Clinical Update

ADAPTED FROM:

2020 ACC/AHA Guideline for the Management of Patients With Valvular Heart Disease



Table 1. ACC/AHA **Applying Class of** Recommendation and Level of **Evidence to** Clinical Strategies, Interventions, Treatments, or **Diagnostic Testing** in Patient Care (Updated May 2019)*



CLASS (STRENGTH) OF RECOMMENDATION	
CLASS 1 (STRONG)	Benefit >>> Risk
Suggested phrases for writing recommendations: Is recommended Is indicated/useful/effective/beneficial 	
 Should be performed/administered/other Comparative-Effectiveness Phrases†: 	
 Treatment/strategy A is recommended/indicated in p treatment B Treatment A should be chosen over treatment B 	preference to
CLASS 2a (MODERATE)	Benefit >> Risk
Suggested phrases for writing recommendations: Is reasonable Can be useful/effective/beneficial Comparative-Effectiveness Phrases†: 	
 Treatment/strategy A is probably recommended/indi treatment B 	icated in preference to
 It is reasonable to choose treatment A over treatment 	t B
CLASS 2b (Weak)	Benefit ≥ Risk
Suggested phrases for writing recommendations: • May/might be reasonable	
May/might be consideredUsefulness/effectiveness is unknown/unclear/uncertain of	or not well-established
CLASS 3: No Benefit (MODERATE)	Benefit = Risk
 Suggested phrases for writing recommendations: Is not recommended Is not indicated/useful/effective/beneficial 	
Should not be performed/administered/other	
CLASS 3: Harm (STRONG)	Risk > Benefit
CLASS 5: HUIIII (STRONG)	
Suggested phrases for writing recommendations:	

CLASS (STRENGTH) OF RECOMMENDATION

LEVEL (QUALITY) OF EVIDENCE[‡]

EL A

- ligh-guality evidence‡ from more than 1 RCT
- 1eta-analyses of high-guality RCTs
- One or more RCTs corroborated by high-guality registry studies

EL B-R

- Moderate-quality evidence‡ from 1 or more RCTs
- Meta-analyses of moderate-guality RCTs

EL B-NR

(Nonrandomized)

(Randomized)

- Moderate-quality evidence‡ from 1 or more well-designed, wellexecuted nonrandomized studies, observational studies, or registry tudies
- Meta-analyses of such studies

EL C-LD

(Limited Data)

- 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

EL C-EO

- (Expert Opinion)
- Consensus of expert opinion based on clinical experience.

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

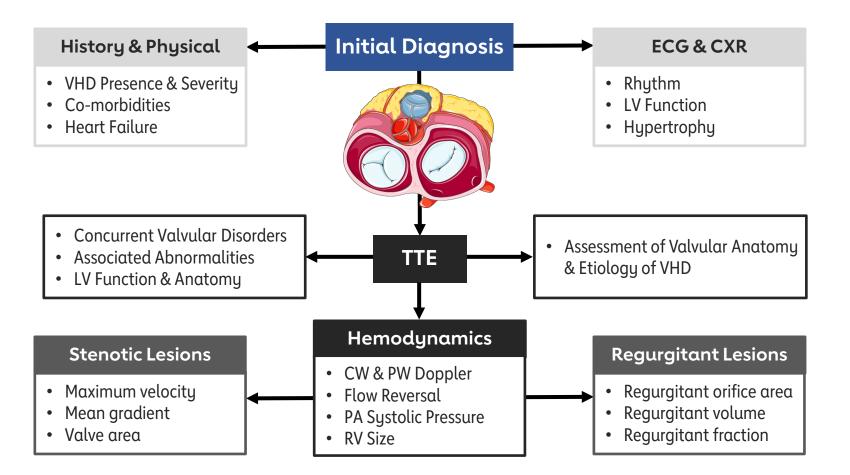
mendation with LOE C does not imply that the recommendation is weak. Many nt clinical questions addressed in quidelines do not lend themselves to clinical trials. h RCTs are unavailable, there may be a very clear clinical consensus that a particular nerapu is useful or effective.

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

nparative-effectiveness recommendation (COR 1 and 2a; LOE A and B only), studies port the use of comparator verbs should involve direct comparisons of the treatments gies being evaluated.

thod of assessing quality is evolving, including the application of standardized, used, and preferably validated evidence grading tools; and for systematic reviews, the ation of an Evidence Review Committee. COR indicates Class of Recommendation; ert opinion: LD, limited data: LOE, Level of Evidence: NR, nonrandomized: R, zed; and RCT, randomized controlled trial.

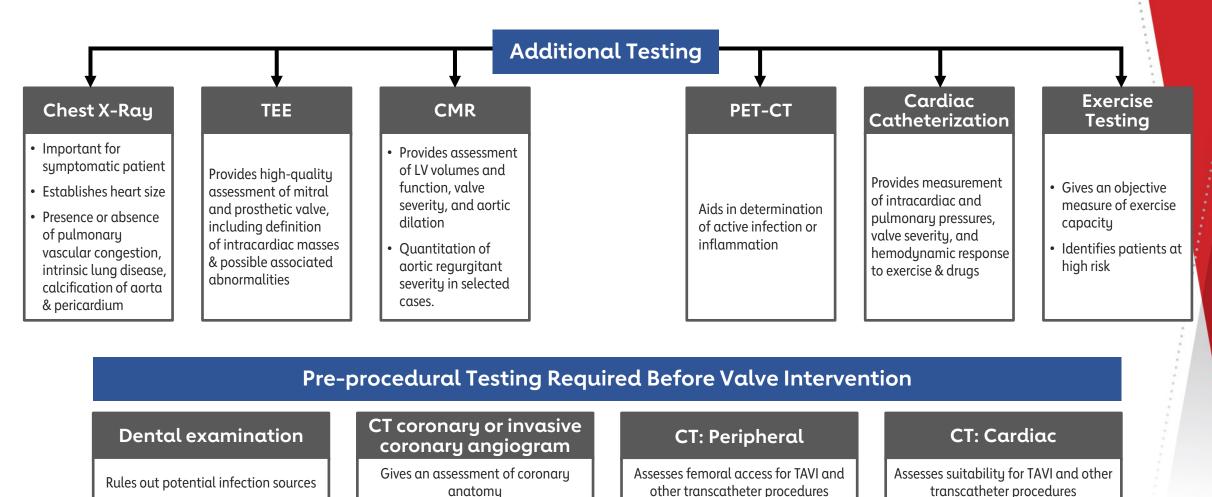
Evaluation of the Patient With Known or Suspected Native VHD



Abbreviations: CW indicates continuous wave; LV, left ventricle; PASP, pulmonary artery systolic pressure; PW, pulsed wave; RV, right ventricle; TTE, transthoracic echocardiography; and VHD, valvular heart disease.



Table 3. Additional Diagnostic Evaluation in VHD



Abbreviations: CW indicates continuous wave; LV, left ventricle; PASP, pulmonary artery systolic pressure; PW, pulsed wave; RV, right ventricle; TTE, transthoracic echocardiography; and VHD, valvular heart disease.



Table 4. Stages of VHD

STAGE	DEFINITION	DESCRIPTION
Α	At Risk	Patients with risk factors for development of VHD
В	Progressive	Patients with progressive VHD (mild to moderate severity and asymptomatic)
С	Asymptomatic Severe	 Asymptomatic patients who have the criteria for severe VHD: C1: Asymptomatic patients with severe VHD in whom the LV or RV remains compensated C2: Asymptomatic patients with severe VHD with decompensation of the LV or RV
D	Symptomatic Severe	Patients who have developed symptoms as a result of VHD

Abbreviations: C1 indicates stage C1; C2; stage C2; LV; left ventricle; RV, right ventricle; and VHD, valvular heart disease.



Diagnostic Testing: Follow-up

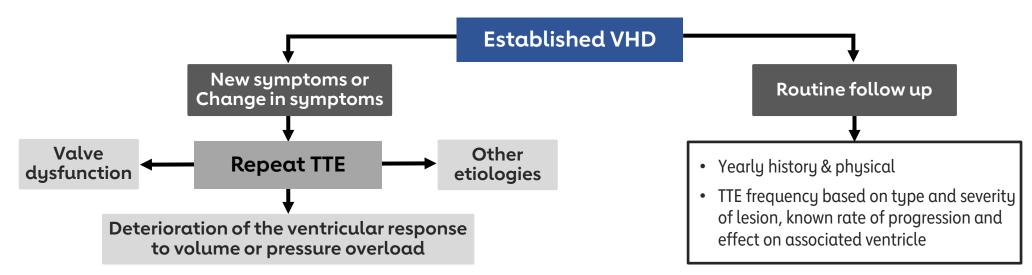


Table 5. Frequency of Echocardiograms in Asymptomatic Patients With VHD and Normal LV Function

	Aortic Stenosis *	Aortic Regurgitation	Mitral Stenosis	Mitral Regurgitation
Progressive (Stage B)	Every 3–5 y (mild severity; Vmax 2.0–2.9 m/s)	Every 3–5 y (mild severity)	Every 3–5 y	Every 3–5 y (mild severity)
	Every 1–2 y moderate severity; Vmax 3.0–3.9 m/s)	Every 1–2 y (moderate severity)	(MV area >1.5 cm²)	Every 1–2 y (moderate severity)
Severe asymptomatic	Every 6–12 mo	Every 6-12 mo	Every 1–2 y (MV area 1.0–1.5 cm²)	Every 6-12 months
(Stage C1)	(Vmax ≥4 m/s)	Dilating LV: More frequently	Every year (MV area <1.0 cm²)	Dilating LV: More frequently

Patients with mixed value disease may require serial evaluations at intervals earlier than recommended for single-value lesions. These intervals apply to most patients with each value lesion and do not take into consideration the etiology of the value disease. *With normal stroke volume. Stages C2 and D disease are not included in this table because they would be considered candidates for intervention.

Abbreviations: CMR indicates cardiac magentic resonance; LV, left ventricle; mo, month; m/s, milliseconds; MV, mitral valve; STS, Society of Thoracic Surgeons; TAVI, transcathether aortic valve implantation; TTE, transcathetheracic echocardiography; VHD, valvular heart disease; y, year; Vmax, maximum transvalvular velocity.



Recommended Treatment Regimens & Duration of Secondary Prophylaxis

Table 6. Secondary Prevention of Rheumatic Fever

Туре	Duration After Last Attack (whichever is longer)*	
Rheumatic fever with carditis <u>AND</u> persistent VHD (clinical or echo)	10 years	Until patient is 40 years of age
Rheumatic fever with carditis <u>BUT NO VHD</u>	10 years	Until patient is 21 years of age
Rheumatic fever <u>WITHOUT</u> carditis	5 years	Until patient is 21 years of age

Table 7. Duration of Secondary Prophylaxis for Rheumatic Fever

Antibiotics for Prevention	Dosage *
Penicillin G benzathine	1.2 million U IM q4 weeks†
Penicillin V potassium	200 mg orally twice daily
Sulfadiazine	1 gram orally once daily
Macrolide or azalide antibiotic (for patients allergic to penicillin and sulfadiazine)‡	Varies

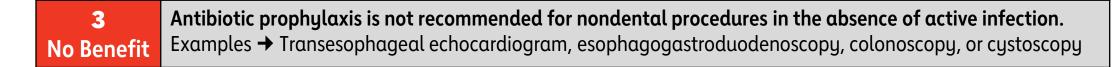
*In patients with documented valvular heart disease, the duration of rheumatic fever prophylaxis should be ≥10 y or until the patient is 40 y of age (whichever is longer). Lifelong prophylaxis may be recommended if the patient is at high risk of group A streptococcus exposure. Secondary rheumatic heart disease prophylaxis is required even after valve replacement. †Administration every 3 week is recommended in certain high-risk situations. ‡Macrolide antibiotics should not be used in persons taking other medications that inhibit cytochrome P450 3A, such as azole antifungal agents, HIV protease inhibitors, and some selective serotonin reuptake inhibitors.

Abbreviations: IM indicates intramuscular; mg; milligrams; Q; every; RHD, rheumatic heart disease; U; units; and VHD, valvular heart disease.



Classification of Recommendations for RHD & IE

4	Secondary Prevention of Rheumatic Fever
	In patients with rheumatic heart disease, secondary prevention of rheumatic fever is indicated.





Abbreviations: IE indicates infective endocarditis; RHD, rheumatic heart disease; VHD valvular heart disease.

Figure 1. Anticoagulation for AF in Patients With VHD Patient with VHD and AF Native valve disease **Bioprosthetic Rheumatic MS** (except rheumatic MS) Valve* **New-onset AF** within 3 months > 3 month after of valve procedure implantation Anticoagulation VKA or NOAC based on Long-term VKA with VKA CHA₂DS₂-VASc Score anticoagulation (2a) (1) (1)

* In patients with mechanical heart valves with or without AF who require long-term anticoagulation with VKA to prevent valve thrombosis, NOACs are not recommended. Class 3:Harm.

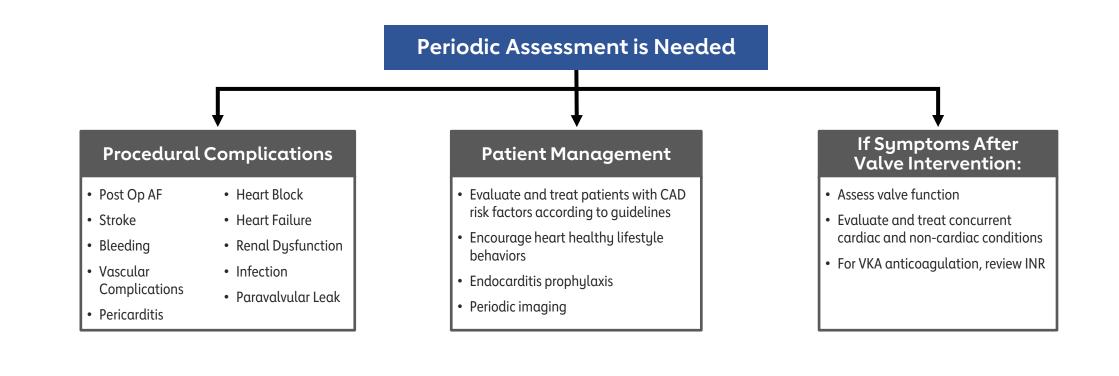
Abbreviations: AF indicates atrial fibrillation; CHA2DS2-VASc score, congestive heart failure, hypertension, age ≥ 75 years, diabetes mellitus, stroke or transient ischemic attack (TIA), vascular disease, age 65 to 74 years, sex category; MS, mitral stenosis; NOAC, non-vitamin K oral anticoagulant; VHD, valvular heart disease; and VKA, vitamin K antagonist.

American Heart

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Management of Patients with VHD After Valve Intervention





Abbreviations: 1 indicates primary; 2°, secondary; AF, atrial fibrillation; CAD, coronary artery disease; INR, international normalized ratio; Op, operative; VHD, valvular heart disease; and VKA, vitamin K antagonist.

Imaging After Valve Intervention

Valve Intervention	Minimal Imaging Frequency	
Bicuspid Aortic Valve Replacement	Continue monitoring if post aortic valve replacement aortic diameter ≥4 cm	
SURGICAL		
Mechanical Valve	Baseline	
Bioprosthetic Valve	Baseline, 5 &10 years post surgery, then annually	
Mitral Valve Repair	Baseline, 1 year, then every 2 to 3 years	
TRANSCATHETER		
Bioprosthetic Valve	Baseline, then annually	
Mitral Valve Repair	Baseline, then annually	



Abbreviations: cm indicates centimeters; LV, left ventricle; and PA, pulmonary artery.

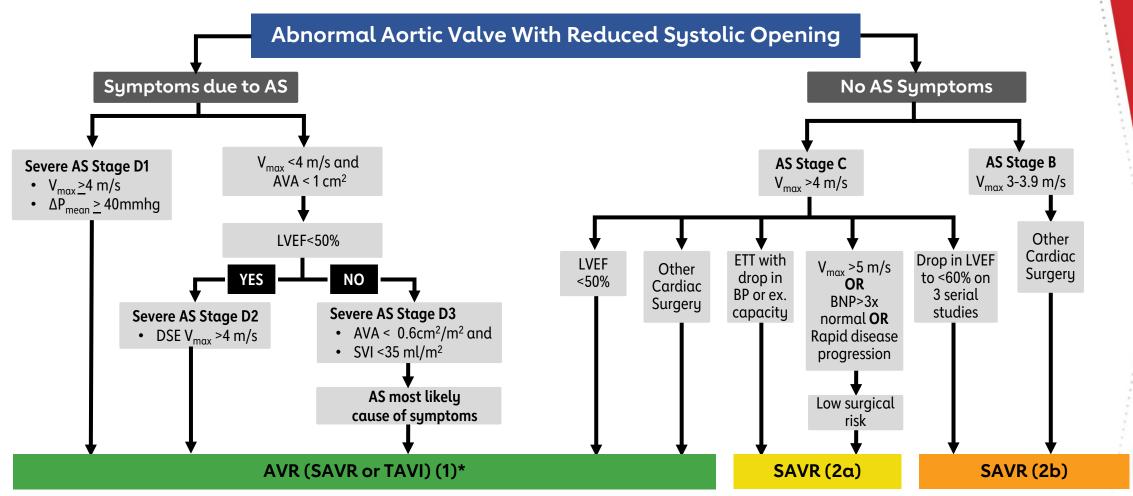
Table 13. The Evaluation and Management of Aortic Stenosis

STAGE	VALVE ANATOMY	VALVE HEMODYNAMICS	SYMPTOMS
A At risk of AS	Bicuspid aortic valve or other congenital valve anomalyAortic valve sclerosis	 Aortic V_{max} <2 m/s with normal leaflet motion 	None
B Progressive AS	 Mild to moderate leaflet calcification Fibrosis of a bicuspid or trileaflet valve with reduction in systolic motion Rheumatic valve changes with commissural fusion 	 Mild AS: V_{max} 2-2.9 m/s or mean ΔP <20 mmHg Moderate AS: V_{max} 3-3.9 m/s or mean ΔP 20-39 mmHg 	None
C Asymptomatic Severe AS	 C1: Asymptomatic severe AS C2: Asymptomatic severe AS with left ventricular systolic dysfunction (LVEF <50%) Both C1 and C2 may show: Severe leaflet calcification/fibrosis Congenital stenosis with severely reduced leaflet opening 	 C1 and C2: V_{max} ≥4 m/s or mean ΔP ≥40 mmHg, AVA typically ≤1 cm² (or AVAi 0.6 cm²/m²) but not required to define severe AS Very severe AS: V_{max} ≥5 m/s or mean ΔP ≥60 mmHg 	C1: None; exercise testing reasonable to confirm symptom status C2: None
D Symptomatic Severe AS	 D1: Symptomatic severe high-gradient AS D2: Symptomatic severe low-flow low-gradient AS with reduced LVEF (<50%) D3: Symptomatic severe low-gradient AS with normal LVEF (>50%) or paradoxical low-flow severe AS D1, D2, and D3 may show: Severe leaflet calcification/fibrosis with reduced leaflet motion 	 D1: V_{max} ≥4 m/s or mean ΔP ≥40 mmHg, AVA typically ≤1 cm² (or AVAi 0.6 cm²/m²) but may be larger with mixed AS/AR D2: AVA ≤1 cm² with V_{max} <4 m/s or mean ΔP <40 mmHg; dobutamine stress echocardiography shows AVA ≤1 cm² with V_{max} ≥4 m/s at any flow rate D3: AVA ≤1 cm² with V_{max} <4 m/s or mean ΔP <40 mmHg AND stroke volume index <35 mL/m² measured in a normotensive patient 	Exertional dyspnea, angina, syncope or presyncope, heart failure, exercise intolerance

Abbreviations: AR indicates aortic regurgitation; AS aortic stenosis; AVA, aortic valve area circulation; AVAi, aortic valve area indexed to body surface area; LVEF, left ventricular ejection fraction; ΔP, pressure gradient between the left ventricle and aorta; and V_{max}, maximum velocity.



Figure 2. Timing of Intervention for Aortic Stenosis

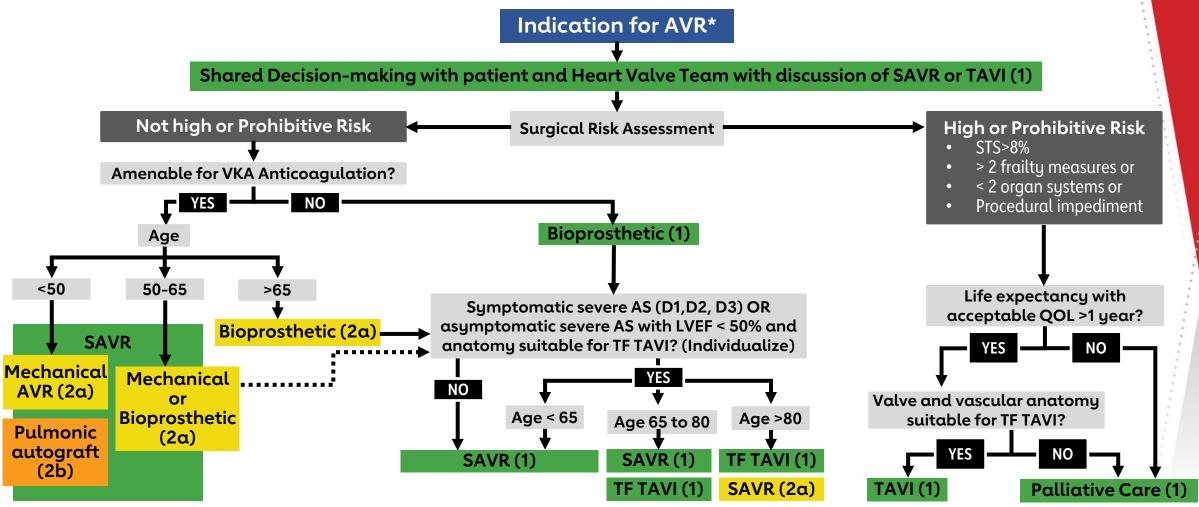


*See section 3.2.4.2

Abbreviations: AS indicates aortic stenosis; AVA, aortic valve area; cm, centimeter; AVR, aortic valve replacement; BNP, B-type natriuretic peptide; DSE, dobutamine stress echocardiography; ETT, exercise treadmill test; LVEF, left ventricular ejection fraction; mmHg, millimeters of mercury; ΔP_{mean}, average change in pressure; SAVR, surgical aortic valve replacement; SVI, stroke volume index; TAVI, transcatheter aortic valve implantation; and V_{max}, maximum transvalvular velocity.



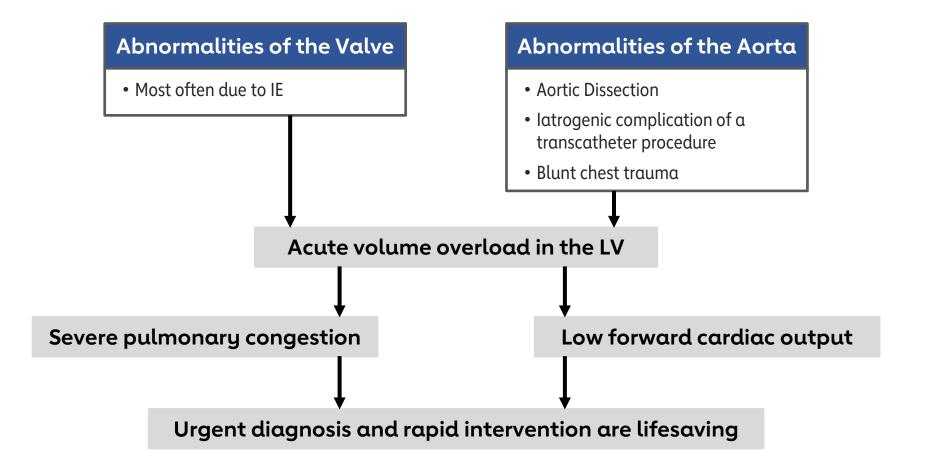
Figure 3. Choice of SAVR versus TAVI for AVR in Valvular AS



*See section 3.2.3 Abbreviations: AS indicates aortic stenosis; AVR, aortic valve replacement; LVEF, left ventricular ejection fraction; QOL, quality of life; SAVR, surgical aortic valve replacement; STS, Society of Thoracic Surgeons; TAVI, transcatheter aortic valve implantation; TF, transfemoral; and VKA, vitamin K antagonist.



Acute Aortic Regurgitation



Abbreviations: AR indicates aortic regurgitation; IE, infective endocarditis, and TAVR, transcatheter aortic valve replacement.

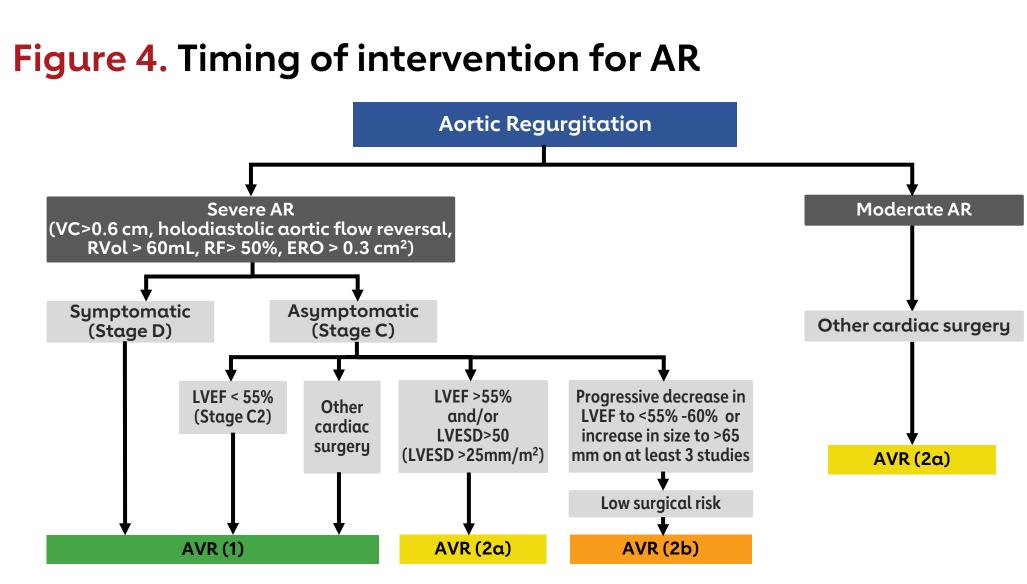


Table 15. Stages of Chronic AR

STAGE	VALVE ANATOMY	VALVE HEMODYNAMICS		SYMPTOMS
A At risk of AS	 Bicuspid aortic valve Aortic valve sclerosis Diseases of the Aortic sinuses or ascending aorta Rheumatic Heart disease Infective Endocarditis 	Echocardiography: None or trace AR.Angiography: Grade 0		None
B Progressive AS	 Mild to Moderate Calcification Bicuspid aortic valve Dilated Aortic Sinuses Rheumatic Valve Changes Previous Infective Endocarditis 	Mild AR by Echocardiography• Jet width <25% of LVOT• Vena contracta <0.3 cm• Regurgitant volume <30 mL/beat• Regurgitant fraction <30%• ERO <0.10 cm²• Angiography: grade 1	 Moderate AR by Echocardiography Jet width 25%-64% of LVOT Vena contracta 0.3-0.6 cm Regurgitant volume 30-59 mL/beat Regurgitant fraction 30% to 49% ERO 0.10-0.29 cm² Angiography: Grade 2 	None
C Asymptomatic Severe AS	 Calcific valve disease Bicuspid aortic valve Dilated Aortic Sinuses or ascending aorta. Rheumatic Valve Changes 	 Severe AR by Echocardiography Jet width ≥65% of LVOT Vena contracta >0.6 cm Holodiastolic flow reversal in proximal abdominal aorta 	C1: Normal LVEF (>55%) and mild to moderate LV dilation (LVESD <50 mm) C2: Abnormal LV systolic function with depressed LVEF (≤55%) or severe LV dilation (LVESD >50 mm or indexed LVESD >25 mm/m ²)	None: Exercise testing is reasonable to confirm symptom status
D Symptomatic Severe AS	 Previous infective endocarditis with abnormal leaflet closure or perforation 	 Regurgitant volume ≥60 mL/beat Regurgitant fraction ≥50% ERO ≥0.3 cm² Angiography: grade 3 to 4 	In addition, diagnosis of chronic severe AR requires evidence of moderate to severe LV dilation. May occur with normal LVEF or mild/moderate or severe LV dysfunction.	Exertional dyspnea or angina or more severe HF symptoms



Abbreviations: AR indicates aortic regurgitation; cm. centimeter; ERO, effective regurgitant orifice; HF, heart failure; IE, infective endocarditis; LV, left ventricle; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic diameter; LVOT, left ventricular outflow track; mm, millimeter; and TAVR, transcatheter aortic valve replacement.



Abbreviations: AR indicates aortic regurgitation; AVR, aortic valve replacement; EDD, end-diastolic dimension; ERO, effective regurgitant orifice; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic dimension; RF, regurgitant fraction; RVol, regurgitant volume; and VC, vena contracta.

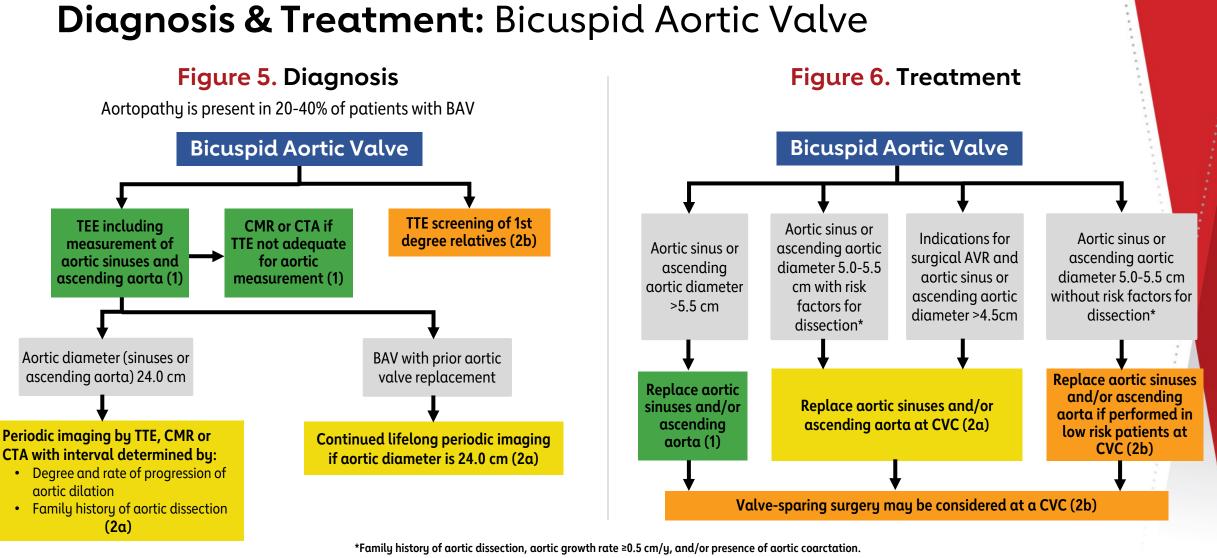


Timing of Intervention in Chronic Aortic Regurgitation

COR	RECOMMENDATIONS
	1. In symptomatic patients with severe AR (Stage D), aortic valve surgery is indicated regardless of LV systolic function.
1	 In asymptomatic patients with chronic severe AR and LV systolic dysfunction (LVEF ≤55%) (Stage C2), aortic valve surgery is indicated if no other cause for systolic dysfunction is identified.
	 In patients with severe AR (Stage C or D) who are undergoing cardiac surgery for other indications, aortic valve surgery is indicated.
2 ~	 In asymptomatic patients with severe AR and normal LV systolic function (LVEF >55%), aortic valve surgery is reasonable when the LV is severely enlarged (LVESD >50 mm or indexed LVESD >25 mm/m2) (Stage C2).
2α	5. In patients with moderate AR (Stage B) who are undergoing cardiac or aortic surgery for other indications, aortic valve surgery is reasonable.
2b	6. In asymptomatic patients with severe AR and normal LV systolic function at rest (LVEF >55%; Stage C1) and low surgical risk, aortic valve surgery may be considered when there is a progressive decline in LVEF on at least 3 serial studies to the low-normal range (LVEF 55% to 60%) or a progressive increase in LV dilation into the severe range (LV end- diastolic dimension [LVEDD] >65 mm).
3 HARM	7. In patients with isolated severe AR who have indications for SAVR and are candidates for surgery, TAVI should not be performed.



Abbreviations: AR indicates aortic regurgitation; COR classification of recommendation; LVEF, left ventricular ejection fraction, LVESD, left ventricular end-systolic diameter; mm; millimeter; SAVR, surgical aortic valve replacement; TAVI, transcatheter aortic valve implantation.



Abbreviations: BAV indicates bicuspid aortic valve; CMR, cardiac magnetic resonance imaging; CTA, computed tomography angiography; CVC, comprehensive valve center; and TTE, trasnsthoracic echocardiography.

Otto, CM et al. 2020 ACC/AHA. Guideline for the Management of Patients With Valvular Heart Disease Circulation.

American Heart

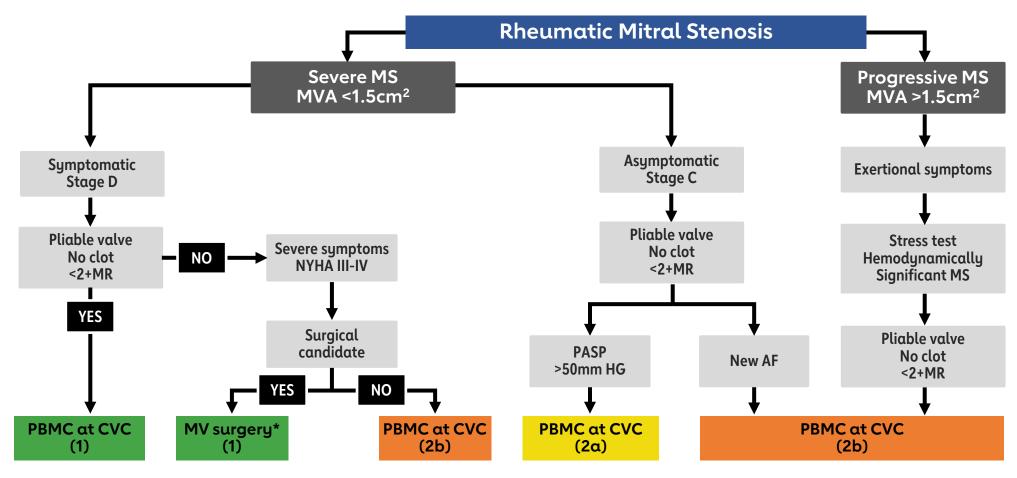
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Table 16. Stages of Mitral Stenosis

STAGE	DEFINITION/ETIOLOGY	DIAGNOSTICS*	SYMPTOMS
A At risk of MS	• Mild valve doming during diastole	Normal transmitral flow velocity	None
B Progressive MS	 Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets Planimetered mitral valve area >1.5 cm² 	 Increased transmitral flow velocities Mitral valve area >1.5 cm² Diastolic pressure half-time <150 milliseconds Mild to moderate LA enlargement Normal pulmonary pressure at rest 	None
C Asymptomatic Severe MS	 Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets 	 Mitral valve area ≤1.5 cm² Diastolic pressure half-time ≥150 milliseconds 	None
D Symptomatic Severe MS	 Planimetered mitral valve area ≤ 1.5 cm² 	 Severe LA enlargement Elevated PASP >50 mm Hg 	Exertional dyspnea or angina or more severe HF symptoms

American Heart Association. Abbreviations: cm indicates centimeter; HTN, hypertension; LA, left atrium; mm Hg; millimeters of mercury; MS, mitral stenosis; and PASP, pulmonary artery systolic pressure. Note: DIAGNOSTICS* include Valve Hemodynamics measured by Echocardiography (doppler) or Cardiac Catheterization.

Figure 7. Recommendations for Mitral Stenosis



*Repair, commissurotomy, or valve replacement.

Abbreviations: AF indicates atrial fibrillation; CVC, Comprehensive Valve Center; MR, mitral regurgitation; MS, mitral stenosis; MV, mitral valve; MVA, mitral valve area; MR, Mitral Regurgitation; NYHA, New York Heart Association; PASP, pulmonary artery systolic pressure; +, plus; and PMBC, percutaneous mitral balloon commissurotomy.



Table 17. Stages of Chronic Primary MR

STAGE	VALVE ANATOMY	VALVE HEMODYNAMICS*	HEMODYNAMIC CONSEQUENCES	SYMPTOMS
A At risk of MR	 Mild mitral valve prolapse with normal coaptation Mild valve thickening and leaflet restriction 	 No MR jet or small central jet area <20% LA on Doppler Small vena contracta <0.3 cm 	None	None
B Progressive MR	 Moderate to severe mitral valve prolapse with normal coaptation Rheumatic valve changes with leaflet restriction and loss of central coaptation Prior IE 	 Central jet MR 20%–40% LA or late systolic eccentric jet MR Vena contracta <0.7 cm Regurgitant volume <60 mL Regurgitant fraction <50% ERO <0.40 cm² Angiographic grade 1–2 	 Mild LA enlargement No LV enlargement Normal pulmonary pressure 	None
C Asymptomatic Severe MR	 Severe mitral valve 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 	 Central jet MR >40% LA or holosystolic eccentric jet MR Vena contracta ≥0.7 cm Regurgitant volume ≥60 mL Regurgitant fraction ≥50% ERO ≥0.40 cm² Angiographic grade 3 to 4 	 Mod. or severe LA enlargement LV enlargement Pulmonary hypertension 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			 Moderate or severe LA enlargement LV enlargement Pulmonary hypertension present 	Decreased exercise toleranceExertional dyspnea

*Valve Hemodynamics measured by echocardiography (doppler) or cardiac catheterization.

Abbreviations: cm indicates centimeter; ERO, effective regurgitant orifice; IE, infective endocarditis; LA, left atrium/atrial; LV, left ventricular; LVEF, left ventricular ejection fraction; LVESD; left ventricular end-systolic dimension; mL, milliliter; mm, millimeter; and MR, mitral regurgitation.



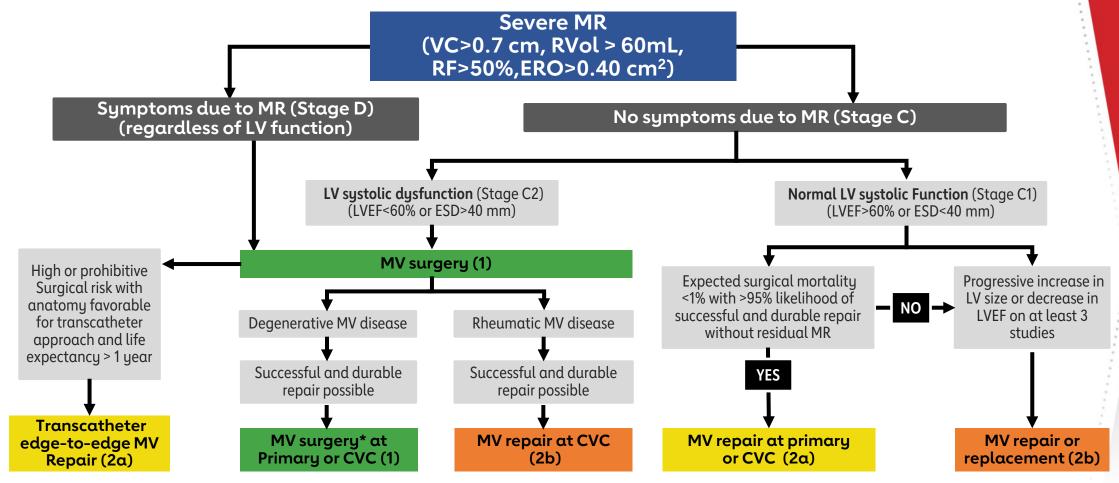
Diagnostic Testing of Primary Mitral Regurgitation

COR	RECOMMENDATIONS		
1	 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, LVEDD, and LVESD) and assessment of pulmonary artery pressure. 		
2b	 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. 		

Abbreviations: CMR indicates cardiac magnetic resonance; COR, classification of recommendation; GDMT, guideline directed medical therapy; LV, left ventricle, LVEDD, left ventricular end-diastolic dimension; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic dimension; MR, mitral regurgitation; PET, positron emission tomography; and TTE, transthoracic echocardiography.



Figure 8. Management of Primary Mitral Regurgitation



.*See Prosthetic Valve section (11.1.2) for choice of mitral valve replacement if mitral valve repair is not possible.

Abbreviations: 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.



Diagnostic Testing Chronic Secondary Mitral Regurgitation

COR RECOMMENDATIONS

	 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	 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.
	 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.
	4. In patients with chronic secondary MR undergoing transcatheter mitral valve intervention, intraprocedural guidance with TEE is recommended.



Abbreviations: CMR indicates cardiac magnetic resonance; COR, classification of recommendation; GDMT, guideline directed medical therapy; LV, left ventricle; LVEDD, left ventricular end-diastolic dimension; LVEF, left ventricular ejection fraction; LVESD, left ventricular end-systolic dimension; MR, mitral regurgitation; PET, positron emission tomography; TEE, transesophageal echocardiography; and TTE, transthoracic echocardiography.

Table 18. Stages of Secondary MR

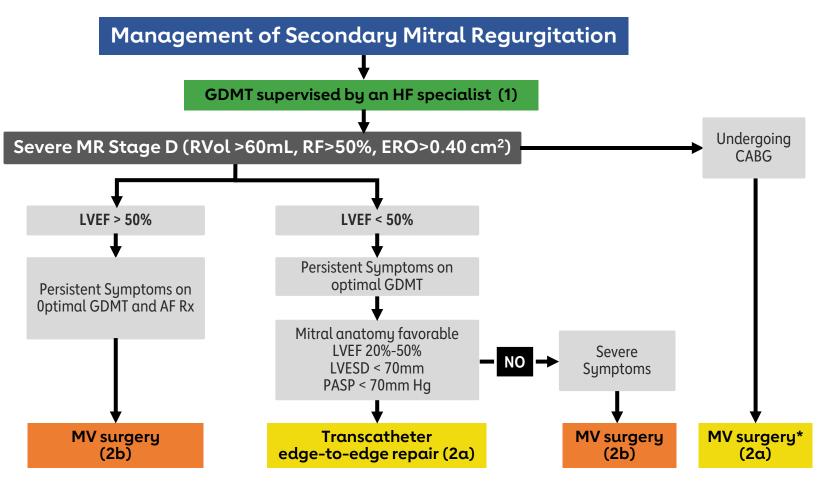
STAGE	VALVE ANATOMY	VALVE HEMODYNAMICS*	ASSOCIATED CARDIAC FINDINGS	SYMPTOMS
A At risk of MR	• Normal valve leaflets, chords, and annulus in a patient with CAD or cardiomyopathy	 No MR jet or small central jet area <20% LA on Doppler Small vena contracta <0.30 cm 	 Normal or mildly dilated LV size with fixed (infarction) or inducible (ischemia) regional wall motion abnormalities Primary myocardial disease with LV dilation and systolic dysfunction 	Attributable to coronary ischemia or HF may be present that respond to revascularization & approp. Medical therapy
B Progressive MR	 Regional wall motion abnormalities with mild tethering of mitral leaflet Annular dilation with mild loss of central coaptation of the mitral leaflets 	 ERO <0.40 cm²† Regurgitant volume <60 mL Regurgitant fraction <50% 	 Regional wall motion abnormalities with reduced LV systolic function LV dilation and systolic dysfunction attributable to primary myocardial disease 	
C Asymptomatic Severe MR	 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 	 ERO ≥0.40 cm²† Regurgitant volume ≥60 mL‡ Regurgitant fraction ≥50% 		
D Symptomatic Severe MR				 HF symptoms attributable to MR persist even after revasc. & 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.

Abbreviations: 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.



Figure 9. Secondary MR



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

Abbreviations: GDMT indicates guideline directed medical 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.



Table 19. Classification of TR

Primary

- Rheumatic
- Infective endocarditis
- Iatrogenic (device leads, endomyocardial biopsy)
- Congenital (eg, Ebstein's, levo-transposition of the great arteries)
- Other (eg, trauma, carcinoid, drugs, irradiation)

Secondary

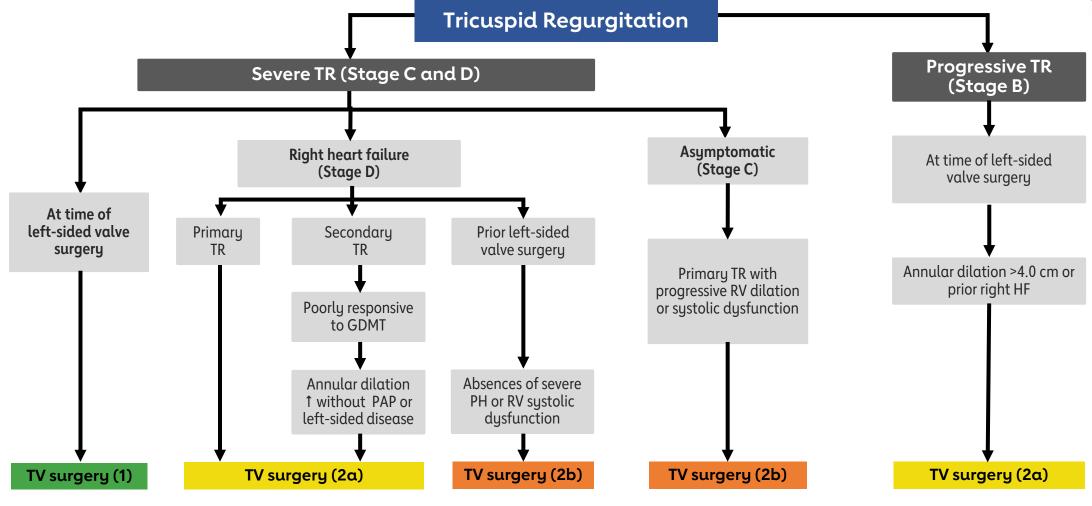
- Pulmonary hypertension with RV remodeling (primary or secondary to leftsided heart disease)
- Dilated cardiomyopathy
- Annular dilation (associated with AF)*
- RV volume overload (shunts/high output)

*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.

Abbreviations: AF indicates atrial fibrillation; LVEF, left ventricular ejection fraction; RV, right ventricular; and TR, tricuspid regurgitation.

American Heart Association

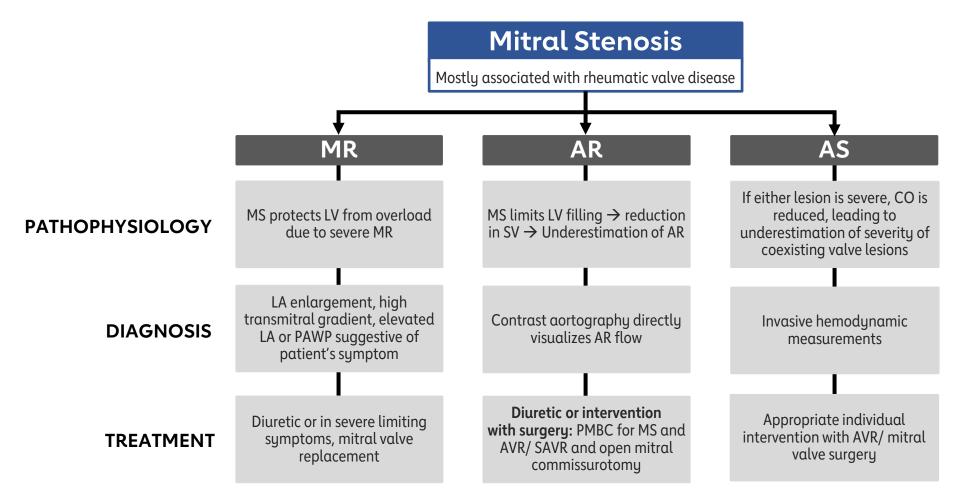
Figure 10. Management of Tricuspid Regurgitation



Abbreviations: GDMT indicates guideline-directed management and therapy; HF, heart failure; PAP, pulmonary artery pressure; PH, pulmonary hypertension; RV, right ventricular; TR, tricuspid regurgitation; and TV, tricuspid valve.

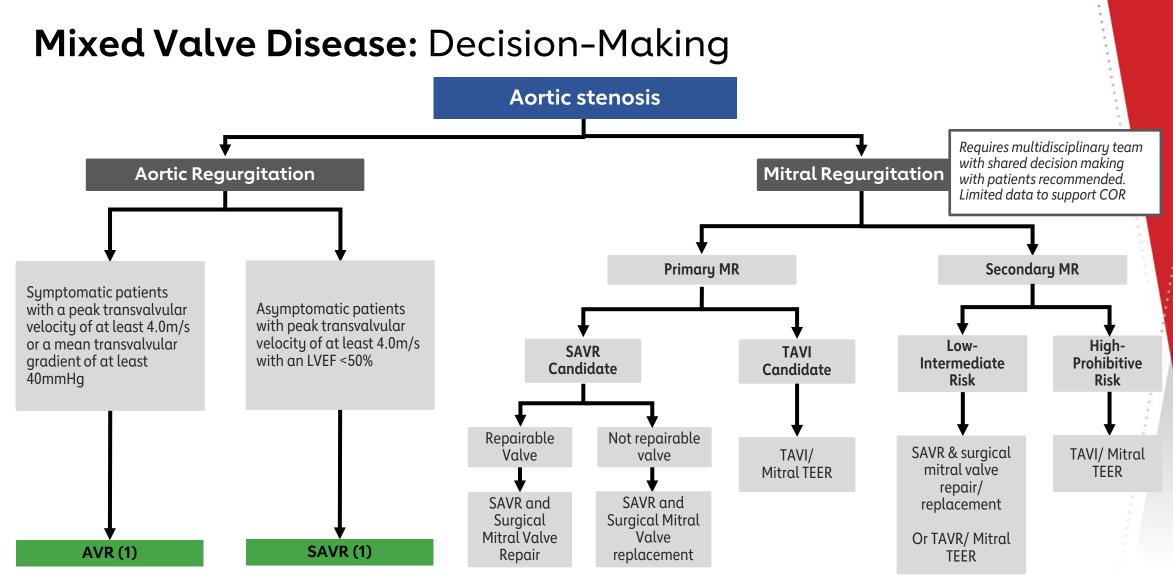


Mixed Valve Disease: Diagnosis and Follow up



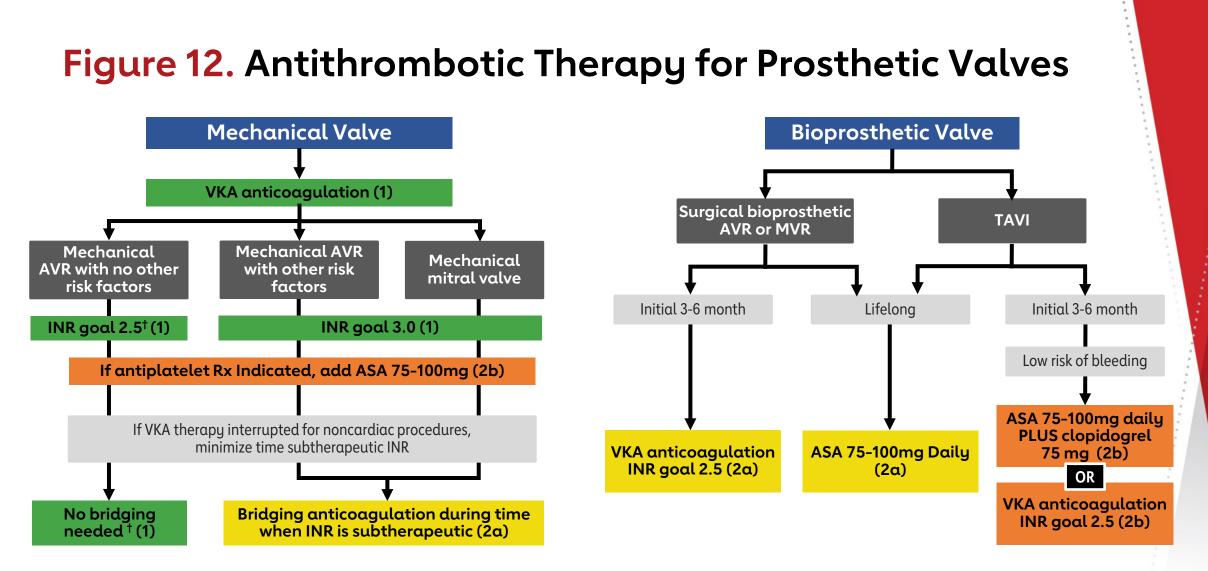
Abbreviations: AR indicates aortic regurgitation; AS, aortic stenosis; AVR, aortic valve replacement; CO, cardiac output; LA, left atrium; MR, mitral regurgitation; MS, mitral stenosis; PAWP, pulmonary artery wedge pressure; PMBC, percutaneous mitral balloon commissurotomy; SAVR, surgical aortic vale replacement; SV, stroke volume; and TTE transthoracic echocardiogram.





Abbreviations: AVR indicates aortic valve replacement; LVEF, left ventricle ejection fraction; MR, mitral regurgitation; SAVR, surgical aortic valve replacement; TAVI, transcatheter aortic valve implantation; and TEER, transcatheter edge-to-edge repair.





*Thromboembolic risk factors include an older-generation valve, AF, previous thromboembolism, hypercoagulable state, and LV systolic dysfunction. †For a mechanical On-X AVR and no thromboembolic risk factors, a goal INR of 1.5–2.0 plus aspirin 75–100 mg daily may be reasonable starting ≥3 months after surgery.

Abbreviations: ASA indicates aspirin; AVR, aortic valve replacement; INR, international normalized ratio; MVR, mitral valve replacement; Rx, medication; TAVI, transcatheter aortic valve implantation; and VKA, vitamin K antagonist.



Management of Prosthetic Valve Complications

Serious Bleeds:

For mechanical valves, use of four-factor prothrombin complex is reasonable (2a).

If bleeding is not controlled despite fourfactor prothrombin complex, intravenous Vitamin K is reasonable to consider if use of a VKA is not anticipated for 7 days (2a).

For patients with bioprosthetic valves or annuloplasty rings who are receiving a DOAC and who require immediate reversal of anticoagulation because of uncontrollable bleeding, treatment with idarucizumab (for dabigatran) or andexanet alfa (for anti-Xa agents) is reasonable (2a).

For patients with a mechanical prosthetic valve and supratherapeutic INR (>5.0) who are not actively bleeding, the benefit of individualized treatment with oral vitamin K, in addition to temporary withdrawal of the VKA, is uncertain (2b).

Thromboembolic Events:

For a mechanical AVR, increase the INR from 2.5 to 3 or add Aspirin 75-100 mg (2a).

For a mechanical MVR, increase the INR from 3 to 4 or add Aspirin 75-100 mg (2a).

For a bioprosthetic valve, VKA anticoagulation can be considered in place of an antiplatelet regimen (2b).

Acute Valve Thrombosis:

For mechanical valves, urgent TTE, TEE, fluro, and/or CT imaging is recommended for suspected valve thrombosis (1).

For a thrombosed left sided mechanical valve, slow infusion, low dose fibrinolytic therapy or emergency surgery is recommended (1).

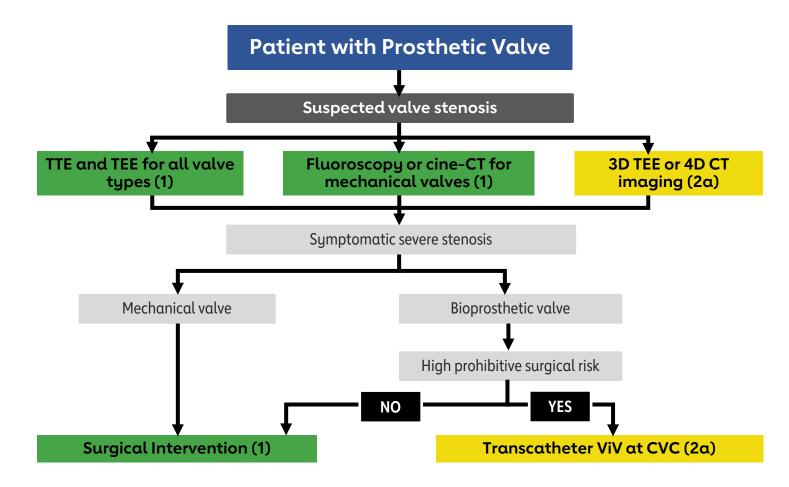
In a suspected bioprosthetic valve thrombosis, 3D or 4D CT imaging is reasonable (2a).

In a suspected bioprosthetic valve thrombosis, initial treatment with a VKA is reasonable (2a).

Abbreviations: AVR indicates aortic valve replacement; DOAC, direct oral anticoagulant; INR, international normalized ratio; MVR, mitral valve replacement; and VKA, vitamin K antagonist.



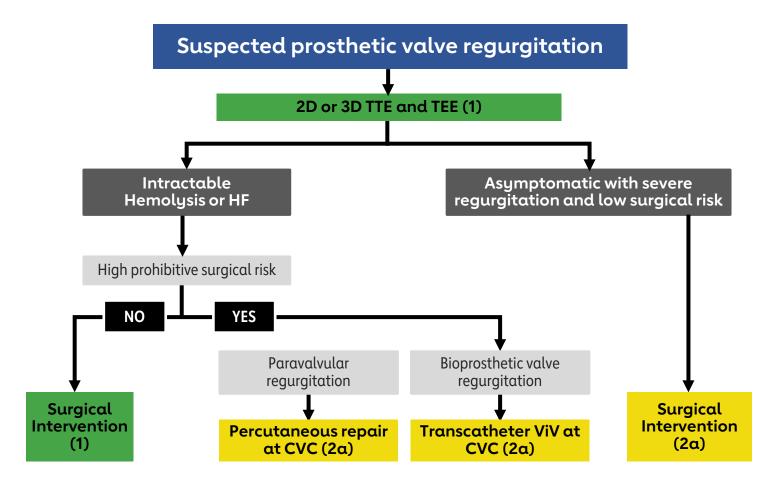
Figure 14. Management of Prosthetic Valve Stenosis



Abbreviations: 3D indicates 3-dimensional; 4D, 4-dimensional; CT, computed tomography; CVC, Comprehensive Valve Center; HF, heart failure; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography/echocardiogram; and ViV, valve-in-valve.



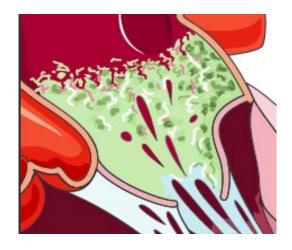
Figure 14. Management of Prosthetic Valve Regurgitation



Abbreviations: 3D indicates 3-dimensional; 4D, 4-dimensional; CT, computed tomography; CVC, Comprehensive Valve Center; HF, heart failure; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography/echocardiogram; and ViV, valve-in-valve.



Infective Endocarditis: Diagnostic Evaluation



Patients At risk OR with suspected NVE or PVE

Blood Cultures (1)

Purpose of TTE (1)

- Identify vegetations
- Hemodynamic severity of valvular lesions
- Assess ventricular function and pulmonary pressures
- Detect complications

At Risk:

- Congenital or acquired VHD
- Previous IE
- Prosthetic heart valves
- Certain congenital or heritable cardiac malformations
- Immunodeficiency state
- Injection drug use

Utilize TEE (1)

- If TTE non-diagnostic
- Complication suspected or present
- Intra-cardiac leads present

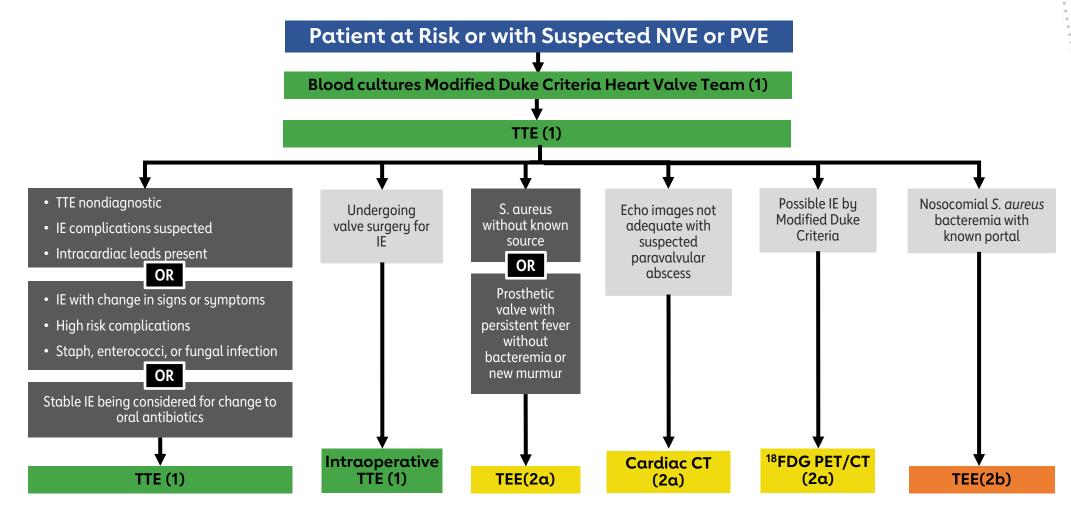
Heart Valve Team (1)

- Cardiology
- Cardiac Surgery
- Infectious Disease
- If surgery cardiac anesthesia
- If neurological event neurology

Abbreviations: IE indicates infective endocarditis; NVE, native valve endocarditis; PVE, prosthetic valve endocarditis; TTE, trans-thoracic echocardiography; and TEE, trans-esophageal echocardiography.



Figure 15. Diagnosis of Infective Endocarditis



Abbreviations: CT indicates computed tomography; IE, infective endocarditis; 18FDG, 18F-fluorodeoxyglucose; NVE, native valve endocarditis; PET, positron emission tomography; PVE, prosthetic valve endocarditis; S, staph; TEE, transesophageal echocardiography; and TTE, transthoracic echocardiography.



Infective Endocarditis: Medical Therapy



Antibiotics should be initiated after blood cultures are obtained, with guidance from infectious disease plus antibiotic sensitivity data (1)

*In stable left-sided IE - consider changing to oral antibiotics if:

- No paravalvular infection on TEE
- Follow-up can be assured
- Follow-up TEE can be performed 1-3 days prior to antibiotics completion (2b)

Patients with known VHD and unexplained fever should NOT receive antibiotics before blood cultures are obtained (3:Harm)

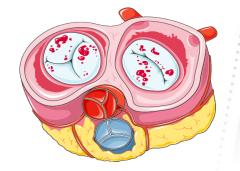


If there is evidence of cerebral embolism or stroke, irrespective of other indications for anticoagulation, it is reasonable to temporarily hold anticoagulation (2a)

In patients on VKA anticoagulation at the time of IE diagnosis, temporary discontinuation of VKA may be considered (2b)



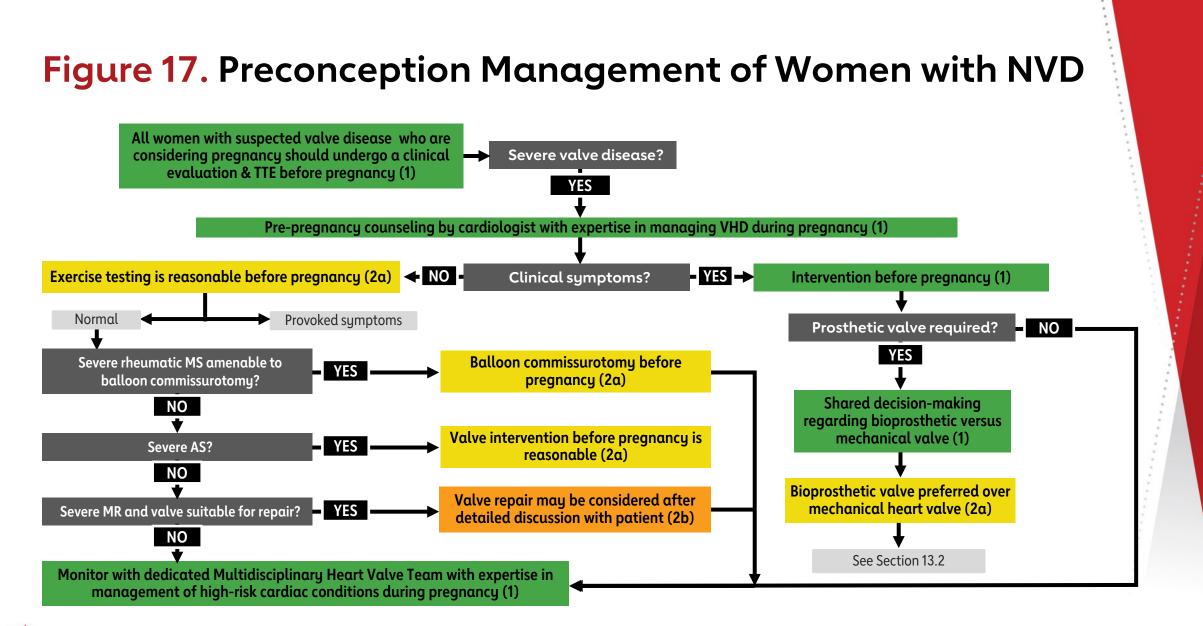
If IE is a consequence of injection drug use, the patient should be referred to addiction treatment for opioid substitution therapy (1)



*IE caused by streptococcus, E. faecalis, S. aureus, or coagulase-negative staphylococci deemed stable by the Heart Valve Team.

Abbreviations: IE indicates infective endocarditis; Rx, treatment; TEE, trans-esophageal echocardiography; VHD, valvular heart disease; and VKA, vitamin K antagonists.

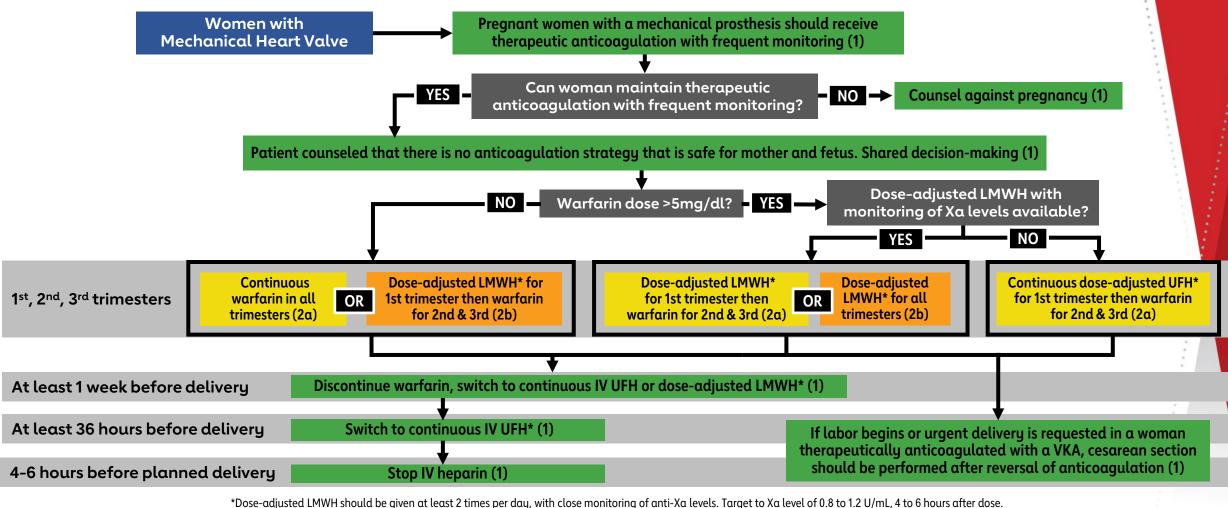




Abbreviations: AS indicates aortic stenosis; MR, mitral regurgitation; MS, mitral stenosis; TTE, transthoracic echocardiography; and VHD, valvular heart disease.



Figure 18. Anticoagulation for Prosthetic Mechanical Heart Valves in Pregnancy

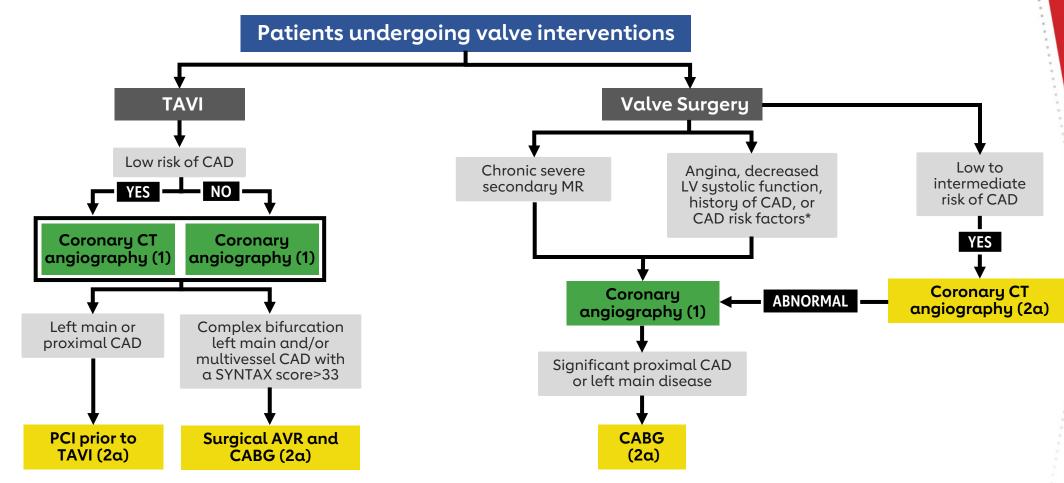


Trough levels may aid in maintaining patient in therapeutic range. Continuous UFH should be adjusted to aPTT 2 times control.



Abbreviations: aPTT indicates activated partial thromboplastin time; IV, intravenous; LMWH, low-molecular-weight heparin; UFH, unfractionated heparin; and VKA, vitamin K antagonist.

Figure 19. Valve Intervention in CAD

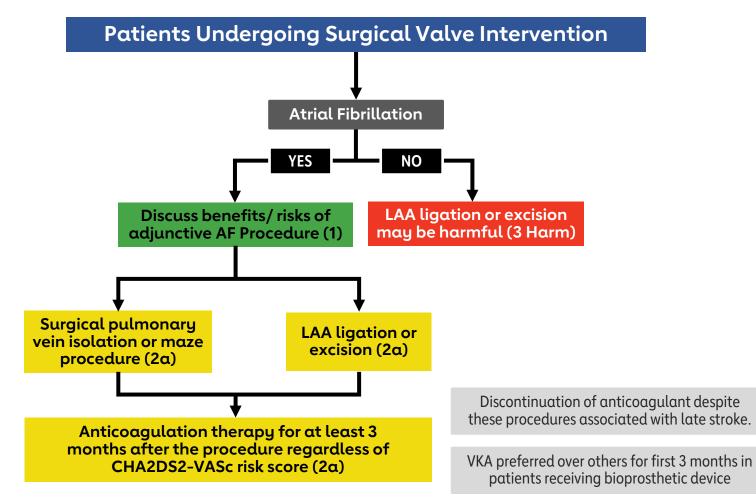


*Including men age >40 years and postmenopausal women.

Abbreviations: AVR indicates aortic valve replacement; CAD, coronary artery disease; CABG, coronary artery bypass graft; CT, computed tomography; LV, left ventricular; MR, mitral regurgitation; PCI, percutaneous coronary intervention; SYNTAX, Synergy Between Percutaneous Coronary Intervention With Taxus and Cardiac Surgery; and TAVI, transcatheter aortic valve implantation.



Figure 20. Intervention for AF in patients with VHD





Abbreviations: AF indicates atrial fibrillation; CAD, coronary artery disease; CHA2DS2-VASc score, congestive heart failure, hypertension, age \geq 75 years, diabetes mellitus, stroke or transient ischemic attack (TIA), vascular disease, age 65 to 74 years, sex category; LAA, left atrial appendage; VHD, valvular heart disease; VKA, vitamin K antagonists.

Recommendations for Noncardiac Surgery in Patients with VHD

Diagnosis in Patients With VHD Undergoing Noncardiac Surgery

COR RECOMMENDATIONS

 In patients with clinically suspected moderate or greater degrees of valvular stenosis or regurgitation who are undergoing noncardiac surgery, preoperative echocardiography is recommended.

Management of the <u>Symptomatic</u> Patient

RECOMMENDATIONS

 In patients who meet standard indications for intervention for VHD (replacement and repair) on the basis of symptoms and disease severity, intervention should be performed before elective noncardiac surgery to reduce perioperative risk if possible, depending on the urgency and risk of the noncardiac procedure.

Management of the <u>Asymptomatic</u> Patient

COR RECOMMENDATIONS

- 1. In asymptomatic patients with moderate or greater degrees of AS and normal LV systolic function, it is reasonable to perform elective noncardiac surgery.
- 2. In asymptomatic patients with moderate or greater degrees of rheumatic MS with less than severe pulmonary hypertension (pulmonary artery systolic pressure <50 mm Hg), it is reasonable to
- 3. In asymptomatic patients with moderate or greater degrees of MR and normal LV systolic function with less than severe pulmonary hypertension (pulmonary artery systolic pressure <50 mm Hg), it is reasonable to perform elective noncardiac surgery.
- 4. In asymptomatic patients with moderate or greater degrees of AR and normal LV systolic function, it is reasonable to perform elective noncardiac surgery.



COR

Abbreviations: AR indicates aortic regurgitation; AS, aortic stenosis; COR, classification of recommendation; LV, left ventricular, mm hg, millimeters of mercury; MR, mitral regurgitation; MS, mitral stenosis; and VHD valvular heart disease.

2a

Evidence Gaps and Future Directions in VHD



Prevention of VHD:

- Disease mechanism and risk factors: Ca++ in BAV, Lp(a)
- Primary & secondary prevention of risk factors



Medical therapy to prevent VHD progression:

- Disease mechanism and targets
- Understanding the interplay between severity of VHD and LV modulation and vascular dysfunction



Timing of intervention:

- Improvement in measures of disease severity and impact on LV
- Patient-centered research and diverse patient groups



Better management options:

- Prosthetic valve durability and long-term management
- Optimal anti-thrombotic regimen
- Prevention of complications
- Promoting equity in care of pts with VHD

Abbreviations: Ca++ in BAV indicates calcium in bicuspid aortic valve; Lp(a), lipoprotein (a); LV indicates left ventricle; pts, patients; and VHD, valvular heart disease.



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