysfunction is reasonable.
3: No Benefit	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.

7.2.4. Intervention		
COR	LOE	Recommendations
1	B-NR	In symptomatic patients with severe primary MR (Stage D), mitral valve intervention is recommended irrespective of LV systolic function.
1	B-NR	In asymptomatic patients with severe primary MR and LV systolic dysfunction (LVEF \leq 60%, LVESD \geq 40 mm) (Stage C2), mitral valve surgery is recommended.
1	B-NR	In patients with severe primary MR for whom surgery is indicated, mitral valve repair is recommended in preference to mitral valve replacement when the anatomic cause of MR is degenerative disease, if a successful and durable repair is possible.
2a	B-NR	In asymptomatic patients with severe primary MR and normal LV systolic function (LVEF \geq 60% and LVESD \leq 40 mm) (Stage C1), mitral valve repair is reasonable 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.
2b	C-LD	In 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, mitral valve surgery may be considered irrespective of the probability of a successful and durable repair.
2a	B-NR	In severely symptomatic patients (NYHA class III or IV) with primary severe MR and high or prohibitive surgical risk, transcatheter edge-to-edge repair (TEER) is reasonable if mitral valve anatomy is favorable for the repair procedure and patient life expectancy is at least 1 year.
2b	B-NR	In symptomatic patients with severe primary MR attributable to rheumatic valve disease, mitral valve repair may be considered at a Comprehensive Valve Center by an experienced team when surgical treatment is indicated, if a durable and successful repair is likely.
3: Harm	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 repair has been attempted at a Primary or Comprehensive Valve Center and was unsuccessful.

Figure 1. Primary MR



* See Prosthetic Valve section (11.1.2) for choice of mitral valve replacement if mitral valve repair is not possible.
 Colors correspond to the Class of Recommendation on page 22-23.



Table 6. 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"> • Normal valve leaflets, chords, and annulus in a patient with coronary artery disease or cardiomyopathy 	<ul style="list-style-type: none"> • No MR jet or small central jet area <20% LA on Doppler • Small vena contracta <0.30 cm 	<ul style="list-style-type: none"> • Normal or mildly dilated LV size with fixed (infarction) or inducible (ischemia) regional wall motion abnormalities • Primary myocardial disease with LV dilation and systolic dysfunction 	<ul style="list-style-type: none"> • Symptoms due to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy
B	Progressive MR	<ul style="list-style-type: none"> • Regional wall motion abnormalities with mild tethering of mitral leaflet • Annular dilation with mild loss of central coaptation of the mitral leaflets 	<ul style="list-style-type: none"> • ERO <0.40 cm²† • Regurgitant volume <60 mL • Regurgitant fraction <50% 	<ul style="list-style-type: none"> • Regional wall motion abnormalities with reduced LV systolic function • LV dilation and systolic dysfunction due to primary myocardial disease 	<ul style="list-style-type: none"> • Symptoms due to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy
C	Asymptomatic severe MR	<ul style="list-style-type: none"> • Regional wall motion abnormalities and/or LV dilation with severe tethering of mitral leaflet • Annular dilation with severe loss of central coaptation of the mitral leaflets 	<ul style="list-style-type: none"> • ERO ≥0.40 cm²† • Regurgitant volume ≥60 mL‡ • Regurgitant fraction ≥50% 	<ul style="list-style-type: none"> • Regional wall motion abnormalities with reduced LV systolic function • LV dilation and systolic dysfunction due to primary myocardial disease 	<ul style="list-style-type: none"> • Symptoms due to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy
D	Symptomatic severe MR	<ul style="list-style-type: none"> • Regional wall motion abnormalities and/or LV dilation with severe tethering of mitral leaflet • Annular dilation with severe loss of central coaptation of the mitral leaflets 	<ul style="list-style-type: none"> • ERO ≥0.40 cm²† • Regurgitant volume ≥60 mL‡ • Regurgitant fraction ≥50% 	<ul style="list-style-type: none"> • Regional wall motion abnormalities with reduced LV systolic function • LV dilation and systolic dysfunction due to primary myocardial disease 	<ul style="list-style-type: none"> • HF symptoms due to MR persist even after revascularization and optimization of medical therapy • Decreased exercise tolerance • Exertional dyspnea

* 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.

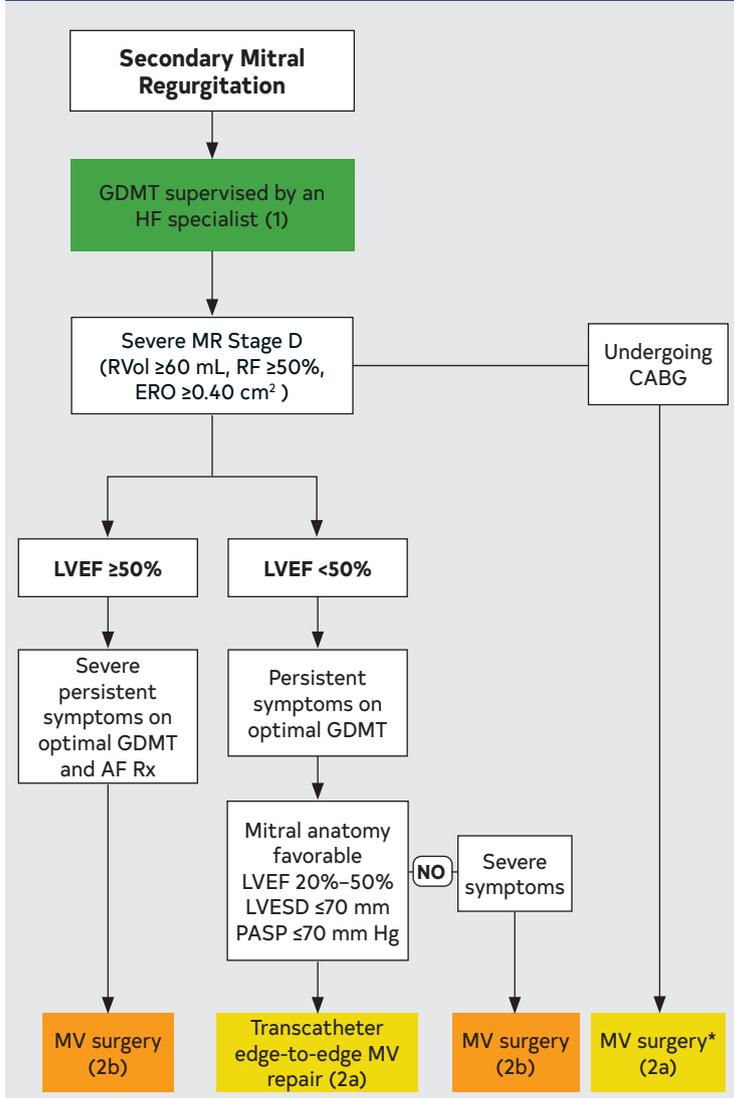
‡ May be lower in low-flow states.

7.3.2. Diagnosis of Chronic Secondary MR		
COR	LOE	Recommendations
1	B-NR	In patients with chronic secondary MR (Stages B to D), TTE is useful to establish the etiology and to assess the extent of regional and global LV remodeling and systolic dysfunction, severity of MR, and magnitude of pulmonary hypertension.
1	C-EO	In patients with chronic secondary MR (Stages B to D), noninvasive imaging (stress nuclear/PET, CMR, or stress echocardiography), coronary CT angiography, or coronary arteriography is useful to establish etiology of MR and to assess myocardial viability.
1	B-NR	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, TEE is indicated to determine suitability for the procedure.
1	C-EO	In patients with chronic secondary MR undergoing transcatheter mitral valve intervention, intraprocedural guidance with TEE is recommended.

7.3.3. Medical Therapy for Secondary MR		
COR	LOE	Recommendations
1	A	Patients with chronic severe secondary MR (Stages C and D) and HF with reduced LVEF should receive standard GDMT for HF, including ACE inhibitors, ARBs, beta blockers, aldosterone antagonists, and/or sacubitril/valsartan, and biventricular pacing as indicated.
1	C-EO	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.

7.3.4. Intervention for Secondary MR		
COR	LOE	Recommendations
2a	B-R	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), transcatheter edge-to-edge mitral valve (TEER) repair is reasonable 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 mm Hg.
2a	B-NR	In patients with severe secondary MR (Stages C and D), mitral valve surgery is reasonable when CABG is undertaken for the treatment of myocardial ischemia.
2b	B-NR	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), mitral valve surgery may be considered.
2b	B-NR	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), mitral valve surgery may be considered.
2b	B-R	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, chordal-sparing mitral valve replacement may be reasonable to choose over downsized annuloplasty repair.

Figure 2. Secondary MR



* Chordal sparing mitral valve replacement may be reasonable to choose over downsized annuloplasty repair.

Colors correspond to the Class of Recommendation on page 22-23.

Tricuspid Regurgitation

8.2.1. Diagnosis of TR

COR	LOE	Recommendations
1	C-LD	In patients with TR, TTE is indicated to evaluate the presence and severity of TR, determine the etiology, measure the sizes of the right-sided chambers and inferior vena cava, assess RV systolic function, estimate pulmonary artery systolic pressure, and characterize any associated left-sided heart disease.
2a	C-LD	In patients with TR, invasive measurement of the cardiac index, right-sided diastolic pressures, pulmonary artery pressures, and pulmonary vascular resistance, as well as right ventriculography, can be useful when clinical and noninvasive data are discordant or inadequate.

Table 7. Classification of TR

Primary	Secondary
<ul style="list-style-type: none"> • Rheumatic • Infective endocarditis • Iatrogenic (device leads, endomyocardial biopsy) • Congenital (e.g., Ebstein's, levo-transposition of the great arteries) • Other (trauma, carcinoid, drugs, irradiation, etc.) 	<ul style="list-style-type: none"> • Pulmonary hypertension with RV remodeling (primary or secondary to left-sided heart disease) • Dilated cardiomyopathy • Annular dilation (associated with AF)* • RV volume overload (shunts/ high output)

* Isolated TR is associated with AF and has LVEF >60%, pulmonary artery systolic pressure <50 mm Hg, and no left-sided valve disease, with normal-appearing tricuspid valve leaflets.



Table 8. Stages of Tricuspid Regurgitation (TR)

Stage	Definition	Valve Hemodynamics	Hemodynamic Consequences	Clinical Symptoms and Presentation
B	Progressive TR	<ul style="list-style-type: none"> Central jet <50% RA Vena contracta width <0.7 cm ERO <0.40 cm² Regurgitant volume <45 mL 	<ul style="list-style-type: none"> None 	<ul style="list-style-type: none"> None
C	Asymptomatic severe TR	<ul style="list-style-type: none"> Central jet >50% RA Vena contracta width >0.7 cm ERO ≥0.40 cm² Regurgitant volume ≥45 mL Dense continuous wave signal with triangular shape Hepatic vein systolic flow reversal 	<ul style="list-style-type: none"> Dilated RV and RA Elevated RA with “c-V” wave 	<ul style="list-style-type: none"> Elevated venous pressure No symptoms
D	Symptomatic severe TR	<ul style="list-style-type: none"> Central jet ≥50% RA Vena contracta width ≥0.7 cm ERO ≥0.40 cm² Regurgitant volume ≥45 mL Dense continuous wave signal with triangular shape Hepatic vein systolic flow reversal 	<ul style="list-style-type: none"> Dilated RV and RA Elevated RA with “c-V” wave 	<ul style="list-style-type: none"> Elevated venous pressure Dyspnea on exertion, fatigue, ascites, edema

8.2.2. Medical Therapy for TR

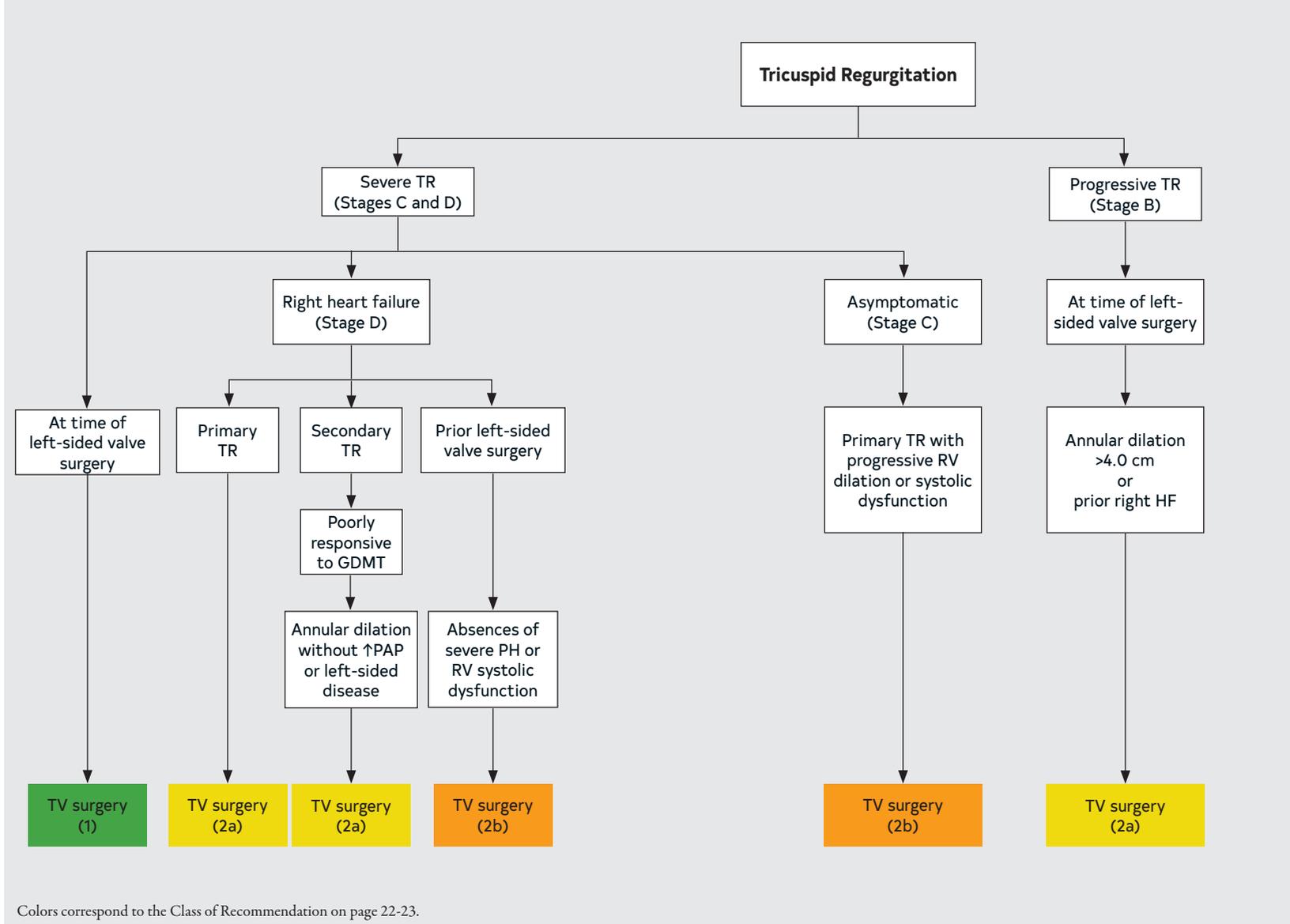
COR	LOE	Recommendations
2a	C-EO	In patients with signs and symptoms of right-sided HF attributable to severe TR (Stages C and D), diuretics can be useful.
2a	C-EO	In patients with signs and symptoms of right-sided HF attributable to severe secondary TR (Stages C and D), therapies to treat the primary cause of HF (e.g., pulmonary vasodilators to reduce elevated pulmonary artery pressures, GDMT for HF with reduced LVEF, or rhythm control of AF) can be useful.

8.2.3. Timing of Intervention

COR	LOE	Recommendations
1	B-NR	In patients with severe TR (Stages C and D) undergoing left-sided valve surgery, tricuspid valve surgery is recommended.
2a	B-NR	In patients with progressive TR (Stage B) undergoing left-sided valve surgery, tricuspid valve surgery can be beneficial in the context of either 1) tricuspid annular dilation (tricuspid annulus end diastolic diameter >4.0 cm) or 2) prior signs and symptoms of right-sided HF.
2a	B-NR	In patients with signs and symptoms of right-sided HF and severe primary TR (Stage D), isolated tricuspid valve surgery can be beneficial to reduce symptoms and recurrent hospitalizations.
2a	B-NR	In patients with signs and symptoms of right-sided HF and severe isolated secondary TR attributable to annular dilation (in the absence of pulmonary hypertension or left-sided disease) who are poorly responsive to medical therapy (Stage D), isolated tricuspid valve surgery can be beneficial to reduce symptoms and recurrent hospitalizations.
2b	C-LD	In asymptomatic patients with severe primary TR (Stage C) and progressive RV dilation or systolic dysfunction, isolated tricuspid valve surgery may be considered.
2b	B-NR	In patients with signs and symptoms of right-sided HF and severe TR (Stage D) who have undergone previous left-sided valve surgery, reoperation with isolated tricuspid valve surgery may be considered in the absence of severe pulmonary hypertension or severe RV systolic dysfunction.



Figure 3. Tricuspid Regurgitation



Colors correspond to the Class of Recommendation on page 22-23.



CLASS (STRENGTH) OF RECOMMENDATION	
CLASS I (STRONG)	Benefit >>> Risk
Suggested phrases for writing recommendations:	
<ul style="list-style-type: none"> ■ Is recommended ■ Is indicated/useful/effective/beneficial ■ Should be performed/administered/other ■ Comparative-Effectiveness Phrases[†]: <ul style="list-style-type: none"> ○ Treatment/strategy A is recommended/indicated in preference to treatment B ○ Treatment A should be chosen over treatment B 	
CLASS 2a (MODERATE)	Benefit >> Risk
Suggested phrases for writing recommendations:	
<ul style="list-style-type: none"> ■ Is reasonable ■ Can be useful/effective/beneficial ■ Comparative-Effectiveness Phrases[†]: <ul style="list-style-type: none"> ○ Treatment/strategy A is probably recommended/indicated in preference to treatment B ○ It is reasonable to choose treatment A over treatment B 	
CLASS 2b (WEAK)	Benefit ≥ Risk
Suggested phrases for writing recommendations:	
<ul style="list-style-type: none"> ■ May/might be reasonable ■ May/might be considered ■ Usefulness/effectiveness is unknown/unclear/uncertain or not well-established 	
CLASS 3: No Benefit (MODERATE)	Benefit = Risk
<i>(Generally, LOE A or B use only)</i>	
Suggested phrases for writing recommendations:	
<ul style="list-style-type: none"> ■ Is not recommended ■ Is not indicated/useful/effective/beneficial ■ Should not be performed/administered/other 	
CLASS 3: Harm (STRONG)	Risk > Benefit
Suggested phrases for writing recommendations:	
<ul style="list-style-type: none"> ■ Potentially harmful ■ Causes harm ■ Associated with excess morbidity/mortality ■ Should not be performed/administered/other 	

LEVEL (QUALITY) OF EVIDENCE [‡]	
LEVEL A	
<ul style="list-style-type: none"> ■ High-quality evidence[‡] from more than 1 RCT ■ Meta-analyses of high-quality RCTs ■ One or more RCTs corroborated by high-quality registry studies 	
LEVEL B-R	(Randomized)
<ul style="list-style-type: none"> ■ Moderate-quality evidence[‡] from 1 or more RCTs ■ Meta-analyses of moderate-quality RCTs 	
LEVEL B-NR	(Nonrandomized)
<ul style="list-style-type: none"> ■ Moderate-quality evidence[‡] from 1 or more well-designed, well-executed nonrandomized studies, observational studies, or registry studies ■ Meta-analyses of such studies 	
LEVEL C-LD	(Limited Data)
<ul style="list-style-type: none"> ■ Randomized or nonrandomized observational or registry studies with limitations of design or execution ■ Meta-analyses of such studies ■ Physiological or mechanistic studies in human subjects 	
LEVEL C-EO	(Expert Opinion)
Consensus of expert opinion based on clinical experience	

COR and LOE are determined independently (any COR may be paired with any LOE).

A recommendation with LOE C does not imply that the recommendation is weak. Many important clinical questions addressed in guidelines do not lend themselves to clinical trials. Although RCTs are unavailable, there may be a very clear clinical consensus that a particular test or therapy is useful or effective.

* The outcome or result of the intervention should be specified (an improved clinical outcome or increased diagnostic accuracy or incremental prognostic information).

† For comparative-effectiveness recommendations (COR I and IIa; LOE A and B only), studies that support the use of comparator verbs should involve direct comparisons of the treatments or strategies being evaluated.

‡ The method of assessing quality is evolving, including the application of standardized, widely used, and preferably validated evidence grading tools; and for systematic reviews, the incorporation of an Evidence Review Committee.

COR indicates Class of Recommendation; EO, expert opinion; LD, limited data; LOE, Level of Evidence; NR, nonrandomized; R, randomized; RCT, randomized controlled trial.

Abbreviations

2D, 2-dimensional; ACE, angiotensin-converting enzyme; AF, atrial fibrillation; CABG, coronary artery bypass graft surgery; CAD, coronary artery disease; CMR, cardiac magnetic resonance; COR, Class of Recommendation; CT, computed tomography; ECG, electrocardiogram; GDMT, guideline-directed management and therapy; HF, heart failure; IE, infective endocarditis; INR, international normalized ratio; LA, left atrium (left atrial); LOE, Level of Evidence; LV, left ventricle (left ventricular); LVEDD, left ventricular end-diastolic dimension; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic dimension; MDT, multidisciplinary team; MR, mitral regurgitation; NYHA, New York Heart Association; PET, positron emission tomography; RCT, randomized controlled trial; RV, right ventricle (right ventricular); SAVR, surgical aortic valve replacement; TAVI, transcatheter aortic valve implantation; TR, tricuspid regurgitation; TEE, transesophageal echocardiography (echocardiogram); TEER, transcatheter edge to edge repair; TTE, transthoracic echocardiography (echocardiogram); VHD, valvular heart disease; VKA, vitamin K antagonist



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