

Clinical Update

ADAPTED FROM:

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

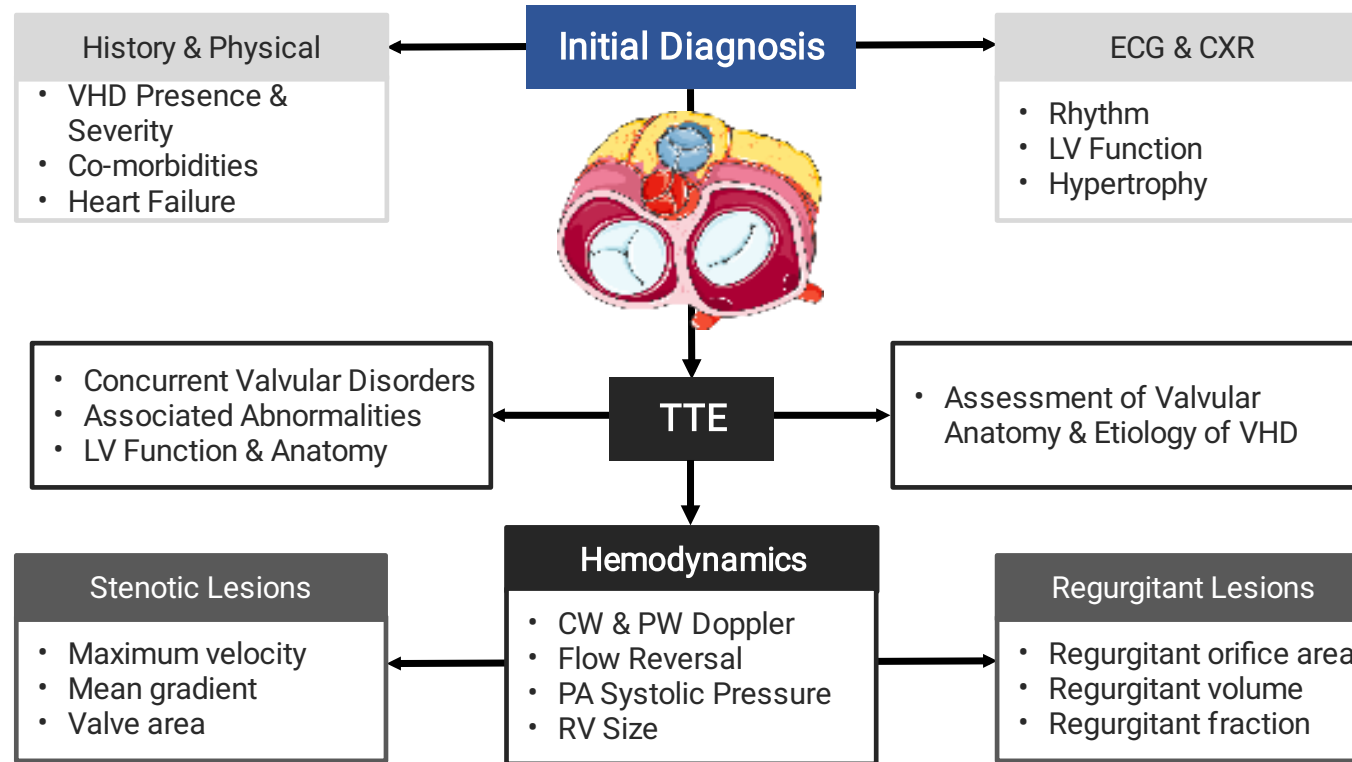
Table 1.
ACC/AHA Applying
Class of
Recommendation
and Level of
Evidence to Clinical
Strategies,
Interventions,
Treatments, or
Diagnostic Testing in
Patient Care
(Updated May 2019)*



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 preference to treatment B – Treatment A should be chosen over treatment B	
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/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:	
• 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	
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	
Suggested phrases for writing recommendations:	
• Potentially harmful • Causes harm • Associated with excess morbidity/mortality • Should not be performed/administered/other	

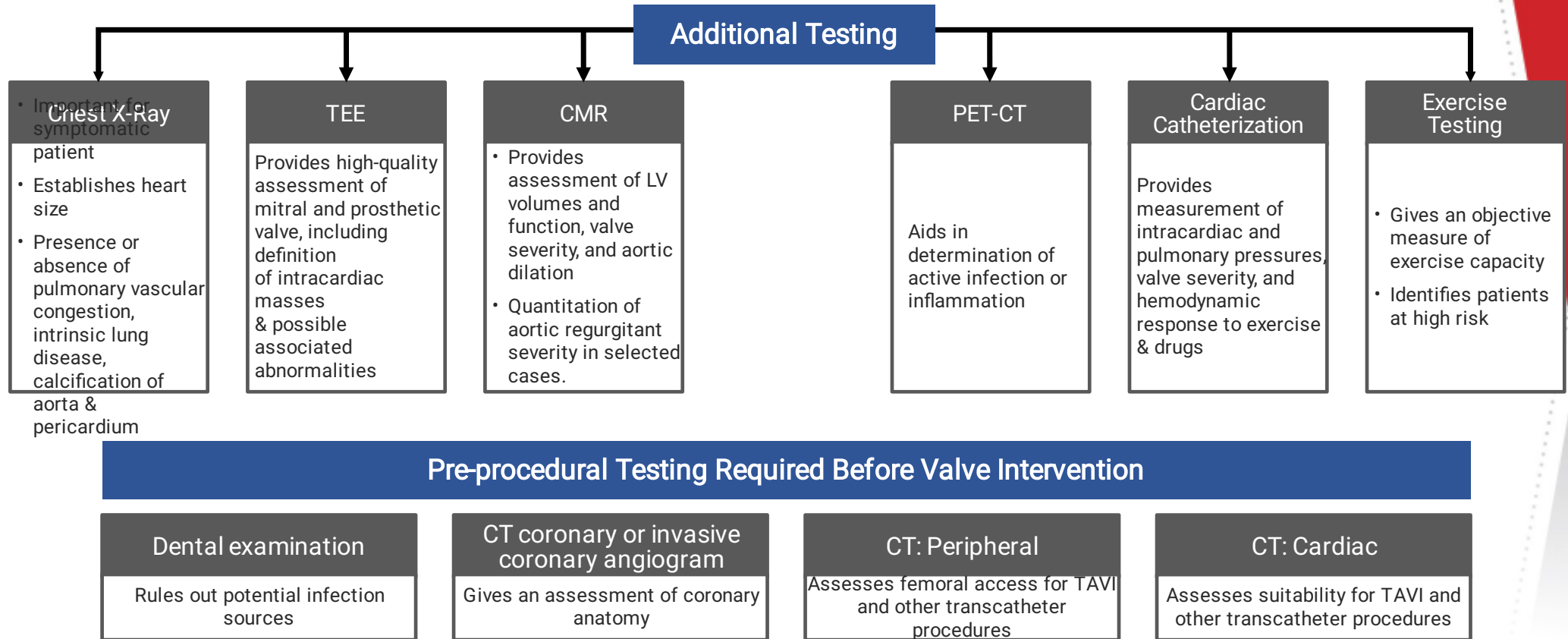
LEVEL (QUALITY) OF EVIDENCE‡	
LEVEL A	
• High-quality evidence‡ from more than 1 RCT • Meta-analyses of high-quality RCTs • One or more RCTs corroborated by high-quality registry studies	
LEVEL B-R (Randomized)	
• Moderate-quality evidence‡ from 1 or more RCTs • Meta-analyses of moderate-quality RCTs	
LEVEL B-NR (Nonrandomized)	
• 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)	(Limited)
• 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)	(Expert Opinion)
CORs are determined independently (any COR may be paired with any LOE). • Consensus of expert opinion based on clinical experience. A recommendation with expert opinion implies 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 recommendation (COR 1 and 2a; 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; 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
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 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

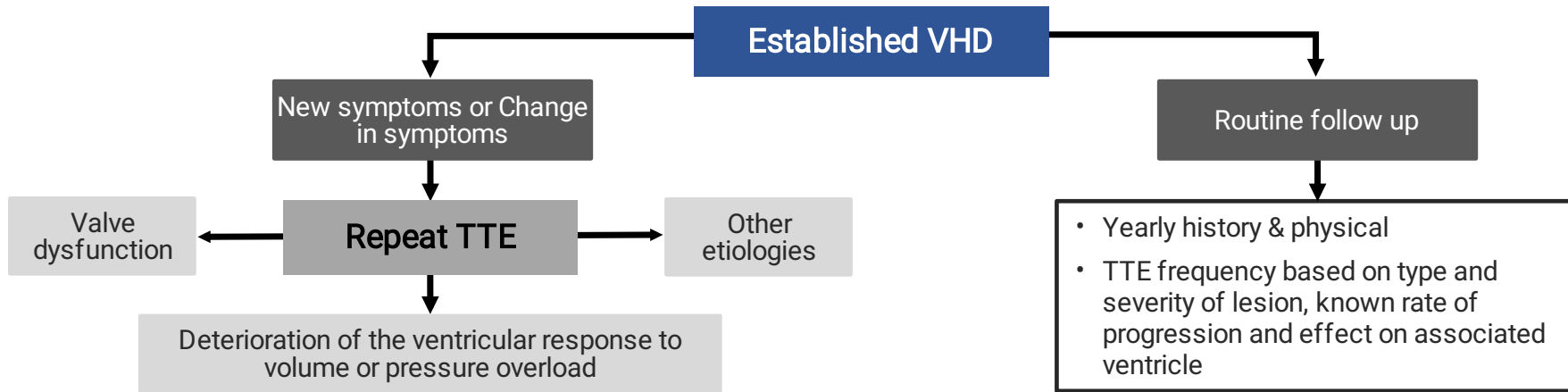


Table 5. Frequency of Echocardiograms in Asymptomatic Patients With VHD and Normal LV Function

	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 1–2 y moderate severity; Vmax 3.0–3.9 m/s)	Every 3–5 y (mild severity) Every 1–2 y (moderate severity)	Every 3–5 y (MV area >1.5 cm ²)	Every 3–5 y (mild severity) Every 1–2 y (moderate severity)
Severe asymptomatic (Stage C1)	Every 6–12 mo (Vmax ≥4 m/s)	Every 6–12 mo Dilating LV: More frequently	Every 1–2 y (MV area 1.0–1.5 cm ²) Every year (MV area <1.0 cm ²)	Every 6–12 months 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. Stages C2 and D disease are not included in this table because they would be considered candidates for intervention.

Abbreviations: CMR indicates cardiac magnetic resonance; LV, left ventricle; mo, month; m/s, milliseconds; MV, mitral valve; STS, Society of Thoracic Surgeons; TAVI, transcatheter aortic valve implantation; TTE, transthoracic 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

Type	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</u> VHD	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

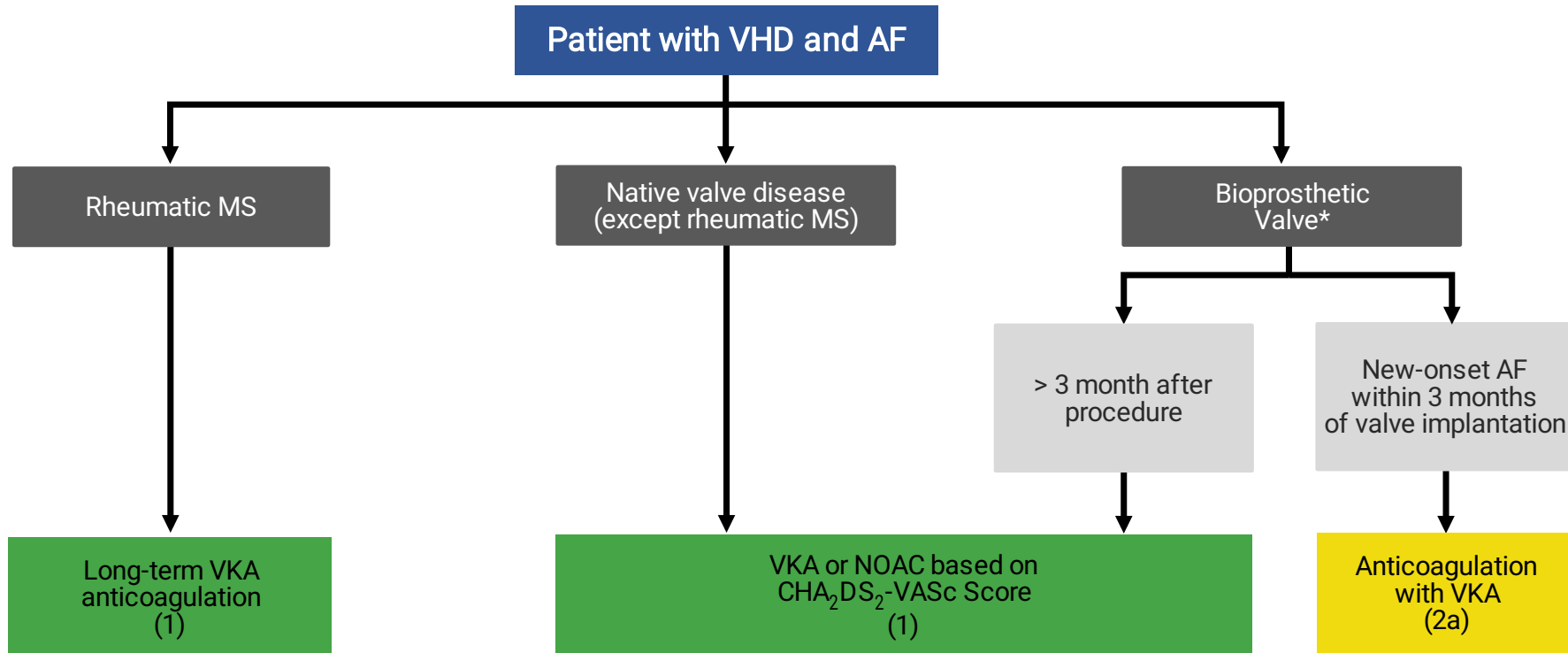
*In patients with documented valvular heart disease, the duration of rheumatic fever prophylaxis should be ≥ 10 y or until the patient is 40 y of age (whichever is longer). Lifelong prophylaxis may be recommended if the patient is at high risk of group A streptococcus exposure. Secondary rheumatic heart 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

1	Secondary Prevention of Rheumatic Fever In patients with rheumatic heart disease, secondary prevention of rheumatic fever is indicated.
2a	Infective Endocarditis Prophylaxis Antibiotic prophylaxis is reasonable before dental procedures that involve manipulation of gingival tissue, manipulation of the periapical region of teeth, or perforation of the oral mucosa in patients with VHD when: • Prosthetic cardiac valves, including transcatheter prostheses and homograft • Prosthetic material used for cardiac valve repair (annuloplasty rings, chords, or clips) • Previous infective endocarditis • Unrepaired cyanotic congenital heart disease or repaired congenital heart disease, with residual shunts or valvular regurgitation at the site of or adjacent to the site of a prosthetic patch or prosthetic device • Cardiac transplant with valve regurgitation attributable to a structurally abnormal valve
3 No Benefit	Antibiotic prophylaxis is not recommended for nondental procedures in the absence of active infection. Examples ✕ Transesophageal echocardiogram, esophagogastroduodenoscopy, colonoscopy, or cystoscopy

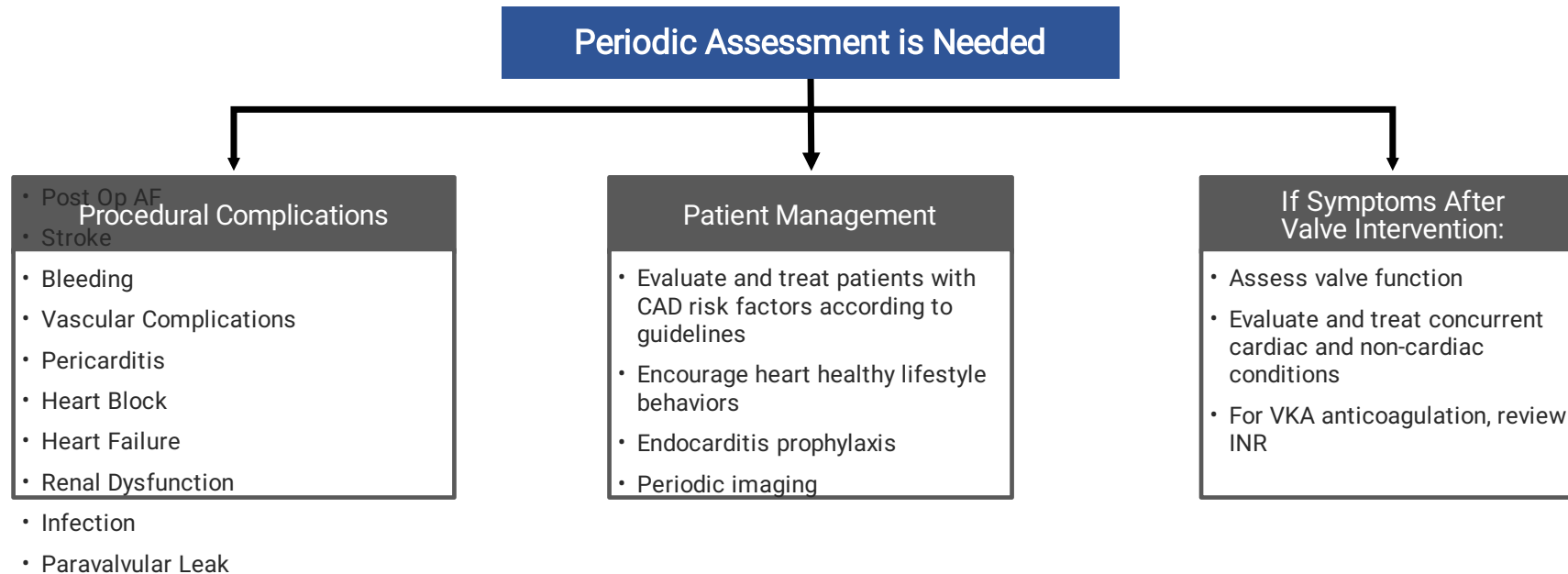
Figure 1. Anticoagulation for AF in Patients With VHD



* 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.

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	
<i>Mechanical Valve</i>	Baseline
<i>Bioprosthetic Valve</i>	Baseline, 5 & 10 years post surgery, then annually
<i>Mitral Valve Repair</i>	Baseline, 1 year, then every 2 to 3 years
TRANSCATHETER	
<i>Bioprosthetic Valve</i>	Baseline, then annually
<i>Mitral Valve Repair</i>	Baseline, then annually

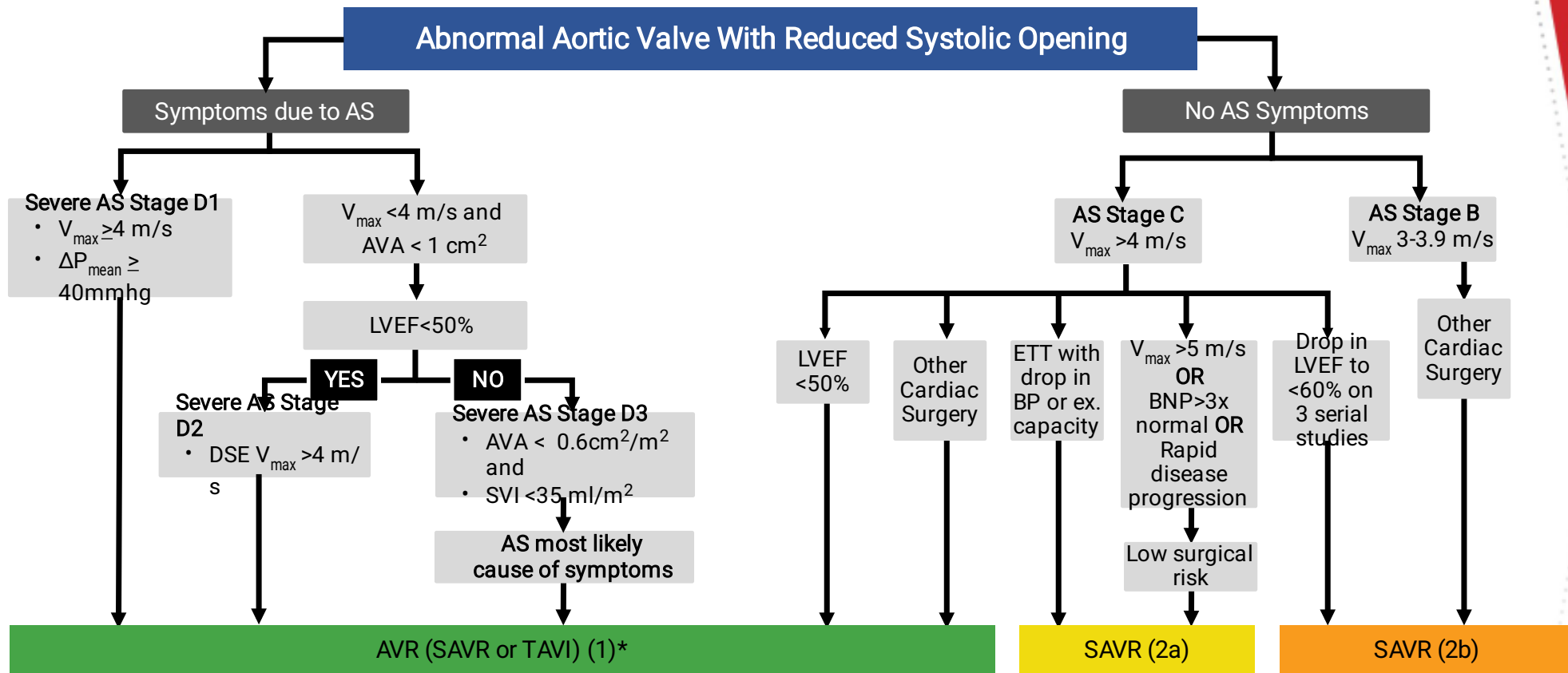
Abbreviations: cm indicates centimeters; LV, left ventricle; and PA, pulmonary artery.

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 anomaly - Aortic 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 $\Delta P < 20$ 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: $V_{\max} \geq 4$ m/s or mean $\Delta P \geq 40$ mmHg, AVA typically ≤ 1 cm² (or AVAi 0.6 cm²/m²) but not required to define severe AS Very severe AS: $V_{\max} \geq 5$ m/s or mean $\Delta P \geq 60$ 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: $V_{\max} \geq 4$ m/s or mean $\Delta P \geq 40$ 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 $\Delta P < 40$ mmHg; dobutamine stress echocardiography shows AVA ≤ 1 cm² with $V_{\max} \geq 4$ m/s at any flow rate D3: AVA ≤ 1 cm² with $V_{\max} < 4$ m/s or mean $\Delta P < 40$ mmHg AND stroke volume index < 35 mL/m² measured in a nonproliferative patient	Exertional dyspnea, angina, syncope or presyncope, heart failure, exercise intolerance

Abbreviations: AR indicates aortic regurgitation; AS aortic stenosis; AVA, aortic valve area; 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.

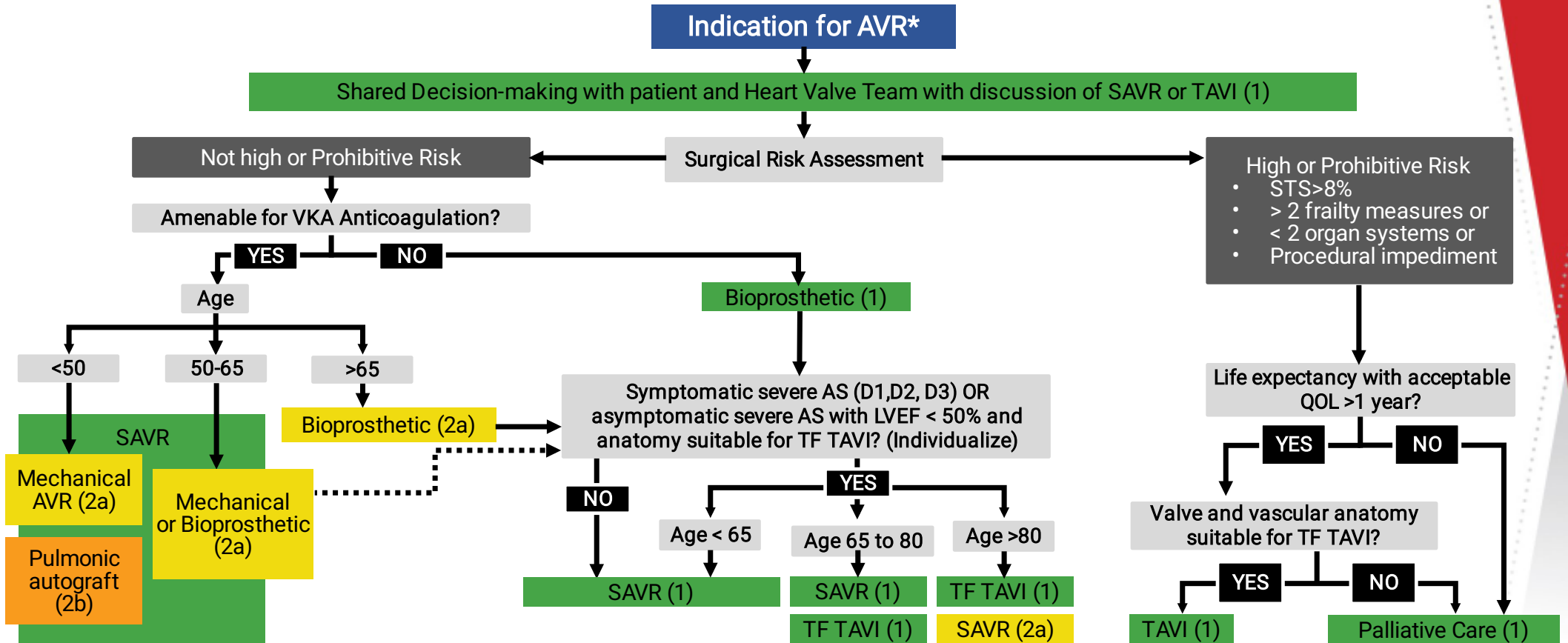
Figure 2. Timing of Intervention for Aortic Stenosis



*See section 3.2.4.2

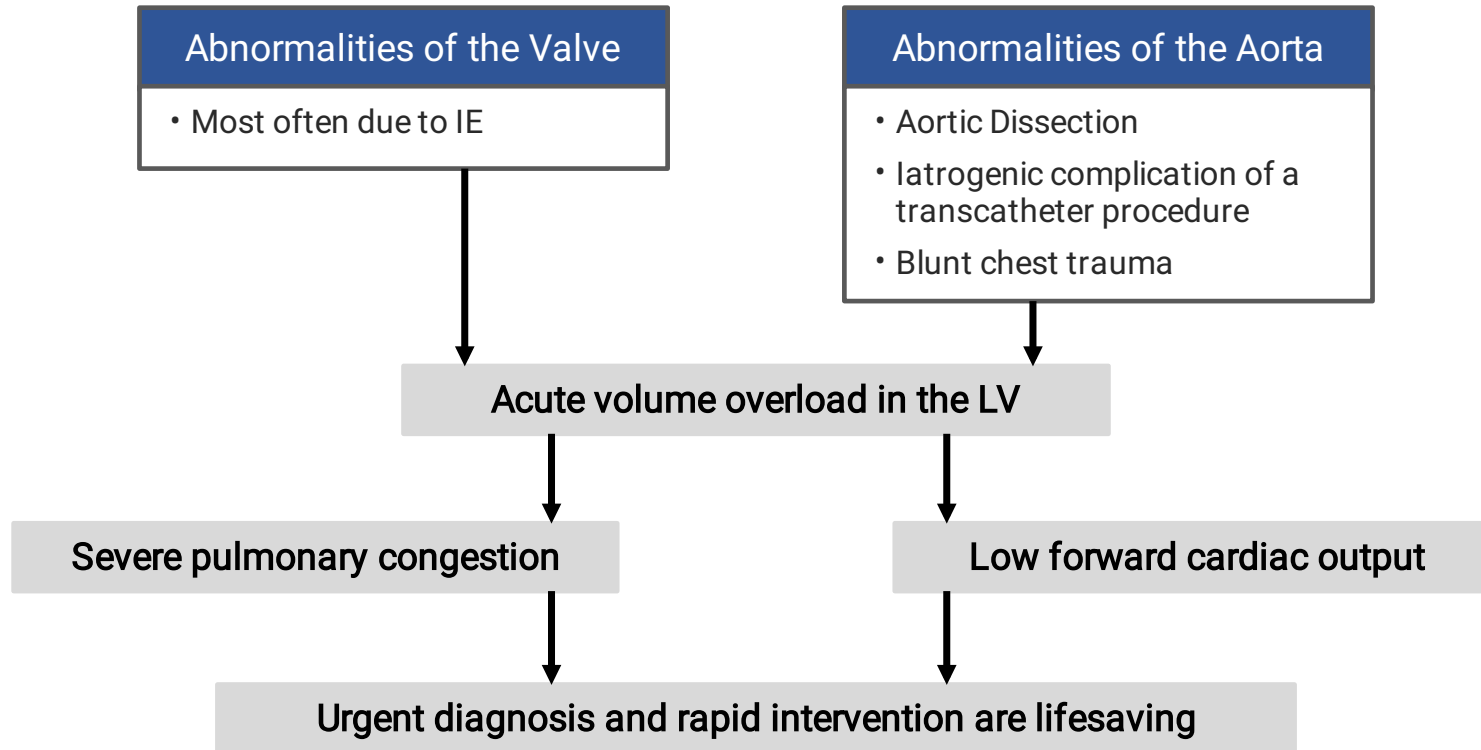
Abbreviations: AS indicates aortic stenosis; AVA, aortic valve area; cm, centimeter; AVR, aortic valve replacement; BNP, B-type natriuretic peptide; DSE, dobutamine stress echocardiography; ETT, exercise treadmill test; LVEF, left ventricular ejection fraction; mmHg, millimeters of mercury; ΔP_{mean} , 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

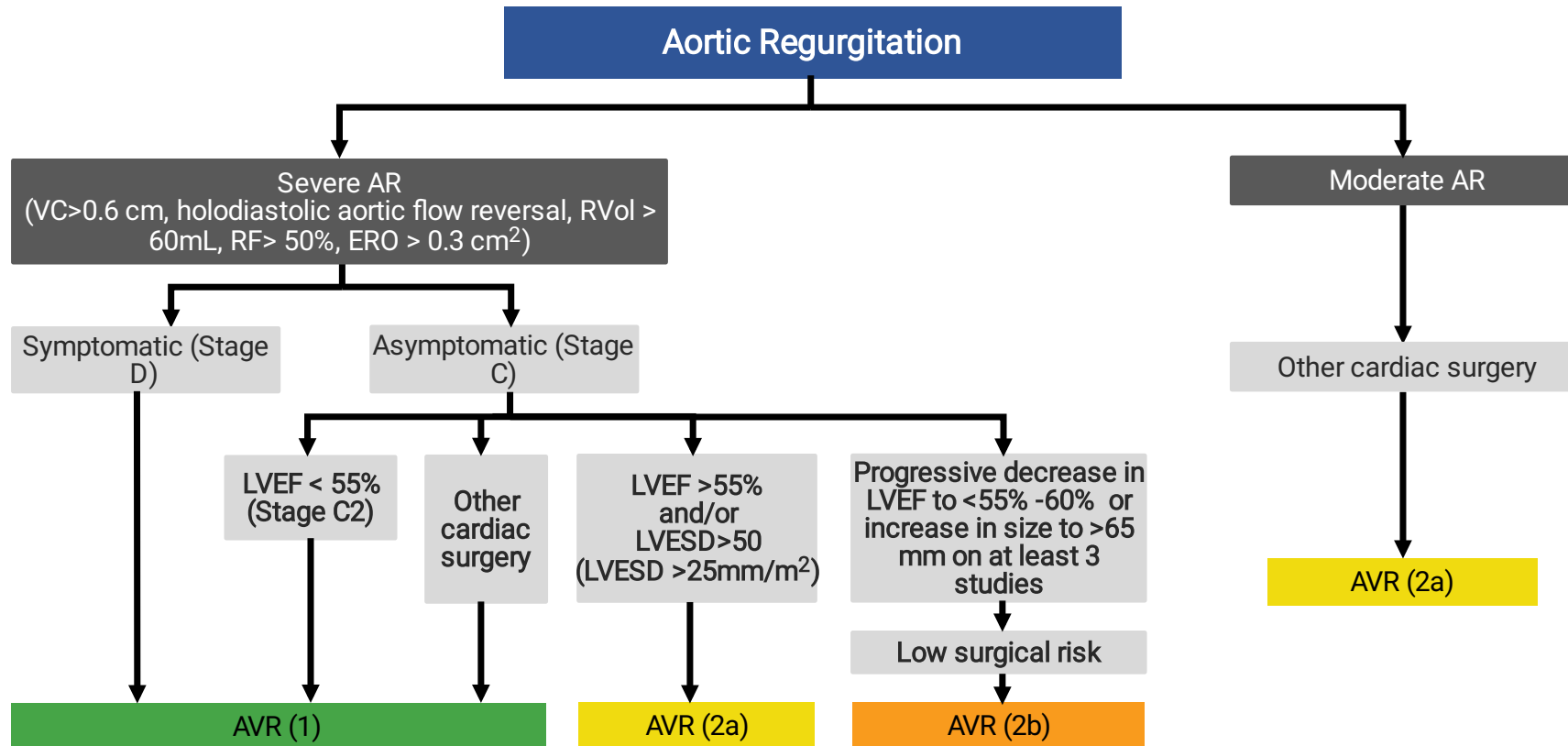


Abbreviations: AR indicates aortic regurgitation; IE, infective endocarditis, and TAVR, transcatheter aortic valve replacement.

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	<u>Mild AR by Echocardiography</u> - 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 <u>Moderate AR by Echocardiography</u> - 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 - Previous infective endocarditis with abnormal leaflet closure or perforation	<u>Severe AR by Echocardiography</u> - Jet width ≥65% of LVOT - Vena contracta >0.6 cm - Holodiastolic flow reversal in proximal abdominal aorta - Regurgitant volume ≥60 mL/beat - Regurgitant fraction ≥50% - ERO ≥0.3 cm² - Angiography: grade 3 to 4 <u>C1: Normal LVEF (>55%) and mild to moderate LV dilation (LVESD <50 mm)</u> <u>C2: Abnormal LV systolic function with depressed LVEF (≤55%) or severe LV dilation (LVESD >50 mm or indexed LVESD >25 mm/m²)</u>	None: Exercise testing is reasonable to confirm symptom status
D Symptomatic Severe AS	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 tract; mm, millimeter; and TAVR, transcatheter aortic valve replacement.	In addition, diagnosis of chronic severe AR requires evidence of moderate to severe LV dilation. May occur with normal LVEF or mild to moderate LV dysfunction.	Exertional dyspnea or angina or more severe HF symptoms

Figure 4. Timing of intervention for AR



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	1. In symptomatic patients with severe AR (Stage D), aortic valve surgery is indicated regardless of LV systolic function. 2. In asymptomatic patients with chronic severe AR and LV systolic dysfunction (LVEF $\leq 55\%$) (Stage C2), aortic valve surgery is indicated if no other cause for systolic dysfunction is identified. 3. In patients with severe AR (Stage C or D) who are undergoing cardiac surgery for other indications, aortic valve surgery is indicated.
2a	4. 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). 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.

Diagnosis & Treatment: Bicuspid Aortic Valve

Figure 5. Diagnosis

Aortopathy is present in 20-40% of patients with BAV

Bicuspid Aortic Valve

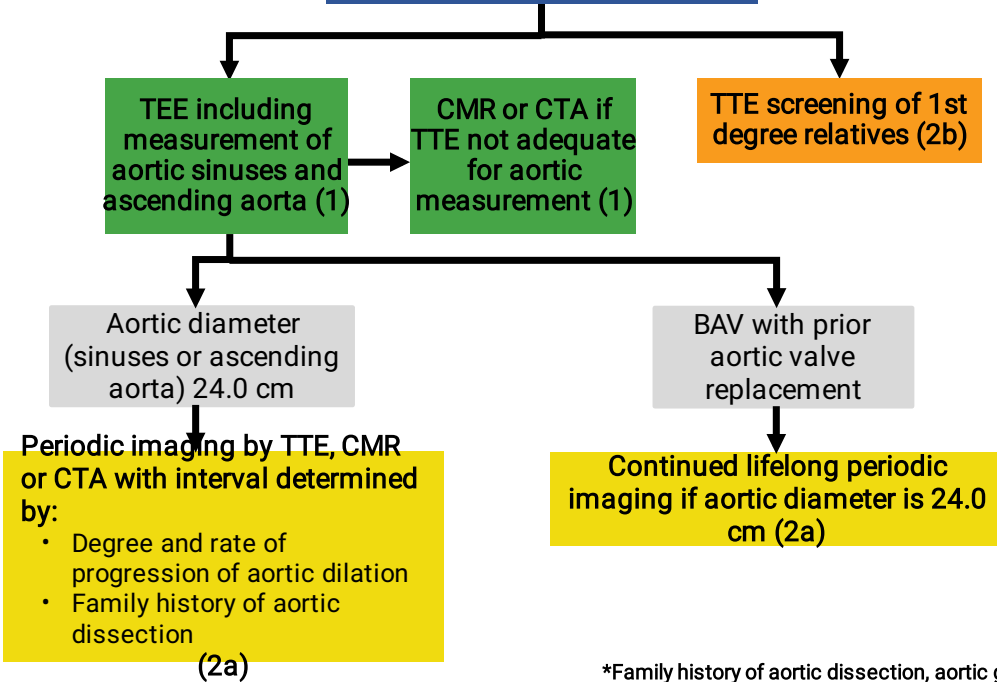
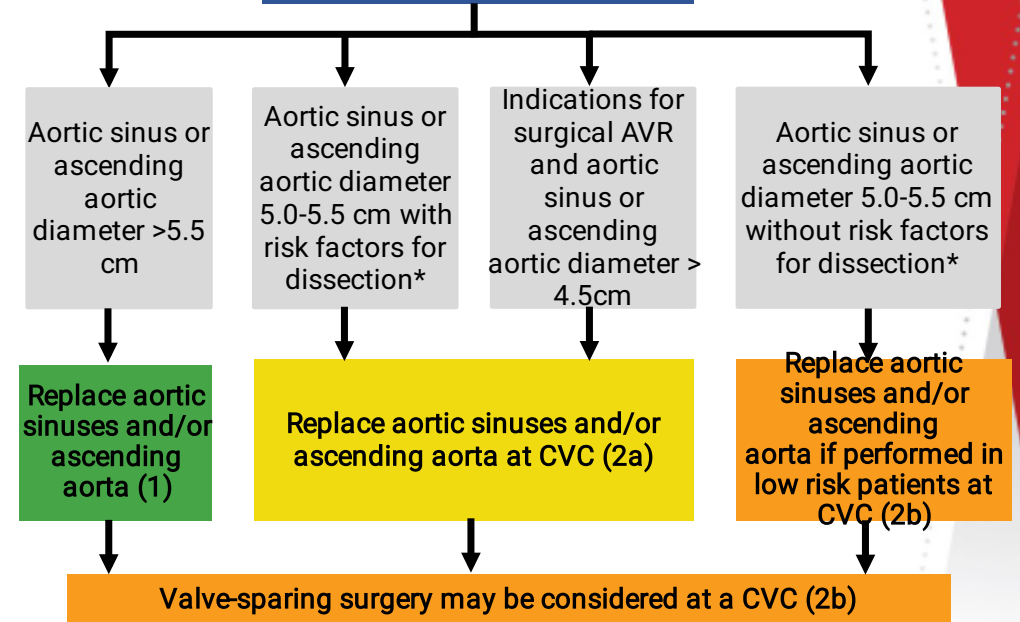


Figure 6. Treatment

Bicuspid Aortic Valve



*Family history of aortic dissection, aortic growth rate ≥ 0.5 cm/y, and/or presence of aortic coarctation.

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

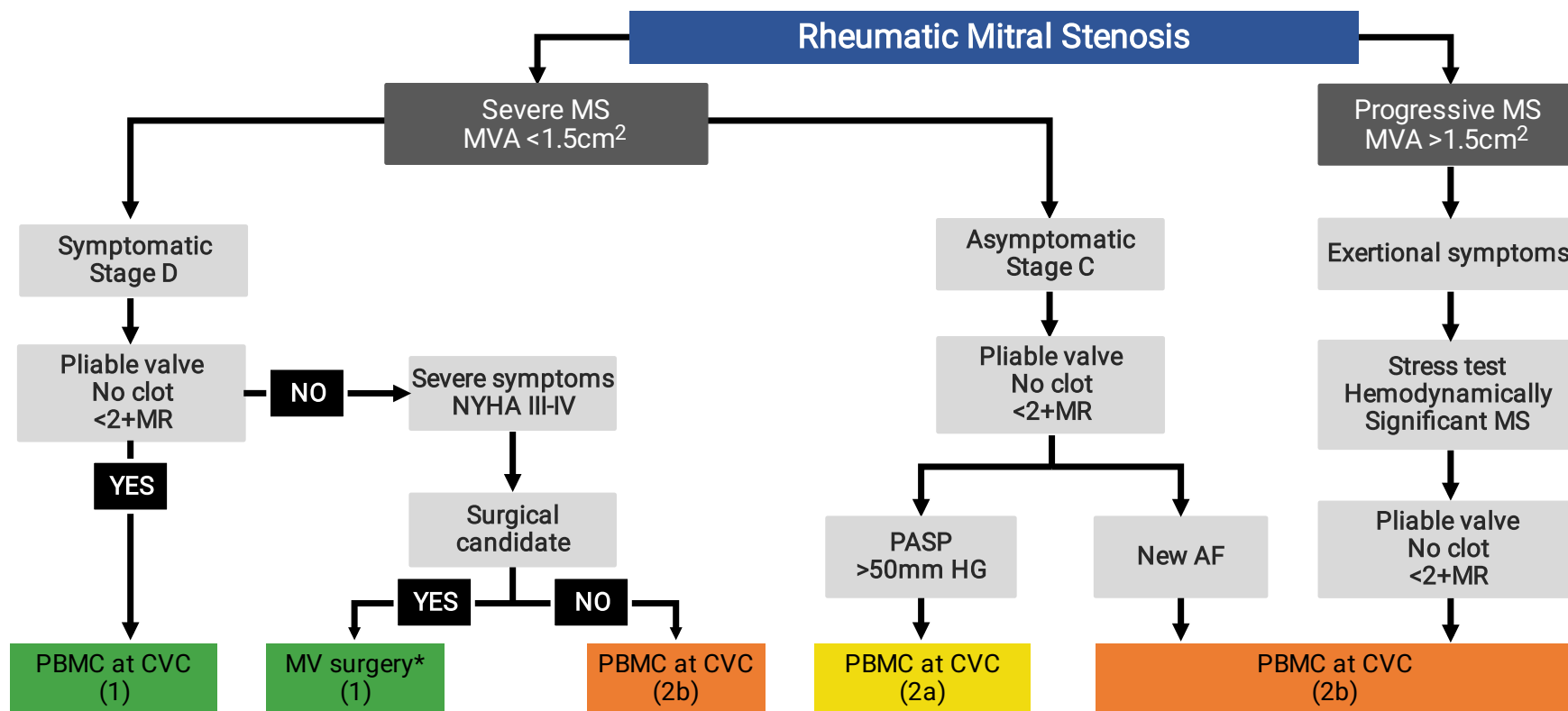
Table 16. Stages of Mitral Stenosis

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 - Severe LA enlargement - Elevated PASP >50 mm Hg	None
D Symptomatic Severe MS	Planimetered mitral valve area ≤ 1.5 cm²		Exertional dyspnea or angina or more severe HF symptoms

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 tolerance - Exertional dyspnea

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

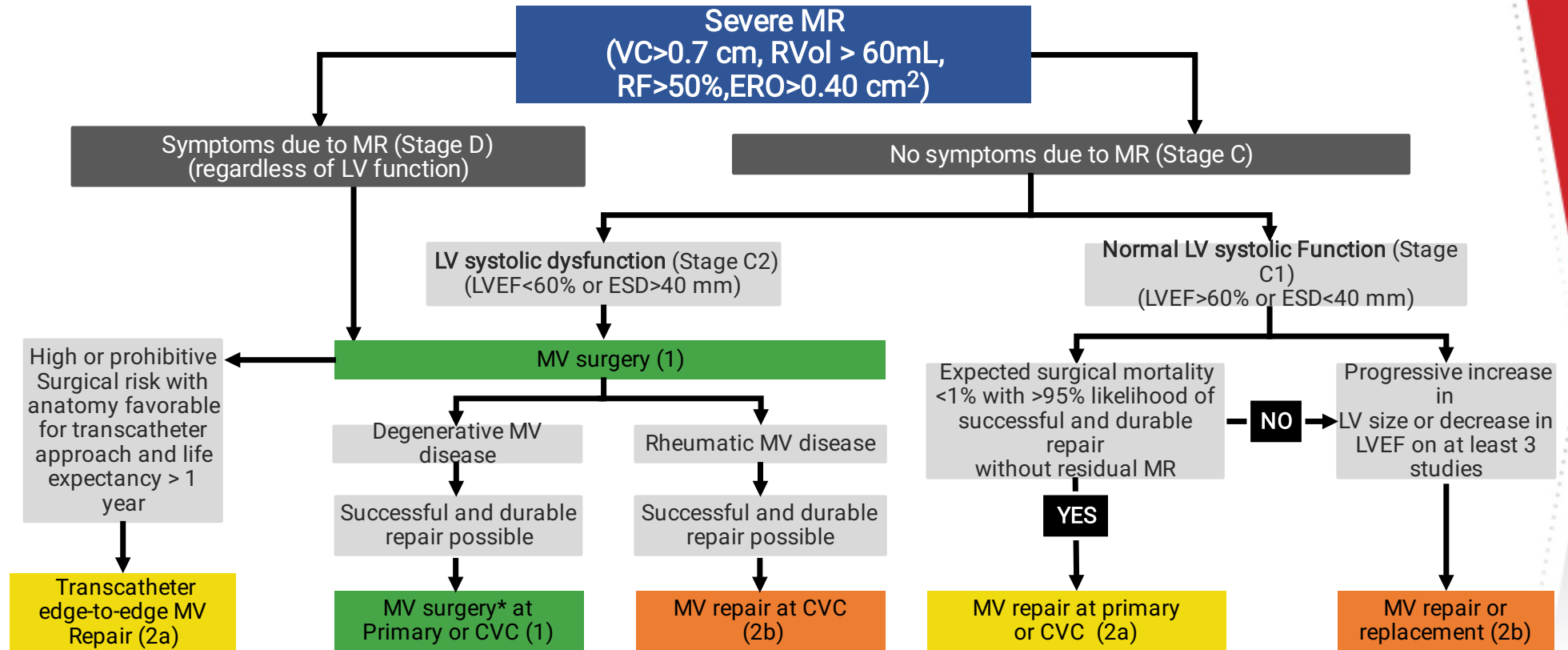
Abbreviations: cm indicates centimeter; ERO, effective regurgitant orifice; IE, infective endocarditis; LA, left atrium/atrial; LV, left ventricular; LVEF, left ventricular ejection fraction; LVESD; left ventricular end-systolic dimension; mL, milliliter; mm, millimeter; and MR, mitral regurgitation.

Diagnostic Testing of Primary Mitral Regurgitation

COR	RECOMMENDATIONS
1	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	2. 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
1	1. 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. 2. 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. 3. 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

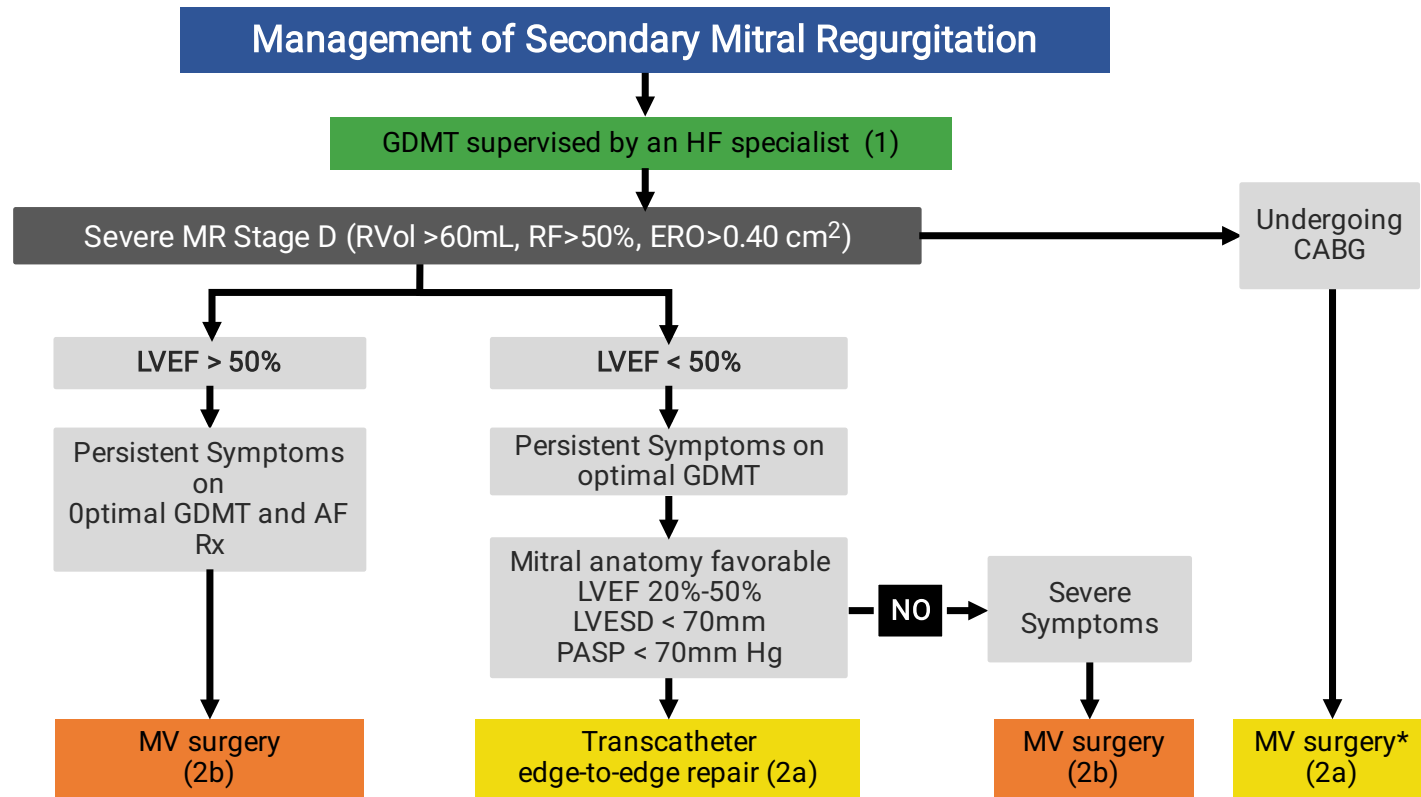
STAGE	VALVE ANATOMY	VALVE HEMODYNAMICS*	ASSOCIATED CARDIAC FINDINGS	SYMPTOMS
A At risk of MR	Normal valve leaflets, chords, and annulus in a patient with CAD or cardiomyopathy	- No MR jet or small central jet area <20% LA on Doppler - Small vena contracta <0.30 cm	- Normal or mildly dilated LV size with 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

*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 flow jet area below in low flow states.

*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 method 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 isovelocity surface area. ‡The method 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 isovelocity surface area.

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.

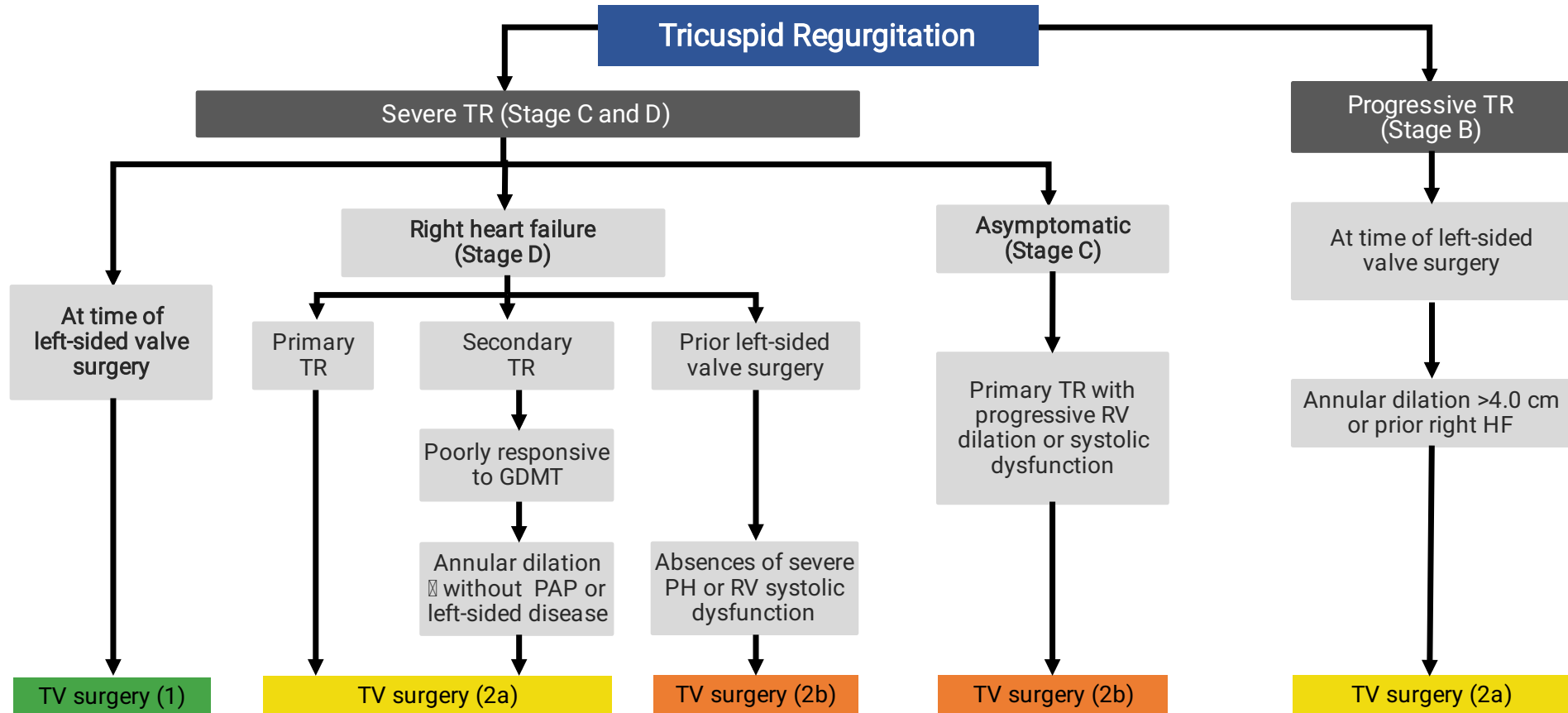
Table 19. Classification of TR

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

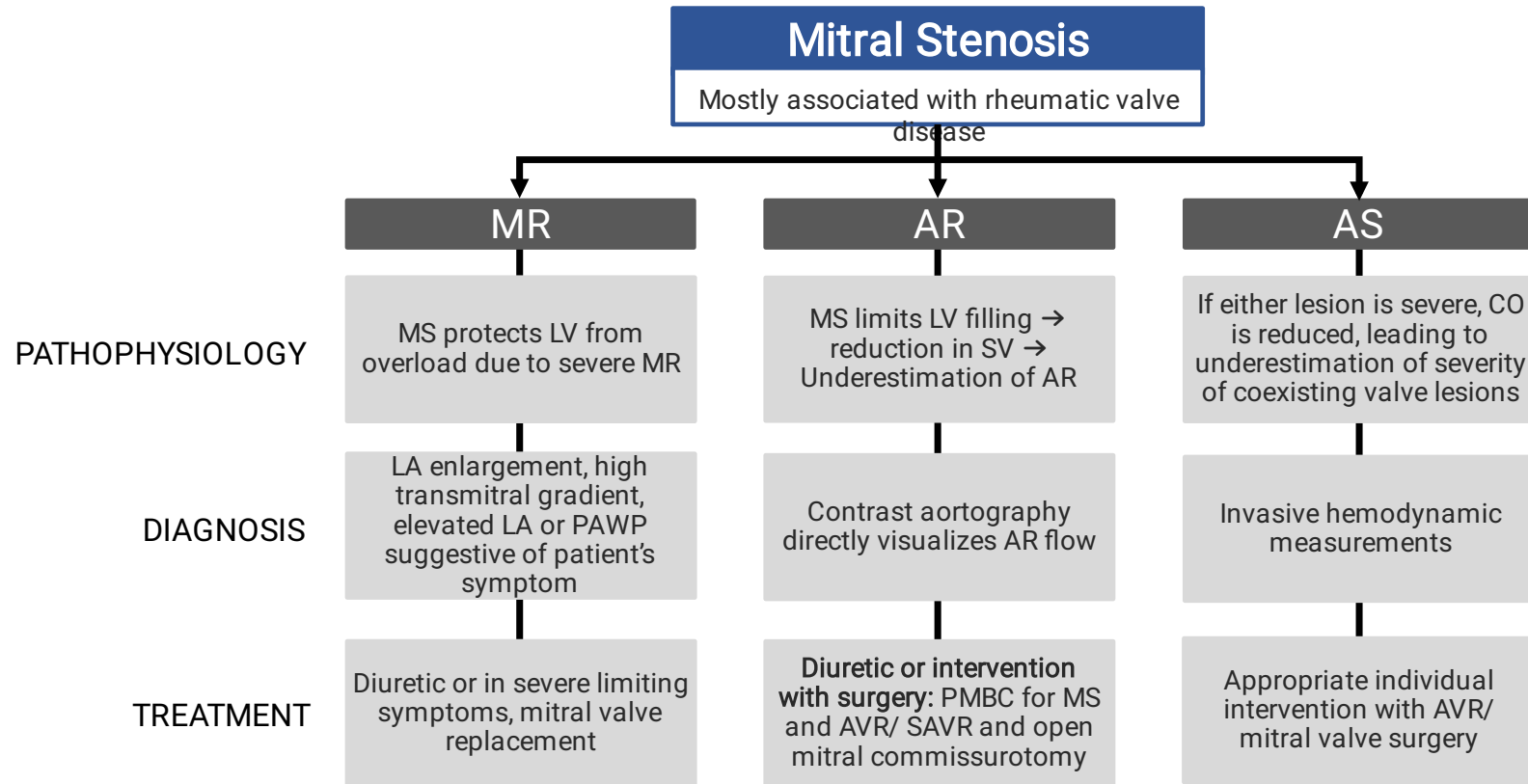
Abbreviations: AF indicates atrial fibrillation; LVEF, left ventricular ejection fraction; RV, right ventricular; and TR, tricuspid regurgitation.

Figure 10. Management of Tricuspid Regurgitation



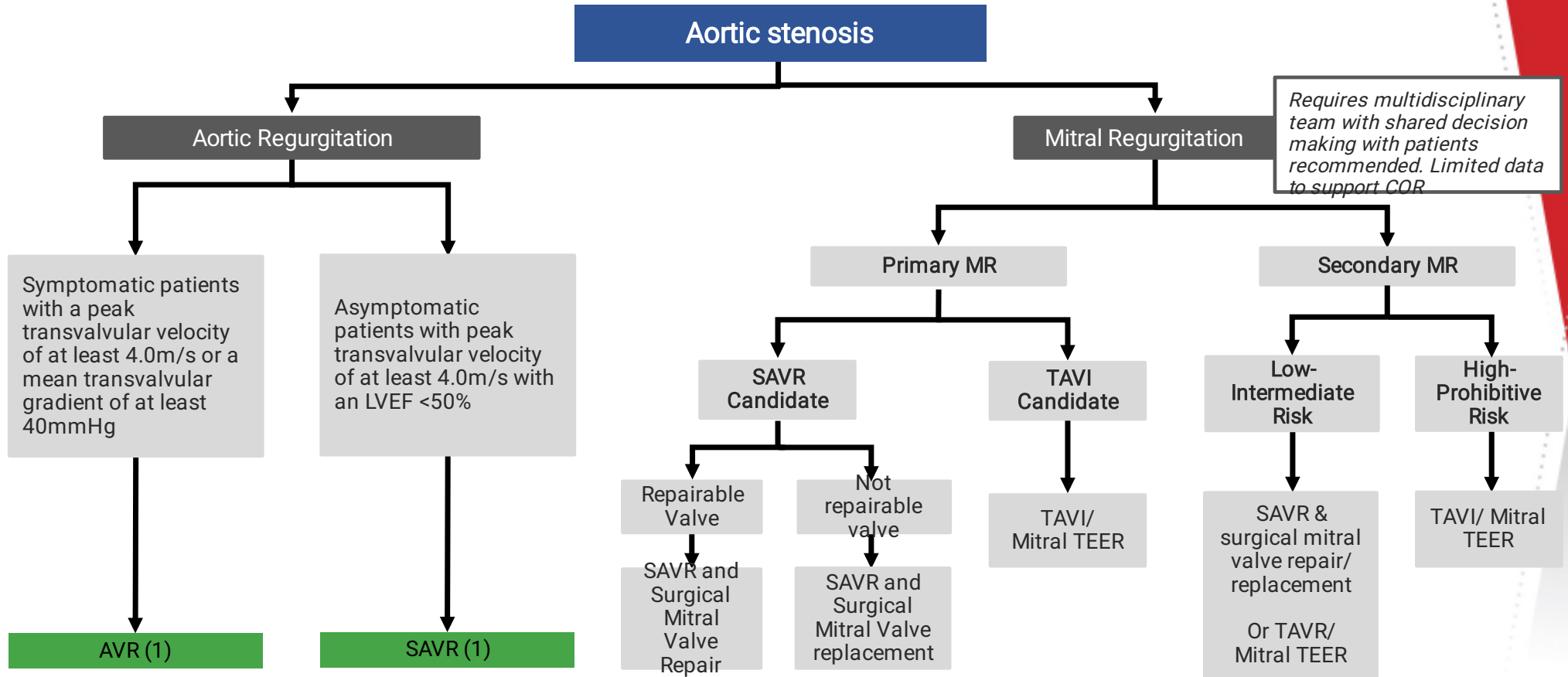
Abbreviations: GDMT indicates guideline-directed management and therapy; HF, heart failure; PAP, pulmonary artery pressure; PH, pulmonary hypertension; RV, right ventricular; TR, tricuspid regurgitation; and TV, tricuspid valve.

Mixed Valve Disease: Diagnosis and Follow up



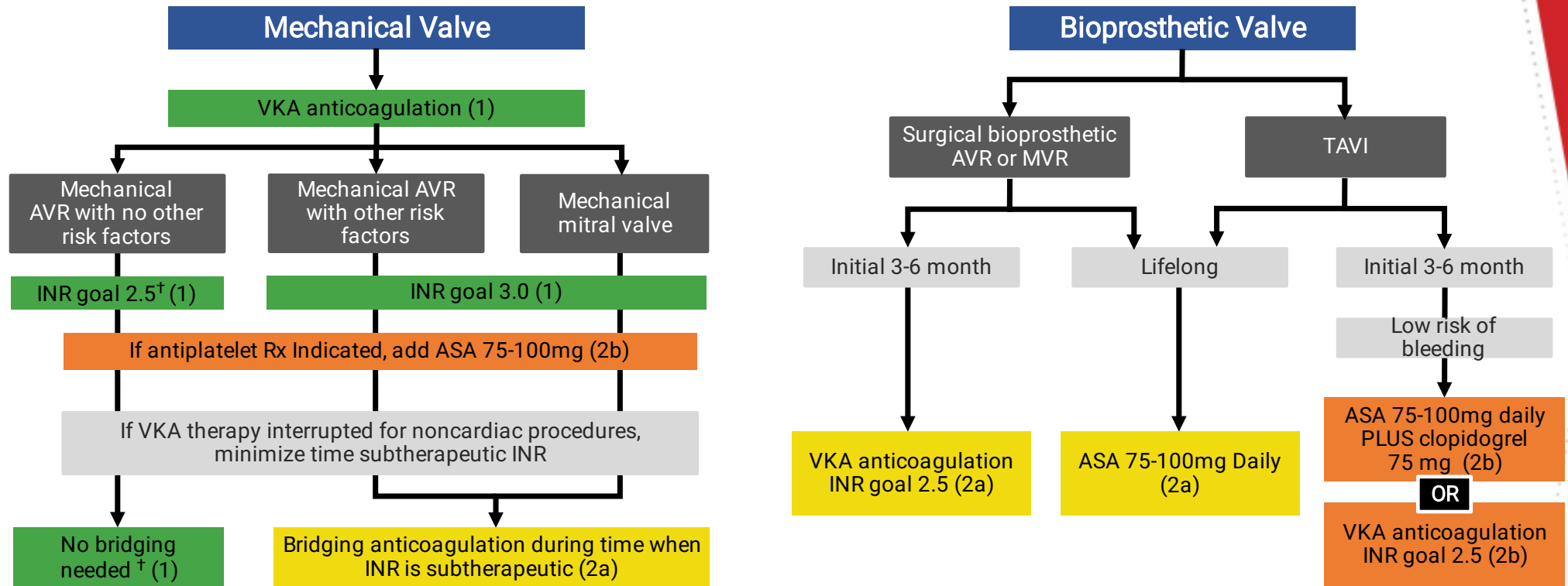
Abbreviations: AR indicates aortic regurgitation; AS, aortic stenosis; AVR, aortic valve replacement; CO, cardiac output; LA, left atrium; MR, mitral regurgitation; MS, mitral stenosis; PAWP, pulmonary artery wedge pressure; PMBC, percutaneous mitral balloon commissurotomy; SAVR, surgical aortic valve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

Mixed Valve Disease: Decision-Making



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.

Figure 12. Antithrombotic Therapy for Prosthetic Valves



*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 four-factor 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:

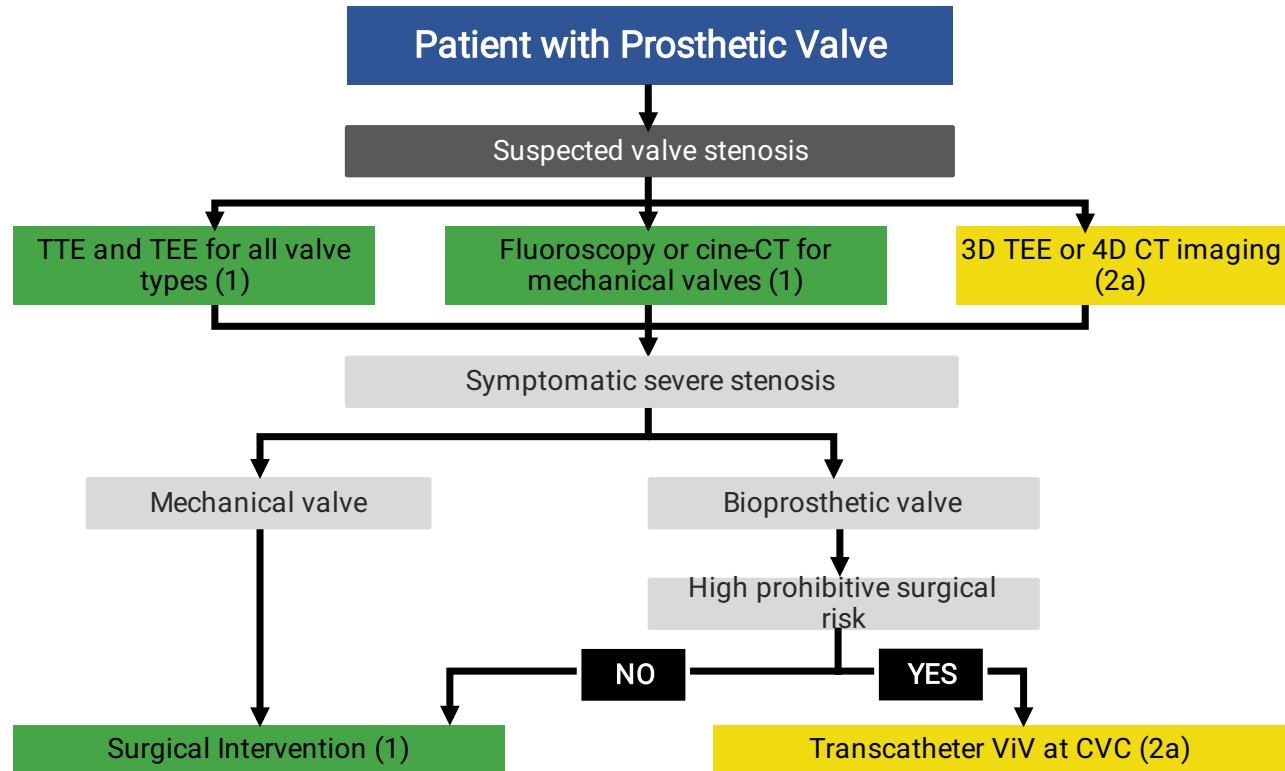
For mechanical valves, **urgent TTE, TEE, fluoro, and/or CT imaging is recommended for suspected valve thrombosis (1).**

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).

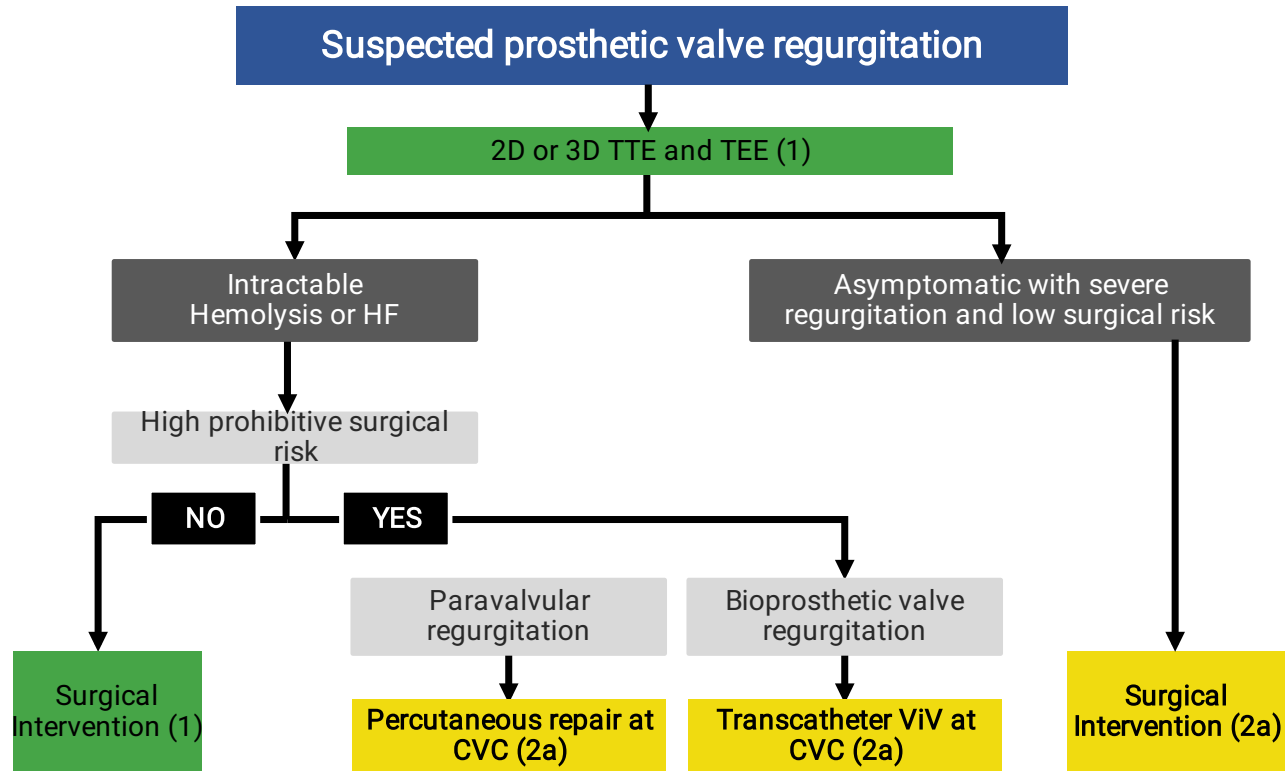
In a **suspected bioprosthetic valve thrombosis**, initial treatment with a VKA is reasonable (2a).

Figure 14. Management of Prosthetic Valve Stenosis



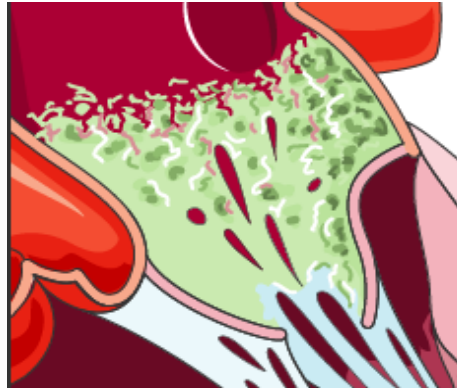
Abbreviations: 3D indicates 3-dimensional; 4D, 4-dimensional; CT, computed tomography; CVC, Comprehensive Valve Center; HF, heart failure; TEE, transesophageal echocardiography; TTE, transthoracic echocardiography/echocardiogram; and ViV, valve-in-valve.

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)

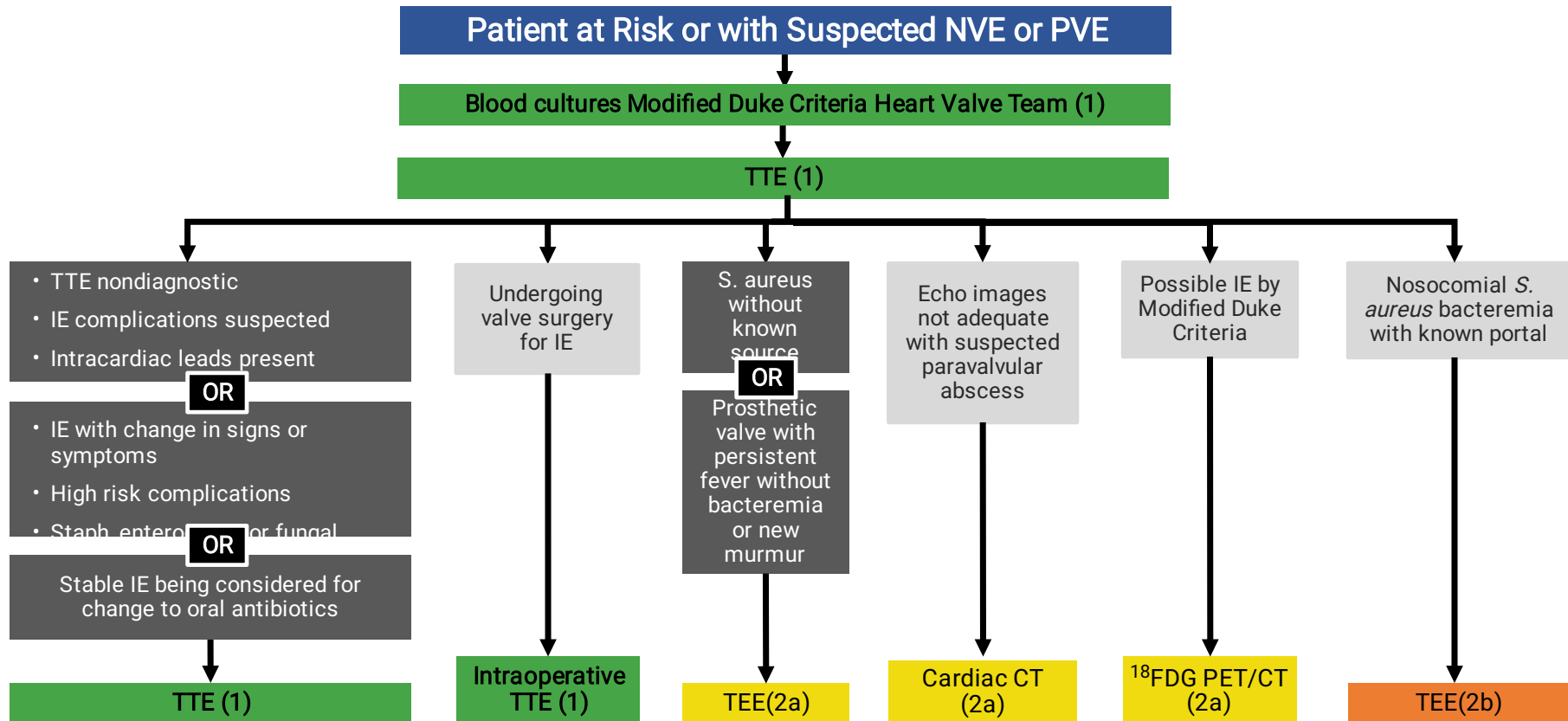
- If TTE non-diagnostic
- Complication suspected or present
- Intra-cardiac leads present

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

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)



Anticoagulation

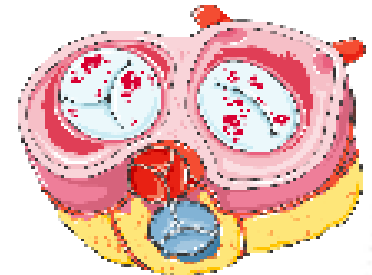
If there is evidence of cerebral embolism or stroke, irrespective of other indications for anticoagulation, it is reasonable to temporarily hold anticoagulation (2a)

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



Addiction Rx

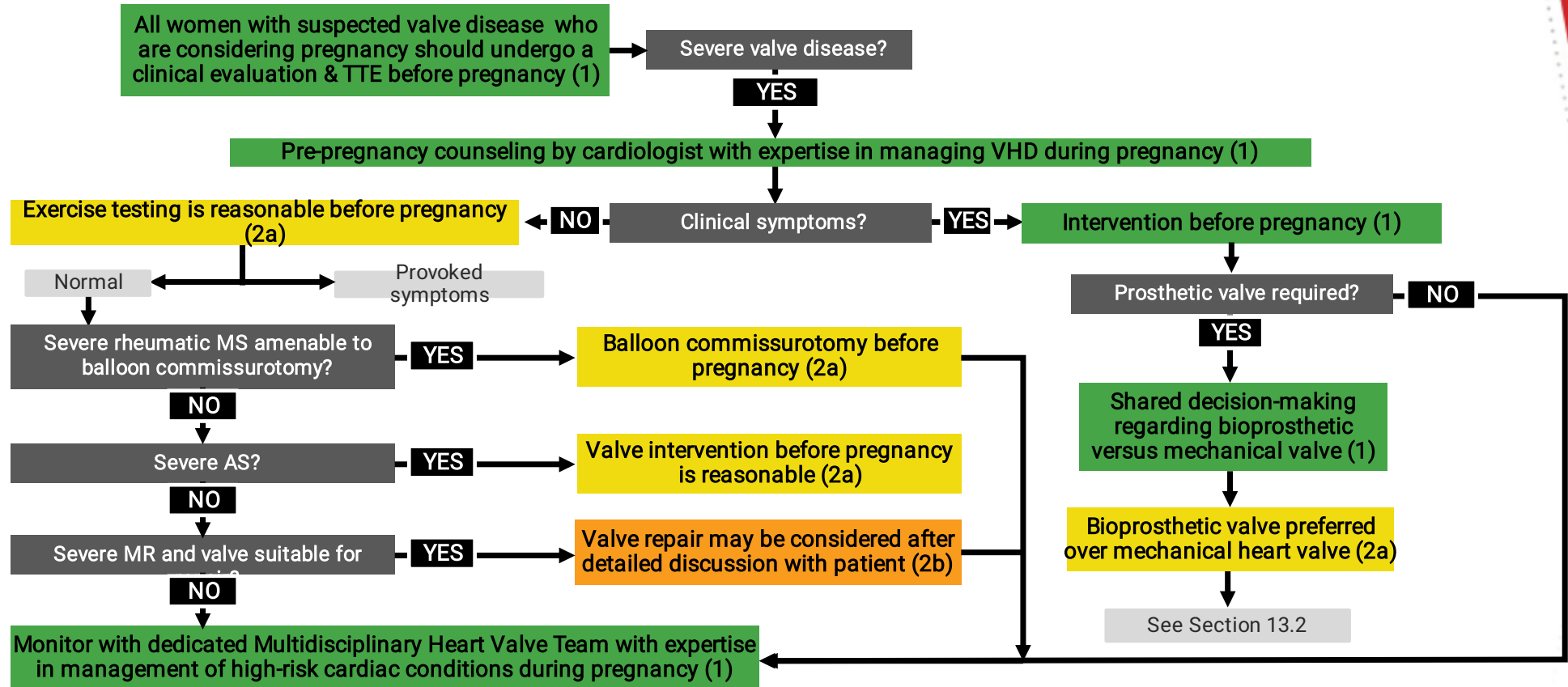
If IE is a consequence of injection drug use, the patient should be referred to addiction treatment for opioid substitution therapy (1)



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

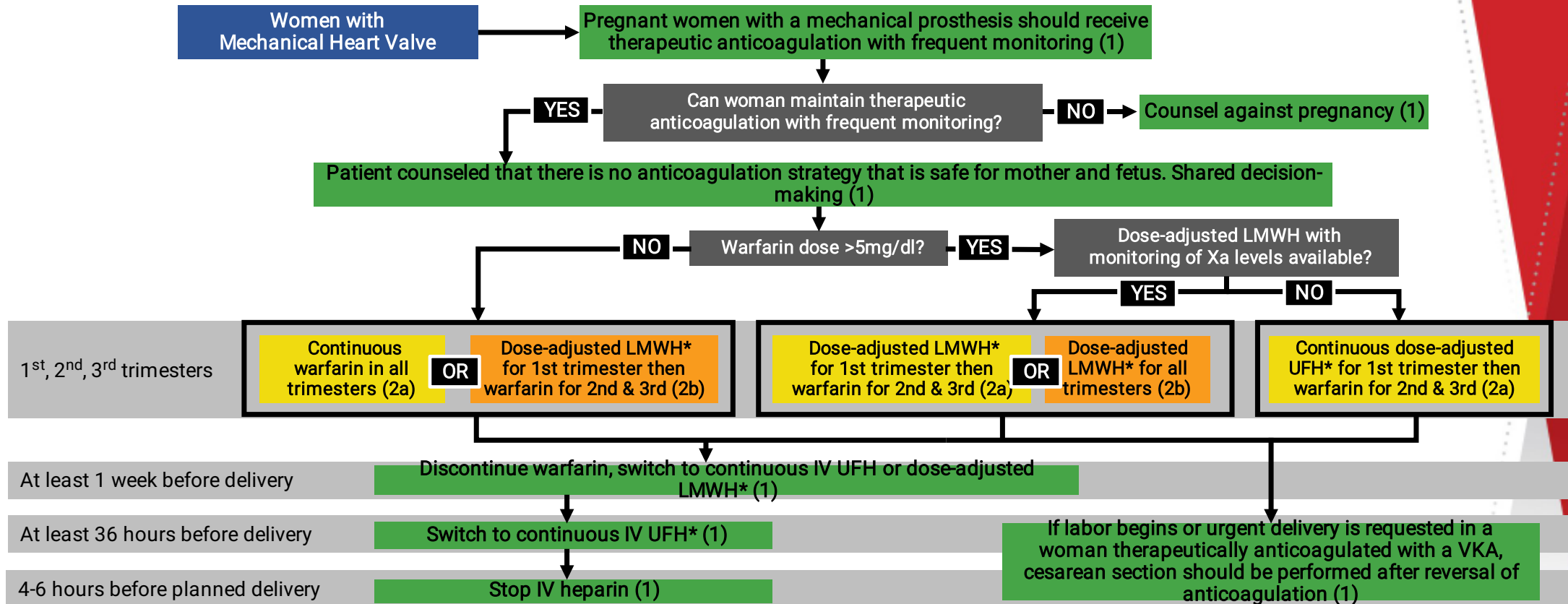
Abbreviations: IE indicates infective endocarditis; Rx, treatment; TEE, trans-esophageal echocardiography; VHD, valvular heart disease; and VKA, vitamin K antagonists.

Figure 17. Preconception Management of Women with NVD



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

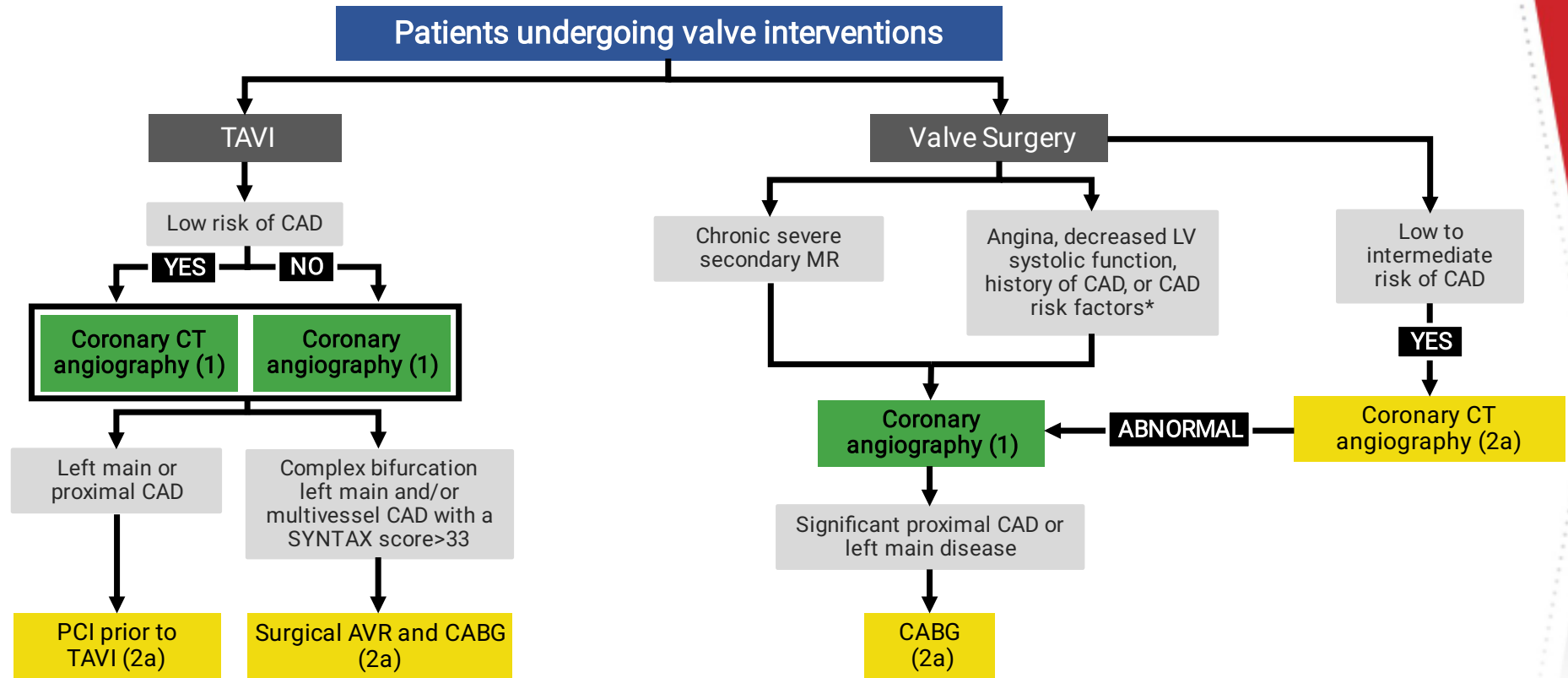
Figure 18. Anticoagulation for Prosthetic Mechanical Heart Valves in Pregnancy



*Dose-adjusted LMWH should be given at least 2 times per day, with close monitoring of anti-Xa levels. Target to Xa level of 0.8 to 1.2 U/mL, 4 to 6 hours after dose. 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.

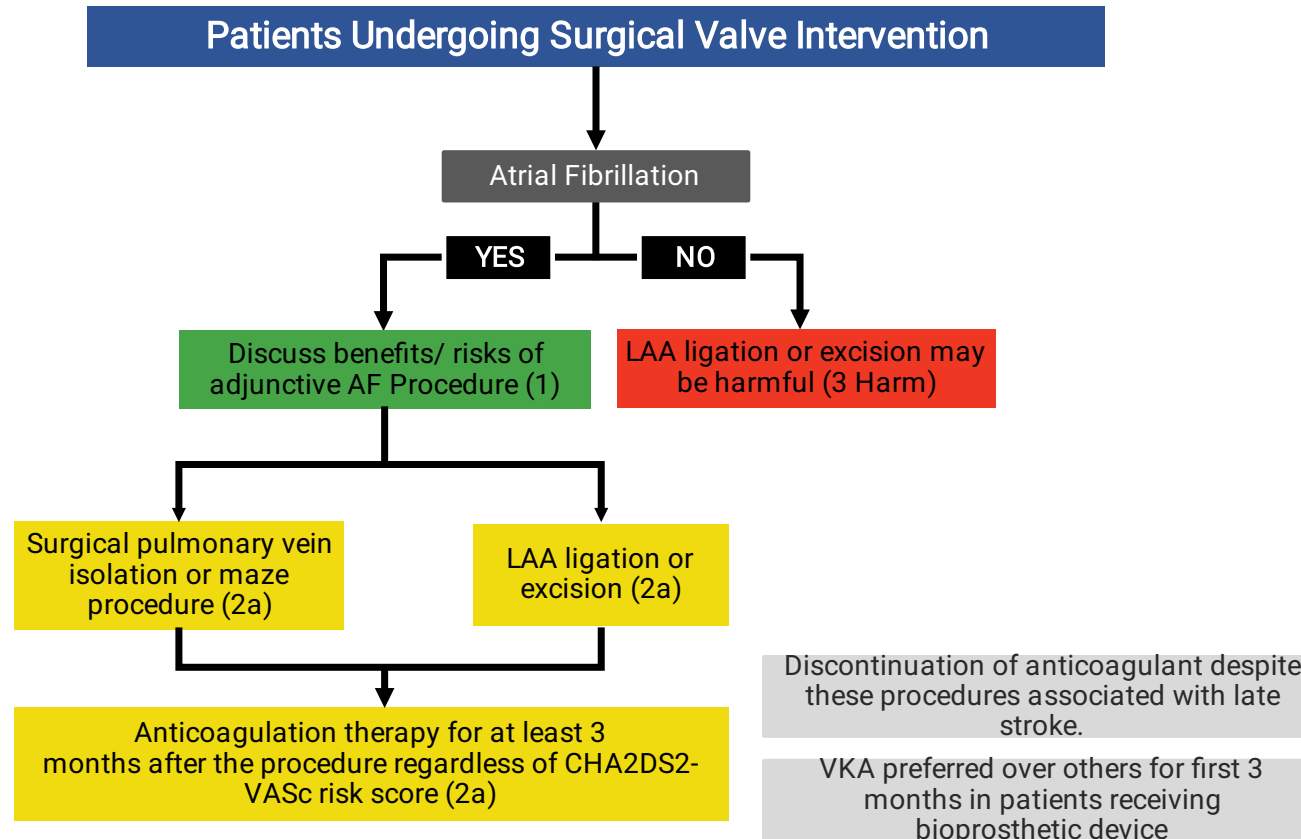
Figure 19. Valve Intervention in CAD



*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 ≥ 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
1	1. 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 Symptomatic Patient

COR	RECOMMENDATIONS
1	1. 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 Asymptomatic Patient

COR	RECOMMENDATIONS
2a	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.

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.

Evidence Gaps and Future Directions in VHD



STAGE A

Prevention of VHD:

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



STAGE B

Medical therapy to prevent VHD progression:

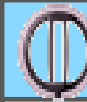
- Disease mechanism and targets
- Understanding the interplay between severity of VHD and LV modulation and vascular dysfunction



STAGE C

Timing of intervention:

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



STAGE D

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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