2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease

Developed in Collaboration with the American Association for Thoracic Surgery, American Society of Echocardiography, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons

Helping Cardiovascular Professionals Learn. Advance. Heal.

Citation

This slide set is adapted from the 2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (*Journal of the American College of Cardiology).* Published on March 3, 2014, available at: http://content.onlinejacc.org/cgi/content/full/j.jacc.2014.02.536 and http://circ.ahajournals.org/content/early/2014/02/27/CIR.0000000000000029.citation

The full-text guidelines are also available on the following Web sites: ACC (www.cardiosource.org) and AHA (my.americanheart.org)

Slide Set Editors

Rick A. Nishimura and Catherine M. Otto

Valvular Heart Disease Guideline Writing Committee Members

Rick A. Nishimura, MD, MACC, FAHA, Co-Chair†

Catherine M. Otto, MD, FACC, FAHA, Co-Chair†

Robert O. Bonow, MD, MACC, FAHA†

Blase A. Carabello, MD, FACC*†

John P. Erwin III, MD, FACC, FAHA‡

Robert A. Guyton, MD, FACC*§

Patrick T. O'Gara, MD, FACC, FAHA†

Carlos E. Ruiz, MD, PhD, FACC†

Nikolaos J. Skubas, MD, FASE¶

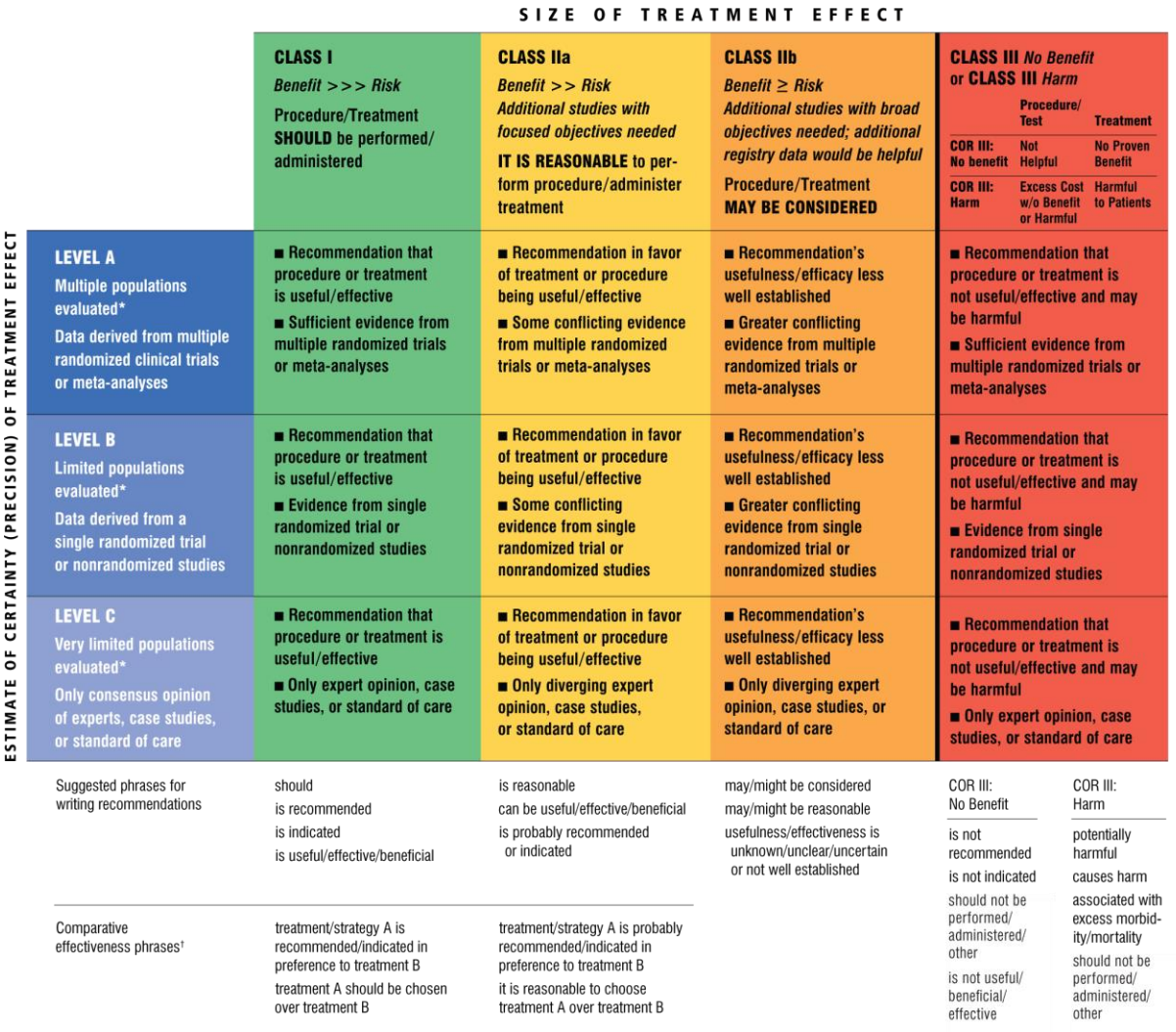
Paul Sorajja, MD, FACC, FAHA#

Thoralf M. Sundt III, MD* **††

James D. Thomas, MD, FASE, FACC, FAHA‡‡

*Writing committee members are required to recuse themselves from voting on sections to which their specific relationships with industry and other entities may apply.
†ACC/AHA representative. ‡ACC/AHA Task Force on Performance Measures liaison. §ACC/AHA Task Force on Practice Guidelines liaison. ¶SCA Representative. #SCAI Representative. **AATS Representative. ††STS Representative. ‡‡ASE Representative.

Classification of Recommendations and Levels of Evidence



SIZE OF TREATMENT EFFECT

ESTIMATE OF CERTAINTY (PRECISION) OF TREATMENT EFFECT

	CLASS I *Benefit >>> Risk* Procedure/Treatment **SHOULD** be performed/ administered	CLASS IIa *Benefit >> Risk* *Additional studies with focused objectives needed* **IT IS REASONABLE** to perform procedure/administer treatment	CLASS IIb *Benefit ≥ Risk* *Additional studies with broad objectives needed; additional registry data would be helpful* Procedure/Treatment **MAY BE CONSIDERED**	CLASS III *No Benefit* or CLASS III *Harm* Procedure/ Test / Treatment COR III: No benefit — Not Helpful / No Proven Benefit COR III: Harm — Excess Cost w/o Benefit or Harmful / Harmful to Patients
LEVEL A Multiple populations evaluated* Data derived from multiple randomized clinical trials or meta-analyses	■ Recommendation that procedure or treatment is useful/effective ■ Sufficient evidence from multiple randomized trials or meta-analyses	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from multiple randomized trials or meta-analyses	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Sufficient evidence from multiple randomized trials or meta-analyses
LEVEL B Limited populations evaluated* Data derived from a single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is useful/effective ■ Evidence from single randomized trial or nonrandomized studies	■ Recommendation in favor of treatment or procedure being useful/effective ■ Some conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation's usefulness/efficacy less well established ■ Greater conflicting evidence from single randomized trial or nonrandomized studies	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Evidence from single randomized trial or nonrandomized studies
LEVEL C Very limited populations evaluated* Only consensus opinion of experts, case studies, or standard of care	■ Recommendation that procedure or treatment is useful/effective ■ Only expert opinion, case studies, or standard of care	■ Recommendation in favor of treatment or procedure being useful/effective ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation's usefulness/efficacy less well established ■ Only diverging expert opinion, case studies, or standard of care	■ Recommendation that procedure or treatment is not useful/effective and may be harmful ■ Only expert opinion, case studies, or standard of care
Suggested phrases for writing recommendations	should is recommended is indicated is useful/effective/beneficial	is reasonable can be useful/effective/beneficial is probably recommended or indicated	may/might be considered may/might be reasonable usefulness/effectiveness is unknown/unclear/uncertain or not well established	COR III: No Benefit: is not recommended; is not indicated; should not be performed/ administered/ other; is not useful/ beneficial/ effective COR III: Harm: potentially harmful; causes harm; associated with excess morbidity/mortality; should not 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	treatment/strategy A is probably recommended/indicated in preference to treatment B it is reasonable to choose treatment A over treatment B		

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

*Data available from clinical trials or registries about the usefulness/ efficacy in different subpopulations, such as sex, age, history of diabetes mellitus, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

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

Stages of Progression of VHD

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

Diagnostic Testing – Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is recommended in the initial evaluation of patients with known or suspected VHD to confirm the diagnosis, establish etiology, determine severity, assess hemodynamic consequences, determine prognosis, and evaluate for timing of intervention	I	B
TTE is recommended in patients with known VHD with any change in symptoms or physical examination findings	I	C
Periodic monitoring with TTE is recommended in asymptomatic patients with known VHD at intervals depending on valve lesion, severity, ventricular size, and ventricular function	I	C

Diagnostic Testing – Diagnosis and Follow-Up

Recommendations	COR	LOE
Cardiac catheterization for hemodynamic assessment is recommended in symptomatic patients when noninvasive tests are inconclusive or when there is a discrepancy between the findings on noninvasive testing and physical examination regarding severity of the valve lesion	I	C
Exercise testing is reasonable in selected patients with asymptomatic severe VHD to 1) confirm the absence of symptoms, or 2) assess the hemodynamic response to exercise, or 3) determine prognosis	IIa	B

Frequency of Echocardiograms in Asymptomatic Patients With VHD and Normal Left Ventricular Function

Stage	Valve Lesion			
Stage	Aortic Stenosis	Aortic Regurgitation	Mitral Stenosis	Mitral Regurgitation
Progressive (stage B)	Every 3–5 y (mild severity V_{max} 2.0–2.9 m/s) Every 1–2 y (moderate severity V_{max} 3.0–3.9 m/s)	Every 3-5 y (mild severity) Every 1-2 y (moderate severity)	Every 3–5 y (MVA >1.5 cm^2)	Every 3–5 y (mild severity) Every 1–2 y (moderate severity)
Severe (stage C)	Every 1 y (V_{max} ≥4 m/s)	Every 1 y Dilating LV–more frequent	Every 1–2 y (MVA 1.0–1.5 cm^2) Every 1 y (MVA <1 cm^2)	Every 6 months to 1 y Dilating LV–more frequent

Basic Principles of Medical Therapy

Recommendations	COR	LOE
Secondary prevention of rheumatic fever is indicated in patients with rheumatic heart disease, specifically mitral stenosis	I	C
Prophylaxis against infective endocarditis (IE) is reasonable for the following patients at highest risk for adverse outcomes from IE prior to dental procedures that involve manipulation of gingival tissue, manipulation of the periapical region of teeth, or perforation of the oral mucosa: • Patients with prosthetic cardiac valves; • Patients with previous IE; • Cardiac transplant recipients with valve regurgitation due to a structurally abnormal valve; or *(continued on next page)*	IIa	B

Basic Principles of Medical Therapy

Recommendations	COR	LOE

(continued)
• Patients with CHD with:
  ○ Unrepaired cyanotic CHD, including palliative shunts and conduits;
  ○ Completely repaired congenital heart defect repaired with prosthetic material or device, whether placed by surgery or by catheter intervention, during the first 6 months after the procedure; or
  ○ Repaired CHD with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device
	IIa	B

Prophylaxis against IE is not recommended in patients with VHD at risk of IE for nondental procedures (e.g., TEE, esophagogastroduodenoscopy, colonoscopy, or cystoscopy) in the absence of active infection	III: No Benefit	B

Risk Assessment Combining STS Risk Estimate, Frailty, Major Organ System Dysfunction, and Procedure-Specific Impediments

	Low Risk (must meet ALL criteria in this column)	Intermediate Risk (any 1 criteria in this column)	High Risk (any 1 criteria in this column)	Prohibitive Risk (any 1 criteria in this column)
STS PROM	<4% **AND**	4% to 8% **OR**	>8% **OR**	Predicted risk with surgery of death or major morbidity (all-cause) >50% at 1 y **OR**
Frailty	None **AND**	1 index (mild) **OR**	2 or more indices (moderate-to-severe) **OR**	
Major organ system compromise not to be improved postoperatively	None **AND**	1 organ system **OR**	No more than 2 organ systems **OR**	3 or more organ systems **OR**
Procedure-specific impediment	None	Possible procedure-specific impediment	Possible procedure-specific impediment	Severe procedure-specific impediment

The Heart Valve Team and Heart Valve Centers of Excellence

Recommendations	COR	LOE
Patients with severe VHD should be evaluated by a multidisciplinary Heart Valve Team when intervention is considered	I	C
Consultation with or referral to a Heart Valve Center of Excellence is reasonable when discussing treatment options 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	IIa	C

Stages of Valvular Aortic Stenosis

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
A	**At risk of AS**	• Bicuspid aortic valve (or other congenital valve anomaly) • Aortic valve sclerosis	• Aortic V_{max} <2 m/s	• None	• None
B	**Progressive AS**	• Mild-to-moderate leaflet calcification of a bicuspid or trileaflet valve with some reduction in systolic motion or • Rheumatic valve changes with commissural fusion	• Mild AS: Aortic V_{max} 2.0–2.9 m/s or mean ΔP <20 mm Hg • Moderate AS: Aortic V_{max} 3.0–3.9 m/s or mean ΔP 20–39 mm Hg	• Early LV diastolic dysfunction may be present • Normal LVEF	• None

Stages of Valvular Aortic Stenosis

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C - Asymptomatic severe AS					
C1	**Asymptomatic severe AS**	• Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening	• Aortic V_{max} ≥4 m/s or mean ΔP ≥40 mm Hg • AVA typically is ≤1 cm^2 (or AVAi ≤0.6 cm^2/m^2) • Very severe AS is an aortic V_{max} ≥5 m/s, or mean ΔP ≥60 mm Hg	• LV diastolic dysfunction • Mild LV hypertrophy • Normal LVEF	• None–exercise testing is reasonable to confirm symptom status
C2	**Asymptomatic severe AS with LV dysfunction**	• Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening	• Aortic V_{max} ≥4 m/s or mean ΔP ≥40 mm Hg • AVA typically is ≤1 cm^2 (or AVAi ≤0.6 cm^2/m^2)	• LVEF <50%	• None

Stages of Valvular Aortic Stenosis

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D - Symptomatic severe AS					
D1	**Symptomatic severe high-gradient AS**	• Severe leaflet calcification or congenital stenosis with severely reduced leaflet opening	• Aortic V_{max} ≥4 m/s, or mean ΔP ≥40 mm Hg • AVA typically is ≤1 cm^2 (or AVAi ≤0.6 cm^2/m^2), but may be larger with mixed AS/AR	• LV diastolic dysfunction • LV hypertrophy • Pulmonary hypertension may be present	• Exertional dyspnea or decreased exercise tolerance • Exertional angina • Exertional syncope or presyncope
D2	**Symptomatic severe low-flow/low-gradient AS with reduced LVEF**	• Severe leaflet calcification with severely reduced leaflet motion	• AVA ≤1 cm^2 with resting aortic V_{max} <4 m/s or mean ΔP <40 mm Hg • Dobutamine stress echo shows AVA ≤1 cm^2 with V_{max} ≥4 m/s at any flow rate	• LV diastolic dysfunction • LV hypertrophy • LVEF <50%	• HF, • Angina, • Syncope or presyncope

Stages of Valvular Aortic Stenosis

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D - Symptomatic severe AS					
D3	**Symptomatic severe low-gradient AS with normal LVEF or paradoxical low-flow severe AS**	• Severe leaflet calcification with severely reduced leaflet motion	• AVA ≤1 cm^2 with aortic V_{max} <4 m/s, or mean ΔP <40 mm Hg • Indexed AVA ≤0.6 cm^2/m^2 and • Stroke volume index <35 mL/m^2 • Measured when the patient is normotensive (systolic BP <140 mm Hg)	• Increased LV relative wall thickness • Small LV chamber with low-stroke volume. • Restrictive diastolic filling • LVEF ≥50%	• HF, • Angina, • Syncope or presyncope

Aortic Stenosis: Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is indicated in patients with signs or symptoms of AS or a bicuspid aortic valve for accurate diagnosis of the cause of AS, hemodynamic severity, LV size and systolic function, and for determining prognosis and timing of valve intervention	I	B
Low-dose dobutamine stress testing using echocardiographic or invasive hemodynamic measurements is reasonable in patients with stage D2 AS with all of the following: a. Calcified aortic valve with reduced systolic opening; b. LVEF less than 50%; c. Calculated valve area 1.0 cm^2 or less; and d. Aortic velocity less than 4.0 m per second or mean pressure gradient less than 40 mm Hg	IIa	B

Aortic Stenosis: Diagnosis and Follow-Up

Recommendations	COR	LOE
Exercise testing is reasonable to assess physiological changes with exercise and to confirm the absence of symptoms in asymptomatic patients with a calcified aortic valve and an aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher (stage C)	IIa	B
Exercise testing should not be performed in symptomatic patients with AS when the aortic velocity is 4.0 m per second or greater or mean pressure gradient is 40 mm Hg or higher (stage D)	III: Harm	B

Aortic Stenosis: Medical Therapy

Recommendations	COR	LOE
Hypertension in patients at risk for developing AS (stage A) and in patients with asymptomatic AS (stages B and C) should be treated according to standard GDMT, started at a low dose, and gradually titrated upward as needed with frequent clinical monitoring	I	B
Vasodilator therapy may be reasonable if used with invasive hemodynamic monitoring in the acute management of patients with severe decompensated AS (stage D) with New York Heart Association (NYHA) class IV heart failure (HF) symptoms	IIb	C

Aortic Stenosis: Medical Therapy

Recommendations	COR	LOE
Statin therapy is not indicated for prevention of hemodynamic progression of AS in patients with mild-to-moderate calcific valve disease (stages B to D)	III: No Benefit	A

Aortic Stenosis: Timing of Intervention

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

Aortic Stenosis: Timing of Intervention (cont.)

Recommendations	COR	LOE
AVR is reasonable for asymptomatic patients with very severe AS (stage C1, aortic velocity ≥5 m/s) and low surgical risk	IIa	B
AVR is reasonable in asymptomatic patients (stage C1) with severe AS and decreased exercise tolerance or an exercise fall in BP	IIa	B
AVR is reasonable in symptomatic patients with low-flow/low-gradient severe AS with reduced LVEF (stage D2) with a low-dose dobutamine stress study that shows an aortic velocity ≥4 m/s (or mean pressure gradient ≥40 mm Hg) with a valve area ≤1.0 cm^2 at any dobutamine dose	IIa	B

Aortic Stenosis: Timing of Intervention (cont.)

Recommendations	COR	LOE
AVR is reasonable in symptomatic patients who have low-flow/low-gradient severe AS (stage D3) who are normotensive and have an LVEF ≥50% if clinical, hemodynamic, and anatomic data support valve obstruction as the most likely cause of symptoms	IIa	C
AVR is reasonable for patients with moderate AS (stage B) (aortic velocity 3.0–3.9 m/s) who are undergoing other cardiac surgery	IIa	C
AVR may be considered for asymptomatic patients with severe AS (stage C1) and rapid disease progression and low surgical risk	IIb	C

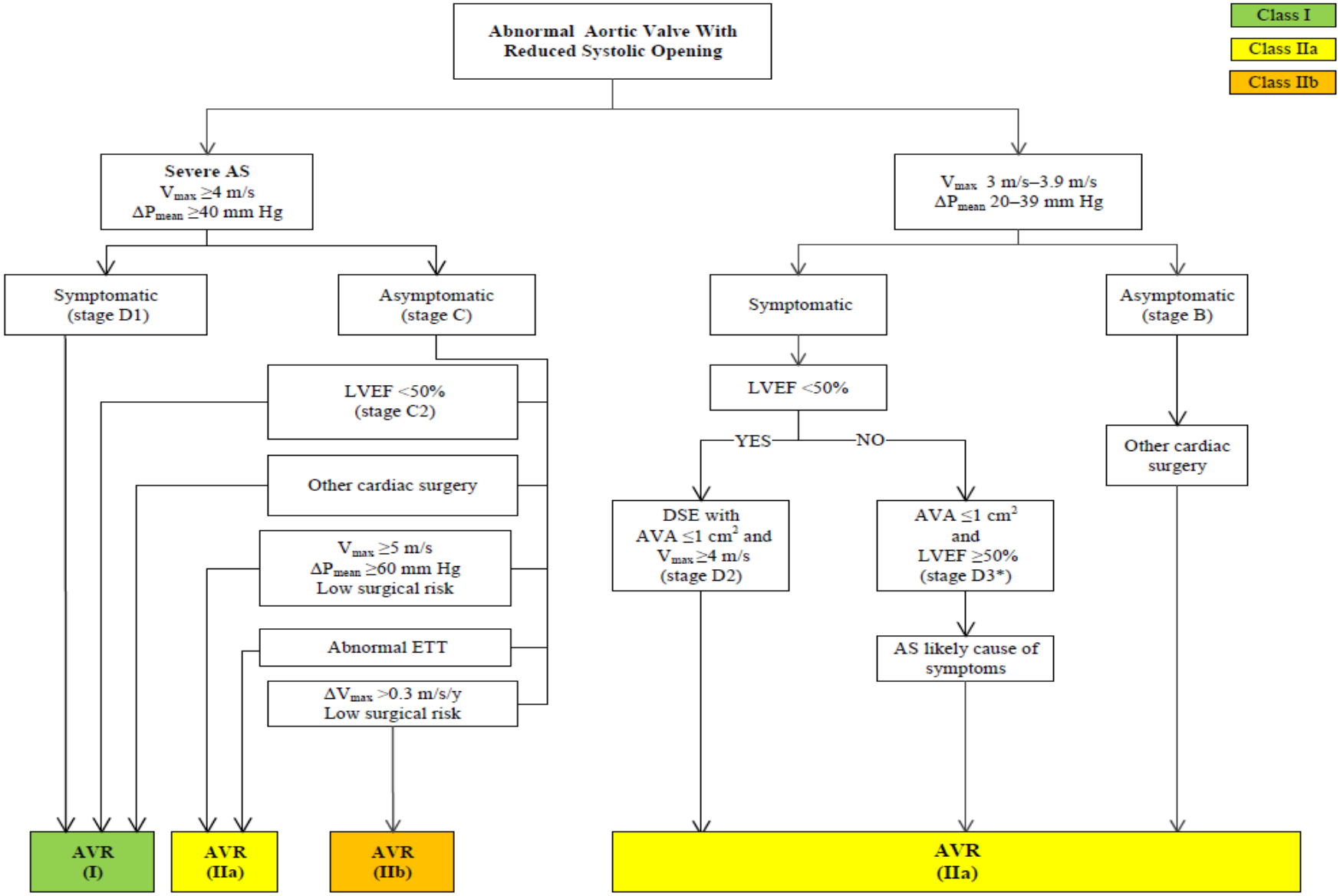
Aortic Stenosis: Choice of Surgical or Transcatheter Intervention

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

Aortic Stenosis: Choice of Surgical or Transcatheter Intervention (cont.)

Recommendations	COR	LOE
TAVR is a reasonable alternative to surgical AVR for AS in patients who meet an indication for AVR and who have high surgical risk	IIa	B
Percutaneous aortic balloon dilation may be considered as a bridge to surgical or transcatheter AVR in severely symptomatic patients with severe AS	IIb	C
TAVR is not recommended in patients in whom the existing comorbidities would preclude the expected benefit from correction of AS	III: No Benefit	B

Indications for Aortic Valve Replacement in Patients With Aortic Stenosis



Stages of Chronic Aortic Regurgitation

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
A	**At risk of AR**	• Bicuspid aortic valve (or other congenital valve anomaly) • Aortic valve sclerosis • Diseases of the aortic sinuses or ascending aorta • History of rheumatic fever or known rheumatic heart disease • IE	• AR severity none or trace	• None	• None

Stages of Chronic Aortic Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
B	**Progressive AR**	• Mild-to-moderate calcification of a trileaflet valve bicuspid aortic valve (or other congenital valve anomaly) • Dilated aortic sinuses • Rheumatic valve changes • Previous IE	• **Mild AR:** ○ Jet width <25% of LVOT ○ Vena contracta <0.3 cm ○ RVol <30 mL/beat ○ RF <30% ○ ERO <0.10 cm^2 ○ Angiography grade 1+ • **Moderate AR:** ○ Jet width 25%–64% of LVOT ○ Vena contracta 0.3–0.6 cm ○ RVol 30–59 mL/beat ○ RF 30%–49% ○ ERO 0.10–0.29 cm^2 ○ Angiography grade 2+	• Normal LV systolic function • Normal LV volume or mild LV dilation	• None

Stages of Chronic Aortic Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C	**Asymptomatic severe AR**	• Calcific aortic valve disease • Bicuspid valve (or other congenital abnormality) • Dilated aortic sinuses or ascending aorta • Rheumatic valve changes • IE with abnormal leaflet closure or perforation	• **Severe AR:** ○ Jet width ≥65% of LVOT ○ Vena contracta >0.6 cm ○ Holodiastolic flow reversal in the proximal abdominal aorta ○ RVol ≥60 mL/beat ○ RF ≥50% ○ ERO ≥0.3 cm^2 ○ Angiography grade 3+ to 4+ ○ In addition, diagnosis of chronic severe AR requires evidence of LV dilation	**C1**: Normal LVEF (≥50%) and mild-to-moderate LV dilation (LVESD ≤50 mm) **C2**: Abnormal LV systolic function with depressed LVEF (<50%) or severe LV dilatation (LVESD >50 mm or indexed LVESD >25 mm/m^2)	• None; exercise testing is reasonable to confirm symptom status

Stages of Chronic Aortic Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D	**Symptomatic severe AR**	• Calcific valve disease • Bicuspid valve (or other congenital abnormality) • Dilated aortic sinuses or ascending aorta • Rheumatic valve changes • Previous IE with abnormal leaflet closure or perforation	• **Severe AR**: ○ Doppler jet width ≥65% of LVOT; ○ Vena contracta >0.6 cm, ○ Holodiastolic flow reversal in the proximal abdominal aorta, ○ RVol ≥60 mL/beat; ○ RF ≥50%; ○ ERO ≥0.3 cm^2; ○ Angiography grade 3+ to 4+ ○ In addition, diagnosis of chronic severe AR requires evidence of LV dilation	• Symptomatic severe AR may occur with normal systolic function (LVEF ≥50%), mild-to-moderate LV dysfunction (LVEF 40% to 50%) or severe LV dysfunction (LVEF <40%); • Moderate-to-severe LV dilation is present.	• Exertional dyspnea or angina, or more severe HF symptoms

Aortic Regurgitation: Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is indicated in patients with signs or symptoms of AR (stages A to D) for accurate diagnosis of the cause of regurgitation, regurgitant severity, and LV size and systolic function, and for determining clinical outcome and timing of valve intervention	I	B
TTE is indicated in patients with dilated aortic sinuses or ascending aorta or with a bicuspid aortic valve (stages A and B) to evaluate the presence and severity of AR	I	B

Aortic Regurgitation: Diagnosis and Follow-Up

Recommendations	COR	LOE
CMR is indicated in patients with moderate or severe AR (stages B, C, and D) and suboptimal echocardiographic images for the assessment of LV systolic function, systolic and diastolic volumes, and measurement of AR severity	I	B

Aortic Regurgitation: Medical Therapy

Recommendations	COR	LOE
Treatment of hypertension (systolic BP >140 mm Hg) is recommended in patients with chronic AR (stages B and C), preferably with dihydropyridine calcium channel blockers or angiotensin-converting enzyme (ACE) inhibitors/angiotensin-receptor blockers (ARBs)	I	B
Medical therapy with ACE inhibitors/ARBs and beta blockers is reasonable in patients with severe AR who have symptoms and/or LV dysfunction (stages C2 and D) when surgery is not performed because of comorbidities	IIa	B

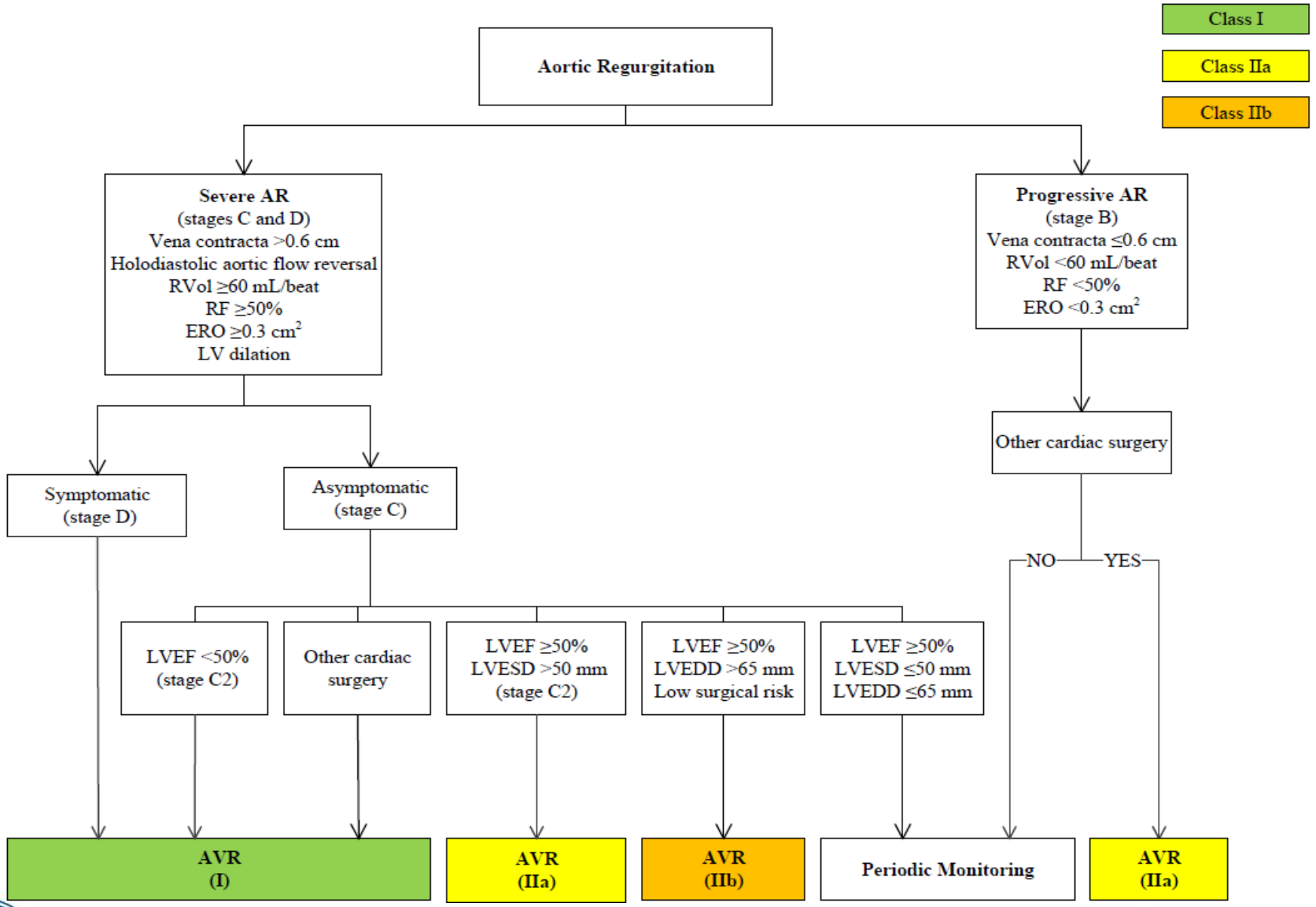
Aortic Regurgitation: Intervention

Recommendations	COR	LOE
AVR is indicated for symptomatic patients with severe AR regardless of LV systolic function (stage D)	I	B
AVR is indicated for asymptomatic patients with chronic severe AR and LV systolic dysfunction (LVEF <50%) (stage C2)	I	B
AVR is indicated for patients with severe AR (stage C or D) who are undergoing other cardiac surgery	I	C

Aortic Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
AVR is reasonable for asymptomatic patients with severe AR with normal LV systolic function (LVEF ≥50%), but severe LV dilation (stage C2, LVESD >50 mm)	IIa	B
AVR is reasonable in patients with moderate AR (stage B) who are undergoing other cardiac surgery	IIa	C
AVR may be considered for asymptomatic patients with severe AR and normal LV systolic function (stage C1, LVEF ≥50%) but severe LV dilation (LVEDD >65 mm) if surgical risk is low*	IIb	C

Indications for Aortic Valve Replacement for Chronic Aortic Regurgitation



Bicuspid Aortic Valve and Aortopathy: Diagnosis and Follow-Up

Recommendations	COR	LOE
An initial TTE is indicated in patients with a known bicuspid aortic valve to evaluate valve morphology, to measure the severity of AS and AR, and to assess the shape and diameter of the aortic sinuses and ascending aorta for prediction of clinical outcome and to determine timing of intervention	I	B
Aortic magnetic resonance angiography or CT angiography is indicated in patients with a bicuspid aortic valve when morphology of the aortic sinuses, sinotubular junction, or ascending aorta cannot be assessed accurately or fully by echocardiography	I	C

Bicuspid Aortic Valve and Aortopathy: Diagnosis and Follow-Up

Recommendations	COR	LOE
Serial evaluation of the size and morphology of the aortic sinuses and ascending aorta by echocardiography, CMR, or CT angiography is recommended in patients with a bicuspid aortic valve and an aortic diameter greater than 4.0 cm, with the examination interval determined by the degree and rate of progression of aortic dilation and by family history. In patients with an aortic diameter greater than 4.5 cm, this evaluation should be performed annually	I	C

Bicuspid Aortic Valve and Aortopathy: Intervention

Recommendations	COR	LOE
Operative intervention to repair the aortic sinuses or replace the ascending aorta is indicated in patients with a bicuspid aortic valve if the diameter of the aortic sinuses or ascending aorta is greater than 5.5 cm	I	B
Operative intervention to repair the aortic sinuses or replace the ascending aorta is reasonable in patients with bicuspid aortic valves if the diameter of the aortic sinuses or ascending aorta is greater than 5.0 cm and a risk factor for dissection is present (family history of aortic dissection or if the rate of increase in diameter is ≥0.5 cm per year)	IIa	C

Bicuspid Aortic Valve and Aortopathy: Intervention

Recommendations	COR	LOE
Replacement of the ascending aorta is reasonable in patients with a bicuspid aortic valve who are undergoing aortic valve surgery because of severe AS or AR (Sections 3.4 and 4.4) if the diameter of the ascending aorta is greater than 4.5 cm	IIa	C

Stages of Mitral Stenosis

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
A	**At risk of MS**	• Mild valve doming during diastole	• Normal transmitral flow velocity	• None	• None
B	**Progressive MS**	• Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets • Planimetered MVA >1.5 cm^2	• Increased transmitral flow velocities • MVA >1.5 cm^2 • Diastolic pressure half-time <150 msec	• Mild-to-moderate LA enlargement • Normal pulmonary pressure at rest	• None

Stages of Mitral Stenosis

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C	**Asymptomatic severe MS**	• Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets • Planimetered MVA ≤1.5 cm^2 • (MVA ≤1 cm^2 with very severe MS)	• MVA ≤1.5 cm^2 • (MVA ≤1 cm^2 with very severe MS) • Diastolic pressure half-time ≥150 msec • (Diastolic pressure half-time ≥220 msec with very severe MS)	• Severe LA enlargement • Elevated PASP >30 mm Hg	• None

Stages of Mitral Stenosis

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D	**Symptomatic severe MS**	• Rheumatic valve changes with commissural fusion and diastolic doming of the mitral valve leaflets • Planimetered MVA ≤1.5 cm^2	• MVA≤1.5 cm^2 • (MVA ≤1 cm^2 with very severe MS) • Diastolic pressure half-time ≥150 msec • (Diastolic pressure half-time ≥220 msec with very severe MS)	• Severe LA enlargement • Elevated PASP >30 mm Hg	• Decreased exercise tolerance • Exertional dyspnea

Mitral Stenosis: Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is indicated in patients with signs or symptoms of MS to establish the diagnosis, quantify hemodynamic severity (mean pressure gradient, mitral valve area, and pulmonary artery pressure), assess concomitant valvular lesions, and demonstrate valve morphology (to determine suitability for mitral commissurotomy)	I	B
TEE should be performed in patients considered for percutaneous mitral balloon commissurotomy to assess the presence or absence of left atrial thrombus and to further evaluate the severity of mitral regurgitation	I	B

Mitral Stenosis: Diagnosis and Follow-Up

Recommendations	COR	LOE
Exercise testing with Doppler or invasive hemodynamic assessment is recommended to evaluate the response of the mean mitral gradient and pulmonary artery pressure in patients with MS when there is a discrepancy between resting Doppler echocardiographic findings and clinical symptoms or signs	I	C

Mitral Stenosis: Medical Therapy

Recommendations	COR	LOE
Anticoagulation (vitamin K antagonist [VKA] or heparin) is indicated in patients with 1) MS and AF (paroxysmal, persistent, or permanent), or 2) MS and a prior embolic event, or 3) MS and a left atrial thrombus	I	B
Heart rate control can be beneficial in patients with MS and AF and fast ventricular response	IIa	C
Heart rate control may be considered for patients with MS in normal sinus rhythm and symptoms associated with exercise	IIb	B

Mitral Stenosis: Intervention

Recommendations	COR	LOE
PMBC is recommended for symptomatic patients with severe MS (MVA $\leq$1.5 cm^2, stage D) and favorable valve morphology in the absence of contraindications	I	A
Mitral valve surgery is indicated in severely symptomatic patients (NYHA class III/IV) with severe MS (MVA $\leq$1.5 cm^2, stage D) who are not high risk for surgery and who are not candidates for or failed previous PMBC	I	B
Concomitant mitral valve surgery is indicated for patients with severe MS (MVA $\leq$1.5 cm^2, stages C or D) undergoing other cardiac surgery	I	C

Mitral Stenosis: Intervention (cont.)

Recommendations	COR	LOE
PMBC is reasonable for asymptomatic patients with very severe MS (MVA ≤1 cm^2, stage C) and favorable valve morphology in the absence of contraindications	IIa	C
Mitral valve surgery is reasonable for severely symptomatic patients (NYHA class III/IV) with severe MS (MVA ≤1.5 cm^2, stage D) provided there are other operative indications	IIa	C

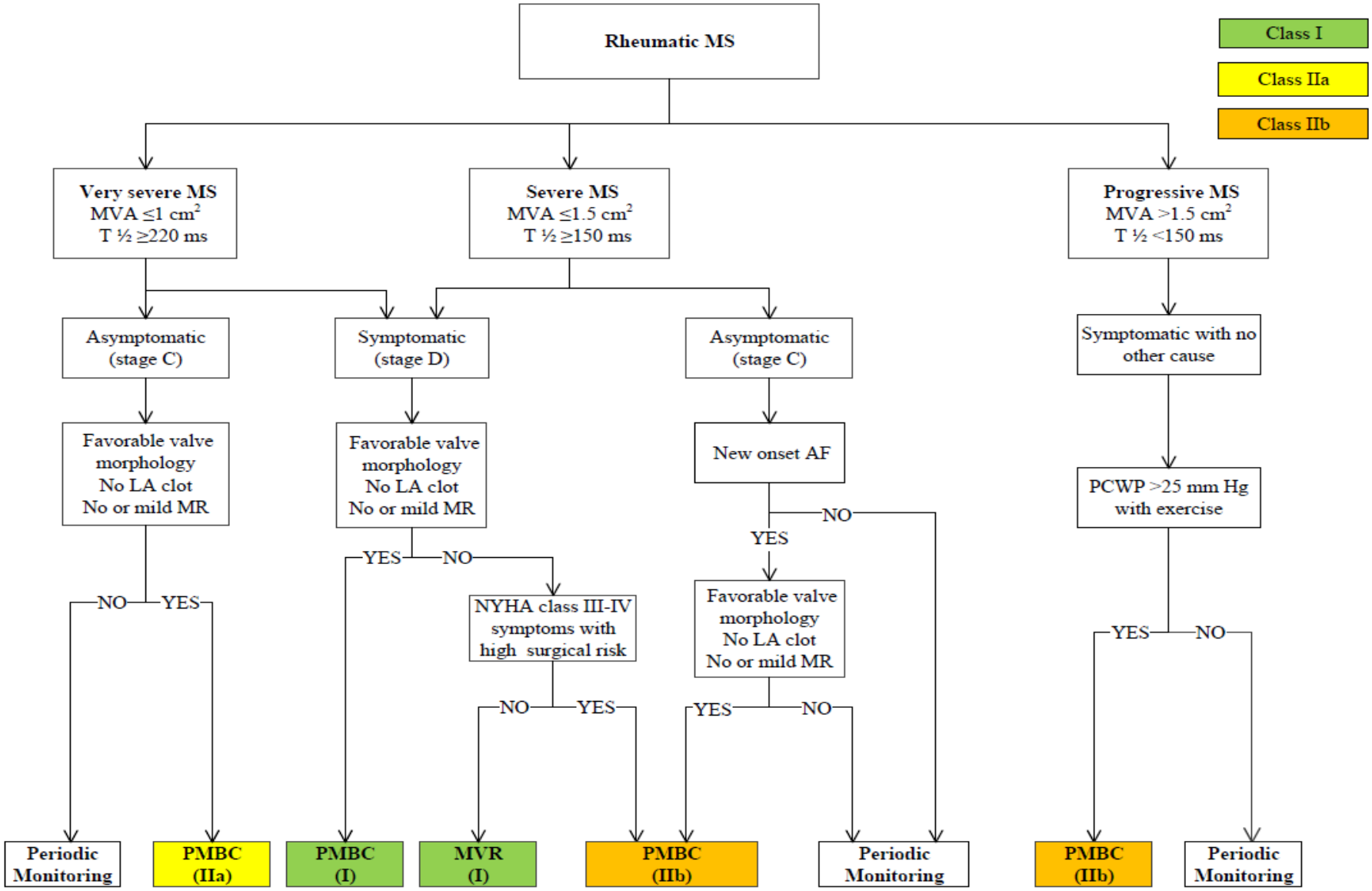
Mitral Stenosis: Intervention (cont.)

Recommendations	COR	LOE
PMBC may be considered for asymptomatic patients with severe MS (MVA ≤1.5 cm^2, stage C) and favorable valve morphology who have new onset of AF in the absence of contraindications	IIb	C
PMBC may be considered for symptomatic patients with MVA >1.5 cm^2 if there is evidence of hemodynamically significant MS during exercise	IIb	C
PMBC may be considered for severely symptomatic patients (NYHA class III-IV) with severe MS (MVA ≤1.5 cm^2, stage D) who have suboptimal valve anatomy and are not candidates for surgery or at high risk for surgery	IIb	C

Mitral Stenosis: Intervention (cont.)

Recommendations	COR	LOE
Concomitant mitral valve surgery might be considered for patients with moderate MS (MVA 1.6–2.0 cm^2) undergoing other cardiac surgery	IIb	C
Mitral valve surgery and excision of the left atrial appendage may be considered for patients with severe MS (MVA ≤1.5 cm^2, stages C and D) who have had recurrent embolic events while receiving adequate anticoagulation	IIb	C

Indications for Intervention for Rheumatic Mitral Stenosis



Stages of *Primary* Mitral Regurgitation

Stage	Definition	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**	• 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 cc • Regurgitant fraction <50% • ERO <0.40 cm^2 • Angiographic grade 1–2+	• Mild LA enlargement • No LV enlargement • Normal pulmonary pressure	• None

Stages of *Primary* Mitral Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
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 cc • Regurgitant fraction ≥50% • ERO ≥0.40 cm^2 • Angiographic grade 3–4+	• Moderate 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 LVESD ≥40 mm	• None

Stages of *Primary* Mitral Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D	**Symptomatic 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 cc • Regurgitant fraction ≥50% • ERO ≥0.40 cm^2 • Angiographic grade 3–4+	• Moderate or severe LA enlargement • LV enlargement • Pulmonary hypertension present	• Decreased exercise tolerance • Exertional dyspnea

Stages of *Secondary* Mitral Regurgitation (cont.)

Grade	Definition	Valve Anatomy	Valve Hemodynamics	Associated Cardiac Findings	Symptoms
A	**At risk of MR**	• Normal valve leaflets, chords, and annulus in a patient with coronary disease or a 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	• Symptoms due to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy

Stages of *Secondary* Mitral Regurgitation (cont.)

Grade	Definition	Valve Anatomy	Valve Hemodynamics	Associated Cardiac Findings	Symptoms
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 <0.20 cm^2 • Regurgitant volume <30 cc	• Regional wall motion abnormalities with reduced LV systolic function • LV dilation and systolic dysfunction due to primary myocardial disease	• Symptoms due to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy

Stages of *Secondary* Mitral Regurgitation (cont.)

Grade	Definition	Valve Anatomy	Valve Hemodynamics	Associated Cardiac Findings	Symptoms
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 ≥0.20 cm^2 • Regurgitant volume ≥30 cc	• Regional wall motion abnormalities with reduced LV systolic function • LV dilation and systolic dysfunction due to primary myocardial disease	• Symptoms due to coronary ischemia or HF may be present that respond to revascularization and appropriate medical therapy

Stages of *Secondary* Mitral Regurgitation (cont.)

Grade	Definition	Valve Anatomy	Valve Hemodynamics	Associated Cardiac Findings	Symptoms
D	**Symptomatic 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 ≥0.20 cm^2 • Regurgitant volume ≥30 cc	• Regional wall motion abnormalities with reduced LV systolic function • LV dilation and systolic dysfunction due to primary myocardial disease.	• HF symptoms due to MR persist even after revascularization and optimization of medical therapy • Decreased exercise tolerance • Exertional dyspnea

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

Recommendations	COR	LOE
TTE is indicated for baseline evaluation of LV size and function, right ventricular (RV) function and left atrial size, pulmonary artery pressure, and mechanism and severity of primary MR (stages A to D) in any patient suspected of having chronic primary MR	I	B
CMR is indicated in patients with chronic primary MR to assess LV and RV volumes, function, or MR severity and when these issues are not satisfactorily addressed by TTE	I	B

Chronic *Primary* Mitral Regurgitation: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Intraoperative TEE is indicated to establish the anatomic basis for chronic primary MR (stages C and D) and to guide repair	I	B
TEE is indicated for evaluation of patients with chronic primary MR (stages B to D) in whom noninvasive imaging provides nondiagnostic information about severity of MR, mechanism of MR, and/or status of LV function	I	C

Chronic *Primary* Mitral Regurgitation: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Exercise hemodynamics with either Doppler echocardiography or cardiac catheterization is reasonable in symptomatic patients with chronic primary MR where there is a discrepancy between symptoms and the severity of MR at rest (stages B and C)	IIa	B
Exercise treadmill testing can be useful in patients with chronic primary MR to establish symptom status and exercise tolerance (stages B and C)	IIa	C

Chronic *Primary* Mitral Regurgitation: Medical Therapy

Recommendations	COR	LOE
Medical therapy for systolic dysfunction is reasonable in symptomatic patients with chronic primary MR (stage D) and LVEF less than 60% in whom surgery is not contemplated	IIa	B
Vasodilator therapy is not indicated for normotensive asymptomatic patients with chronic primary MR (stages B and C1) and normal systolic LV function	III: No Benefit	B

Chronic *Primary* Mitral Regurgitation: Intervention

Recommendations	COR	LOE
MV surgery is recommended for symptomatic patients with chronic severe primary MR (stage D) and LVEF >30%	I	B
MV surgery is recommended for asymptomatic patients with chronic severe primary MR and LV dysfunction (LVEF 30%–60% and/or LVESD ≥40 mm, stage C2)	I	B
MV repair is recommended in preference to MVR when surgical treatment is indicated for patients with chronic severe primary MR limited to the posterior leaflet	I	B

Chronic *Primary* Mitral Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
MV repair is recommended in preference to MVR when surgical treatment is indicated for patients with chronic severe primary MR involving the anterior leaflet or both leaflets when a successful and durable repair can be accomplished	I	B
Concomitant MV repair or replacement is indicated in patients with chronic severe primary MR undergoing other cardiac surgery	I	B

Chronic *Primary* Mitral Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
MV repair is reasonable in asymptomatic patients with chronic severe primary MR (stage C1) with preserved LV function (LVEF >60% and LVESD <40 mm) in whom the likelihood of a successful and durable repair without residual MR is >95% with an expected mortality <1% when performed at a Heart Valve Center of Excellence	IIa	B

Chronic *Primary* Mitral Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
MV repair is reasonable for asymptomatic patients with chronic severe nonrheumatic primary MR (stage C1) and preserved LV function in whom there is a high likelihood of a successful and durable repair with 1) new onset of AF or 2) resting pulmonary hypertension (PA systolic arterial pressure >50 mm Hg)	IIa	B
Concomitant MV repair is reasonable in patients with chronic moderate primary MR (stage B) undergoing other cardiac surgery	IIa	C

Chronic *Primary* Mitral Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
MV surgery may be considered in symptomatic patients with chronic severe primary MR and LVEF ≤30% (stage D)	IIb	C
MV repair may be considered in patients with rheumatic mitral valve disease when surgical treatment is indicated if a durable and successful repair is likely or if the reliability of long-term anticoagulation management is questionable	IIb	B

Chronic *Primary* Mitral Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
Percutaneous MV repair may be considered for severely symptomatic patients (NYHA class III-IV) with chronic severe primary MR (stage D) who have a reasonable life expectancy, but a prohibitive surgical risk because of severe comorbidities	IIb	B
MVR should not be performed for the treatment of isolated severe primary MR limited to less than one half of the posterior leaflet unless MV repair has been attempted and was unsuccessful	III: Harm	B

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

Recommendations	COR	LOE
TTE is useful to establish the etiology of chronic secondary MR (stages B to D) and the extent and location of wall motion abnormalities and to assess global LV function, severity of MR, and magnitude of pulmonary hypertension	I	C
Noninvasive imaging (stress nuclear/positron emission tomography, CMR, or stress echocardiography), cardiac CT angiography, or cardiac catheterization, including coronary arteriography, is useful to establish etiology of chronic secondary MR (stages B to D) and/or to assess myocardial viability, which in turn may influence management of functional MR	I	C

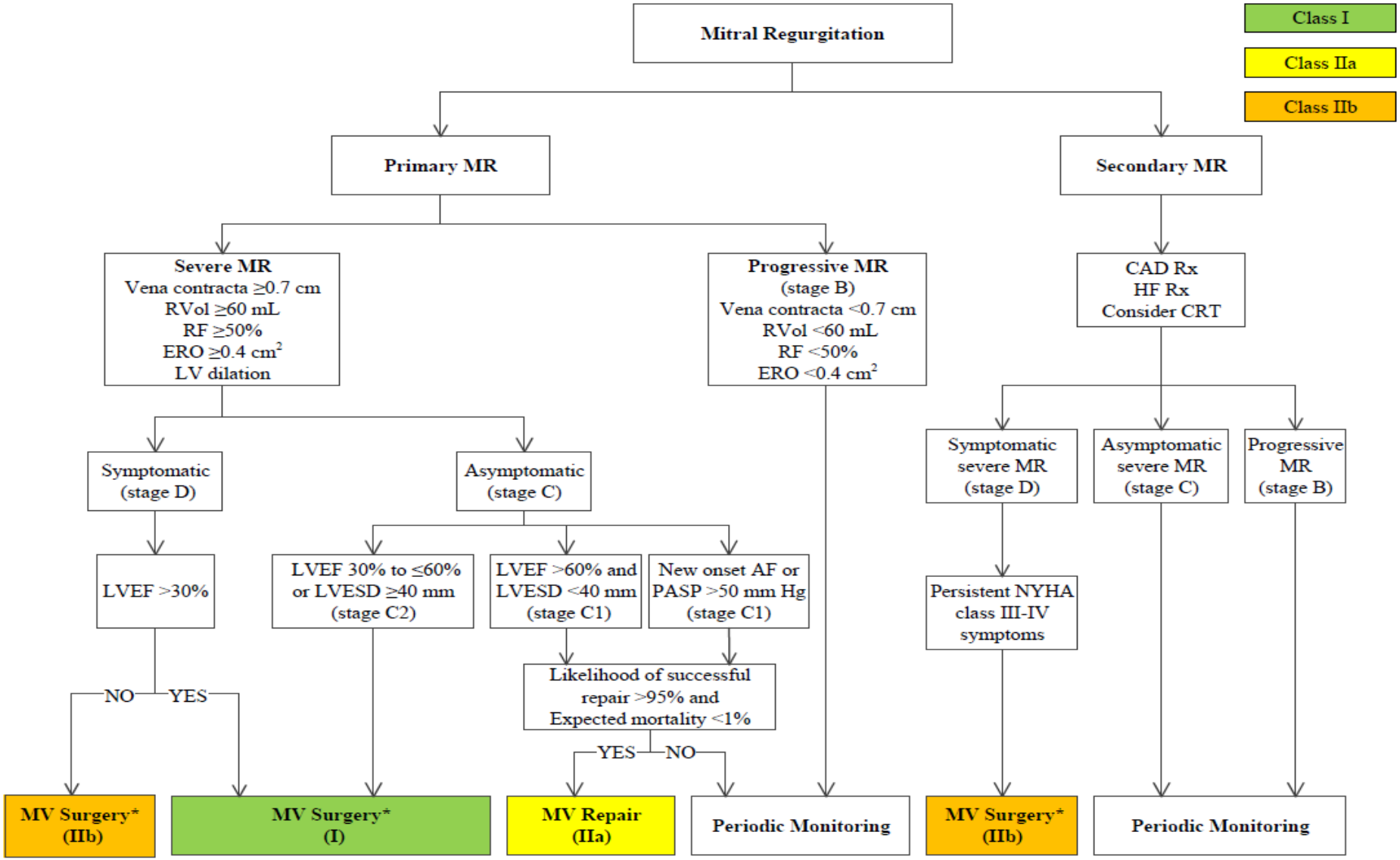
Chronic *Secondary* Mitral Regurgitation: Medical Therapy

Recommendations	COR	LOE
Patients with chronic secondary MR (stages B to D) and HF with reduced LVEF should receive standard GDMT therapy for HF, including ACE inhibitors, ARBs, beta blockers, and/or aldosterone antagonists as indicated	I	A
Noninvasive imaging (stress nuclear/positron emission tomography, CMR, or stress echocardiography), cardiac CT angiography, or cardiac catheterization, including coronary arteriography, is useful to establish etiology of chronic secondary MR (stages B to D) and/or to assess myocardial viability, which in turn may influence management of functional MR	I	A

Chronic Severe *Secondary* Mitral Regurgitation: Intervention

Recommendations	COR	LOE
MV surgery is reasonable for patients with chronic severe secondary MR (stages C and D) who are undergoing CABG or AVR	IIa	C
MV surgery may be considered for severely symptomatic patients (NYHA class III-IV) with chronic severe secondary MR (stage D)	IIb	B
MV repair may be considered for patients with chronic moderate secondary MR (stage B) who are undergoing other cardiac surgery	IIb	C

Indications for Surgery for Mitral Regurgitation



Stages of Tricuspid Regurgitation

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
A	**At risk of TR**	**Primary** • Mild rheumatic change • Mild prolapse • Other (e.g., IE with vegetation, early carcinoid deposition, radiation) • Intra-annular RV pacemaker or ICD lead • Postcardiac transplant (biopsy-related) **Functional** • Normal • Early annular dilation	• No or trace TR	• None	• None or in relation to other left heart or pulmonary/ pulmonary vascular disease

Stages of Tricuspid Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
B	**Progressive TR**	**Primary** • Progressive leaflet deterioration/ destruction • Moderate-to-severe prolapse, limited chordal rupture **Functional** • Early annular dilation • Moderate leaflet tethering	**Mild TR** • Central jet area <5 cm^2 • Vena contracta width not defined • CW jet density and contour: soft and parabolic • Hepatic vein flow: systolic dominance **Moderate TR** • Central jet area 5–10 cm^2 • Vena contracta width not defined, but <0.70 cm • CW jet density and contour: dense, variable contour • Hepatic vein flow: systolic blunting	**Mild TR** • RV/RA/IVC size normal **Moderate TR** • No RV enlargement • No or mild RA enlargement • No or mild IVC enlargement with normal respirophasic variation • Normal RA pressure	• None or in relation to other left heart or pulmonary/ pulmonary vascular disease

Stages of Tricuspid Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C	**Asymptomatic, severe TR**	**Primary** • Flail or grossly distorted leaflets **Functional** • Severe annular dilation (>40 mm or 21 mm/m^2) • Marked leaflet tethering	• Central jet area >10 cm^2 • Vena contracta width >0.7 cm • CW jet density and contour: dense, triangular with early peak • Hepatic vein flow: systolic reversal	• RV/RA/IVC dilated with decreased IVC respirophasic variation • Elevation RA pressure with “c-V” wave • Diastolic interventricular septal flattening may be present	• None, or in relation to other left heart or pulmonary/ pulmonary vascular disease

Stages of Tricuspid Regurgitation (cont.)

Stage	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
D	**Symptomatic severe TR**	**Primary** • Flail or grossly distorted leaflets **Functional** • Severe annular dilation (>40 mm or >21 mm/m^2) • Marked leaflet tethering	• Central jet area >10 cm^2 • Vena contracta width >0.70 cm • CW jet density and contour: dense, triangular with early peak • Hepatic vein flow: systolic reversal	• RV/RA/IVC dilated with decreased IVC respirophasic variation • Elevation RA pressure with “c-V” wave • Diastolic interventricular septal flattening • Reduced RV systolic function in late phase	• Fatigue, palpitations, dyspnea, abdominal bloating, anorexia, edema

Tricuspid Regurgitation: Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is indicated to evaluate severity of TR, determine etiology, measure sizes of right-sided chambers and inferior vena cava, assess RV systolic function, estimate pulmonary artery systolic pressure, and characterize any associated left-sided heart disease	I	C
Invasive measurement of pulmonary artery pressures and pulmonary vascular resistance can be useful in patients with TR when clinical and noninvasive data regarding their values are discordant	IIa	C

Tricuspid Regurgitation: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
CMR or real-time 3-dimensional echocardiography may be considered for assessment of RV systolic function and systolic and diastolic volumes in patients with severe TR (stages C and D) and suboptimal 2-dimensional echocardiograms	IIb	C
Exercise testing may be considered for the assessment of exercise capacity in patients with severe TR with no or minimal symptoms (stage C)	IIb	C

Tricuspid Regurgitation: Medical Therapy

Recommendations	COR	LOE
Diuretics can be useful for patients with severe TR and signs of right-sided HF (stage D)	IIa	C
Medical therapies to reduce elevated pulmonary artery pressures and/or pulmonary vascular resistance might be considered in patients with severe functional TR (stages C and D)	IIb	C

Tricuspid Regurgitation: Intervention

Recommendations	COR	LOE
Tricuspid valve surgery is recommended for patients with severe TR (stages C and D) undergoing left-sided valve surgery	I	C
Tricuspid valve repair can be beneficial for patients with mild, moderate, or greater functional TR (stage B) at the time of left-sided valve surgery with either 1) tricuspid annular dilation or 2) prior evidence of right HF	IIa	B
Tricuspid valve surgery can be beneficial for patients with symptoms due to severe primary TR that are unresponsive to medical therapy (stage D)	IIa	C

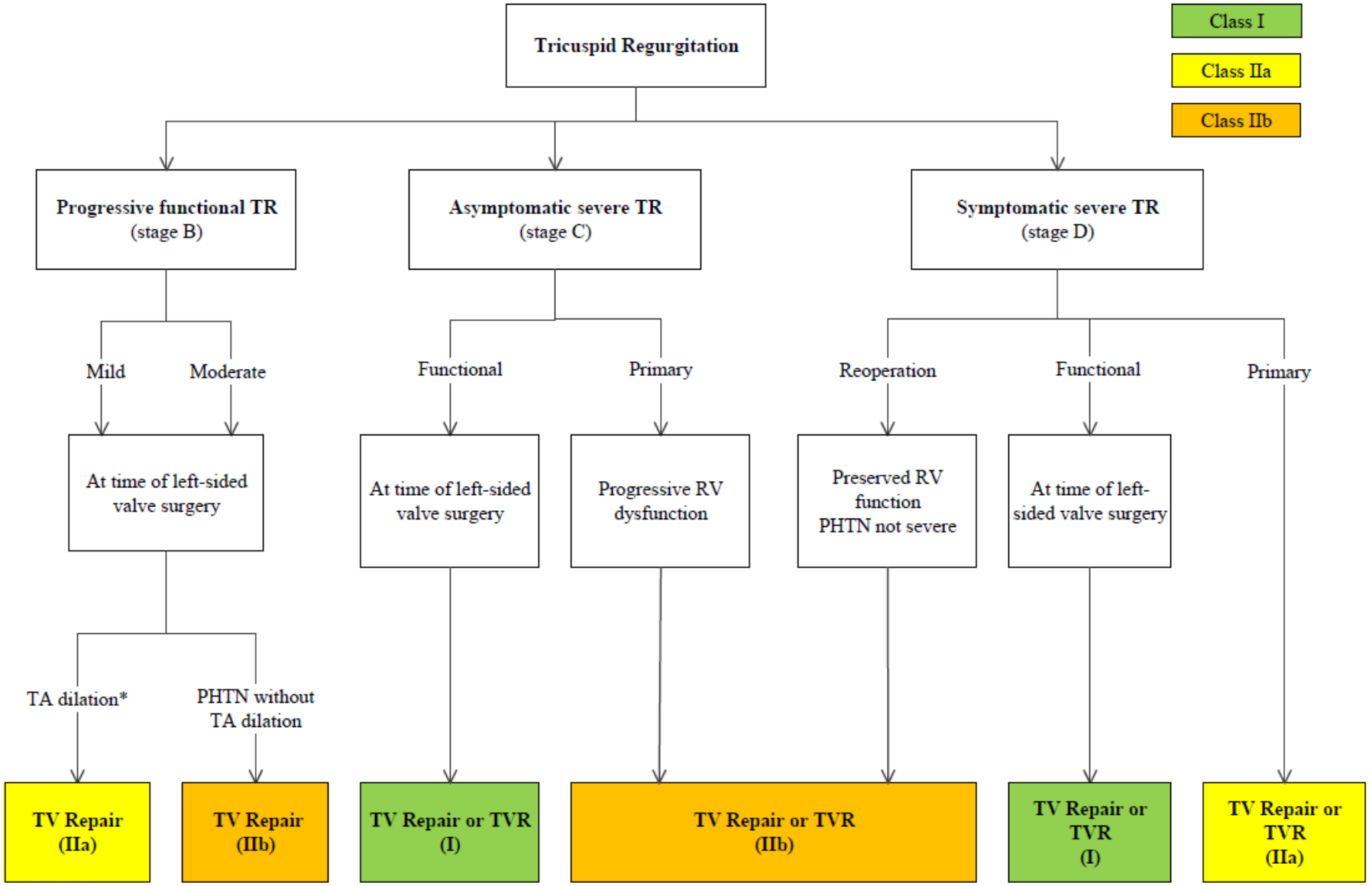
Tricuspid Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
Tricuspid valve repair may be considered for patients with moderate functional TR (stage B) and pulmonary artery hypertension at the time of left-sided valve surgery	IIb	C
Tricuspid valve surgery may be considered for asymptomatic or minimally symptomatic patients with severe primary TR (stage C) and progressive degrees of moderate or greater RV dilation and/or systolic dysfunction	IIb	C

Tricuspid Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
Reoperation for isolated tricuspid valve repair or replacement may be considered for persistent symptoms due to severe TR (stage D) in patients who have undergone previous left-sided valve surgery and who do not have severe pulmonary hypertension or significant RV systolic dysfunction	IIb	C

Indications for Surgery for Tricuspid Regurgitation



Severe Tricuspid Stenosis Stages

Stages	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C, D	**Severe TS**	• Thickened, distorted, calcified leaflets	• T ½ ≥190 msec • Valve area ≤1 cm^2	• RA/IVC enlargement	• None or variable and dependent on severity of associated valve disease and degree of obstruction

Tricuspid Stenosis: Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is indicated in patients with TS to assess the anatomy of the valve complex, evaluate severity of stenosis, and characterize any associated regurgitation and/or left-sided valve disease	I	C
Invasive hemodynamic assessment of severity of TS may be considered in symptomatic patients when clinical and noninvasive data are discordant	IIb	C

Tricuspid Stenosis: Intervention

Recommendations	COR	LOE
Tricuspid valve surgery is recommended for patients with severe TS at the time of operation for left-sided valve disease	I	C
Tricuspid valve surgery is recommended for patients with isolated, symptomatic severe TS	I	C
Percutaneous balloon tricuspid commissurotomy might be considered in patients with isolated, symptomatic severe TS without accompanying TR	IIb	C

Severe Pulmonic Regurgitation Stages

Stages	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C, D	**Severe PR**	• Distorted or absent leaflets, annular dilation	• Color jet fills RVOT • CW jet density and contour: dense laminar flow with steep deceleration slope; may terminate abruptly	• Paradoxical septal motion (volume overload pattern) • RV enlargement	• None or variable and dependent on cause of PR and RV function

Severe Pulmonic Stenosis Stages

Stages	Definition	Valve Anatomy	Valve Hemodynamics	Hemodynamic Consequences	Symptoms
C, D	**Severe PS**	• Thickened, distorted, possibly calcified leaflets with systolic doming and/or reduced excursion • Other anatomic abnormalities may be present, such as narrowed RVOT	• V_{max} >4 m/s; peak instantaneous gradient >64 mm Hg	• RVH • Possible RV, RA enlargement • Poststenotic enlargement of main PA	• None or variable and dependent on severity of obstruction

Prosthetic Valve: Diagnosis and Follow-Up

Recommendations	COR	LOE
An initial TTE study is recommended in patients after prosthetic valve implantation for evaluation of valve hemodynamics	I	B
Repeat TTE is recommended in patients with prosthetic heart valves if there is a change in clinical symptoms or signs suggesting valve dysfunction	I	C
TEE is recommended when clinical symptoms or signs suggest prosthetic valve dysfunction	I	C
Annual TTE is reasonable in patients with a bioprosthetic valve after the first 10 years, even in the absence of a change in clinical status	IIa	C

Prosthetic Valve: Intervention

Recommendations	COR	LOE
Choice of valve intervention and prosthetic valve type should be a shared decision process	I	C
A bioprosthesis is recommended in patients of any age for whom anticoagulant therapy is contraindicated, cannot be managed appropriately, or is not desired	I	C
A mechanical prosthesis is reasonable for AVR or MVR in patients <60 years of age who do not have a contraindication to anticoagulation	IIa	B

Prosthetic Valve: Intervention (cont.)

Recommendations	COR	LOE
A bioprosthesis is reasonable in patients >70 years of age	IIa	B
Either a bioprosthetic or mechanical valve is reasonable in patients between 60 years of age and 70 years of age	IIa	B
Replacement of the aortic valve by a pulmonary autograft (the Ross procedure), when performed by an experienced surgeon, may be considered in young patients when VKA anticoagulation is contraindicated or undesirable	IIb	C

Antithrombotic Therapy for Prosthetic Valves

Recommendations	COR	LOE
Anticoagulation with a VKA and international normalized ratio (INR) monitoring is recommended in patients with a mechanical prosthetic valve	I	A
Anticoagulation with a VKA to achieve an INR of 2.5 is recommended in patients with a mechanical AVR (bileaflet or current-generation single tilting disc) and no risk factors for thromboembolism	I	B

Antithrombotic Therapy for Prosthetic Valves (cont.)

Recommendations	COR	LOE
Anticoagulation with a VKA is indicated to achieve an INR of 3.0 in patients with a mechanical AVR and additional risk factors for thromboembolic events (AF, previous thromboembolism, LV dysfunction, or hypercoagulable conditions) or an older-generation mechanical AVR (such as ball-in-cage)	I	B
Anticoagulation with a VKA is indicated to achieve an INR of 3.0 in patients with a mechanical MVR	I	B

Antithrombotic Therapy for Prosthetic Valves (cont.)

Recommendations	COR	LOE
Aspirin 75 mg to 100 mg daily is recommended in addition to anticoagulation with a VKA in patients with a mechanical valve prosthesis	I	A
Aspirin 75 mg to 100 mg per day is reasonable in all patients with a bioprosthetic aortic or mitral valve	IIa	B
Anticoagulation with a VKA is reasonable for the first 3 months after bioprosthetic MVR or repair to achieve an INR of 2.5	IIa	C

Antithrombotic Therapy for Prosthetic Valves (cont.)

Recommendations	COR	LOE
Anticoagulation, with a VKA, to achieve an INR of 2.5 may be reasonable for the first 3 months after bioprosthetic AVR	IIb	B
Clopidogrel 75 mg daily may be reasonable for the first 6 months after TAVR in addition to life-long aspirin 75 mg to 100 mg daily	IIb	C
Anticoagulant therapy with oral direct thrombin inhibitors or anti-Xa agents should not be used in patients with mechanical valve prostheses	III: Harm	B

Bridging Therapy for Prosthetic Valves

Recommendations	COR	LOE
Continuation of VKA anticoagulation with a therapeutic INR is recommended in patients with mechanical heart valves undergoing minor procedures (such as dental extractions or cataract removal) where bleeding is easily controlled	I	C
Temporary interruption of VKA anticoagulation, without bridging agents while the INR is subtherapeutic, is recommended in patients with a bileaflet mechanical AVR and no other risk factors for thrombosis who are undergoing invasive or surgical procedures	I	C

Bridging Therapy for Prosthetic Valves (cont.)

Recommendations	COR	LOE
Bridging anticoagulation with either intravenous unfractionated heparin (UFH) or subcutaneous low-molecular-weight heparin (LMWH) is recommended during the time interval when the INR is subtherapeutic preoperatively in patients who are undergoing invasive or surgical procedures with a 1) mechanical AVR and any thromboembolic risk factor, 2) older-generation mechanical AVR, or 3) mechanical MVR	I	C

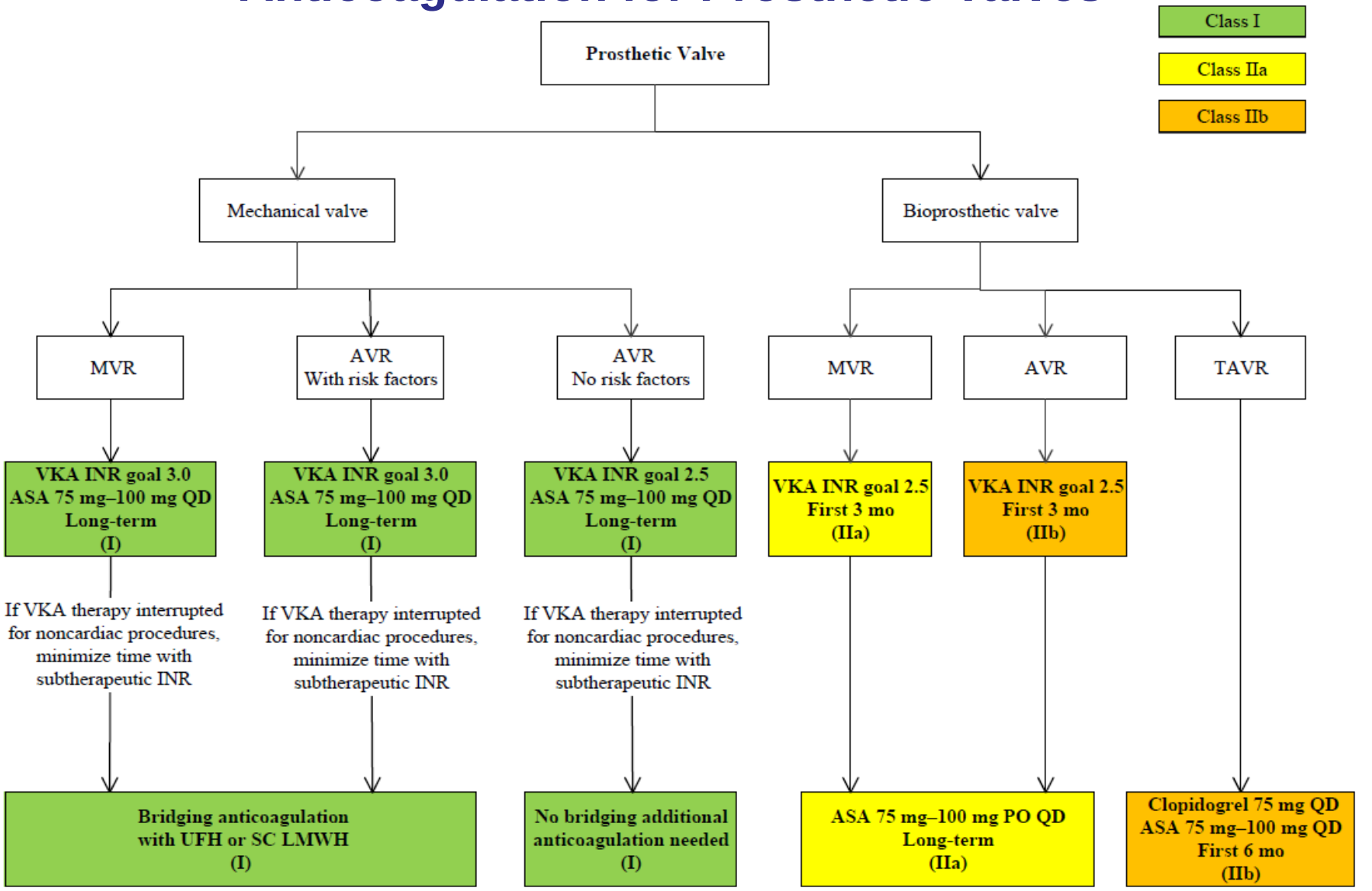
Bridging Therapy for Prosthetic Valves (cont.)

Recommendations	COR	LOE
Administration of fresh frozen plasma or prothrombin complex concentrate is reasonable in patients with mechanical valves receiving VKA therapy who require emergency noncardiac surgery or invasive procedures	IIa	C

Excess Anticoagulation and Serious Bleeding With Prosthetic Valves

Recommendations	COR	LOE
Administration of fresh frozen plasma or prothrombin complex concentrate is reasonable in patients with mechanical valves and uncontrollable bleeding who require reversal of anticoagulation	IIa	B

Anticoagulation for Prosthetic Valves



Prosthetic Valve Thrombosis: Diagnosis and Follow-Up

Recommendations	COR	LOE
TTE is indicated in patients with suspected prosthetic valve thrombosis to assess hemodynamic severity and follow resolution of valve dysfunction	I	B
TEE is indicated in patients with suspected prosthetic valve thrombosis to assess thrombus size and valve motion	I	B
Fluoroscopy or CT is reasonable in patients with suspected valve thrombosis to assess valve motion	IIa	C

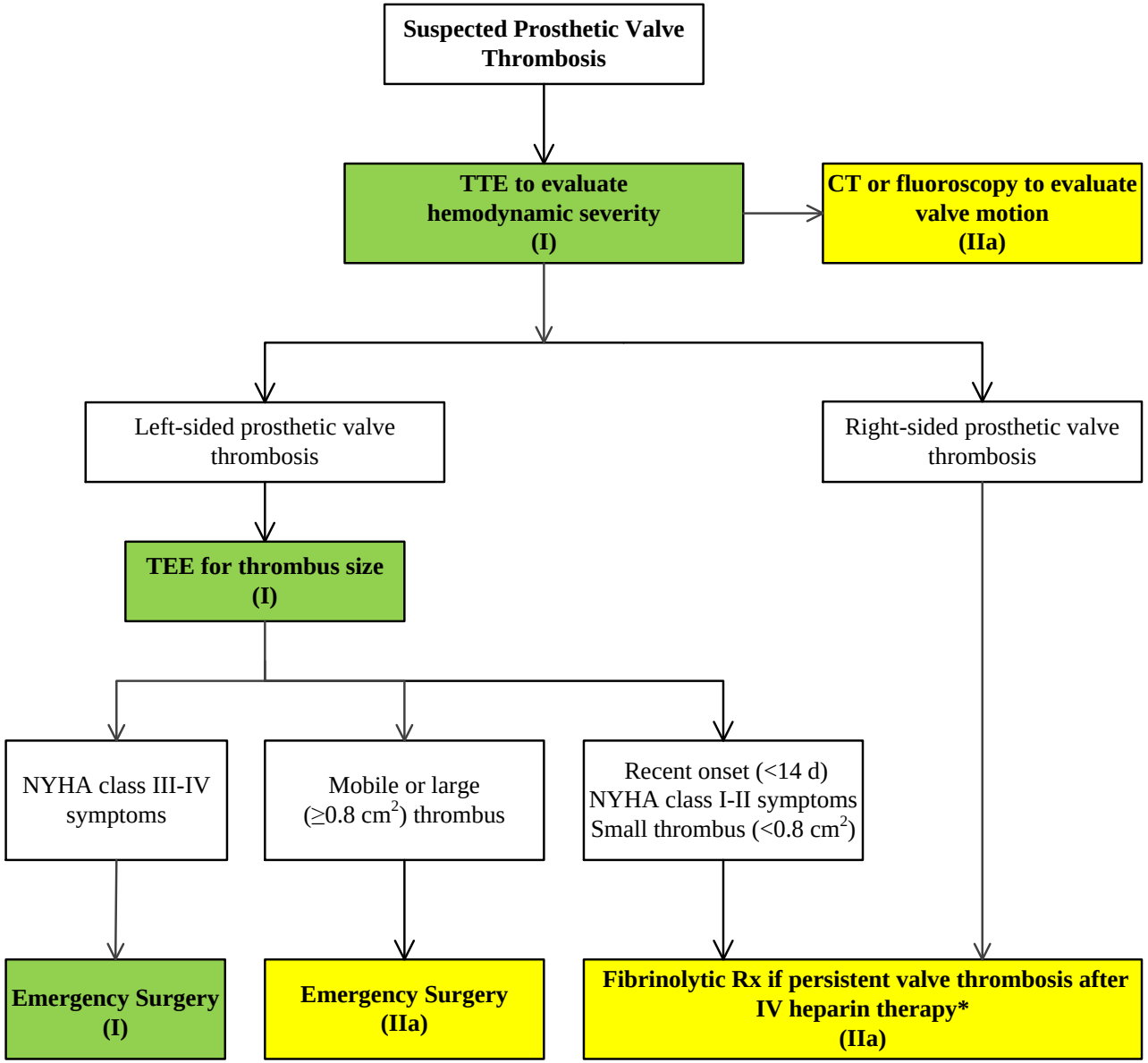
Prosthetic Valve Thrombosis: Medical Therapy

Recommendations	COR	LOE
Fibrinolytic therapy is reasonable for patients with a thrombosed left-sided prosthetic heart valve, recent onset (<14 days) of NYHA class I to II symptoms, and a small thrombus	IIa	B
Fibrinolytic therapy is reasonable for thrombosed right-sided prosthetic heart	IIa	B

Prosthetic Valve Thrombosis: Intervention

Recommendations	COR	LOE
Emergency surgery is recommended for patients with a thrombosed left-sided prosthetic heart valve with NYHA class III to IV symptoms	I	B
Emergency surgery is reasonable for patients with a thrombosed left-sided prosthetic heart valve with a mobile or large thrombus (>0.8 cm^2)	IIa	C

Evaluation and Management of Suspected Prosthetic Valve Thrombosis



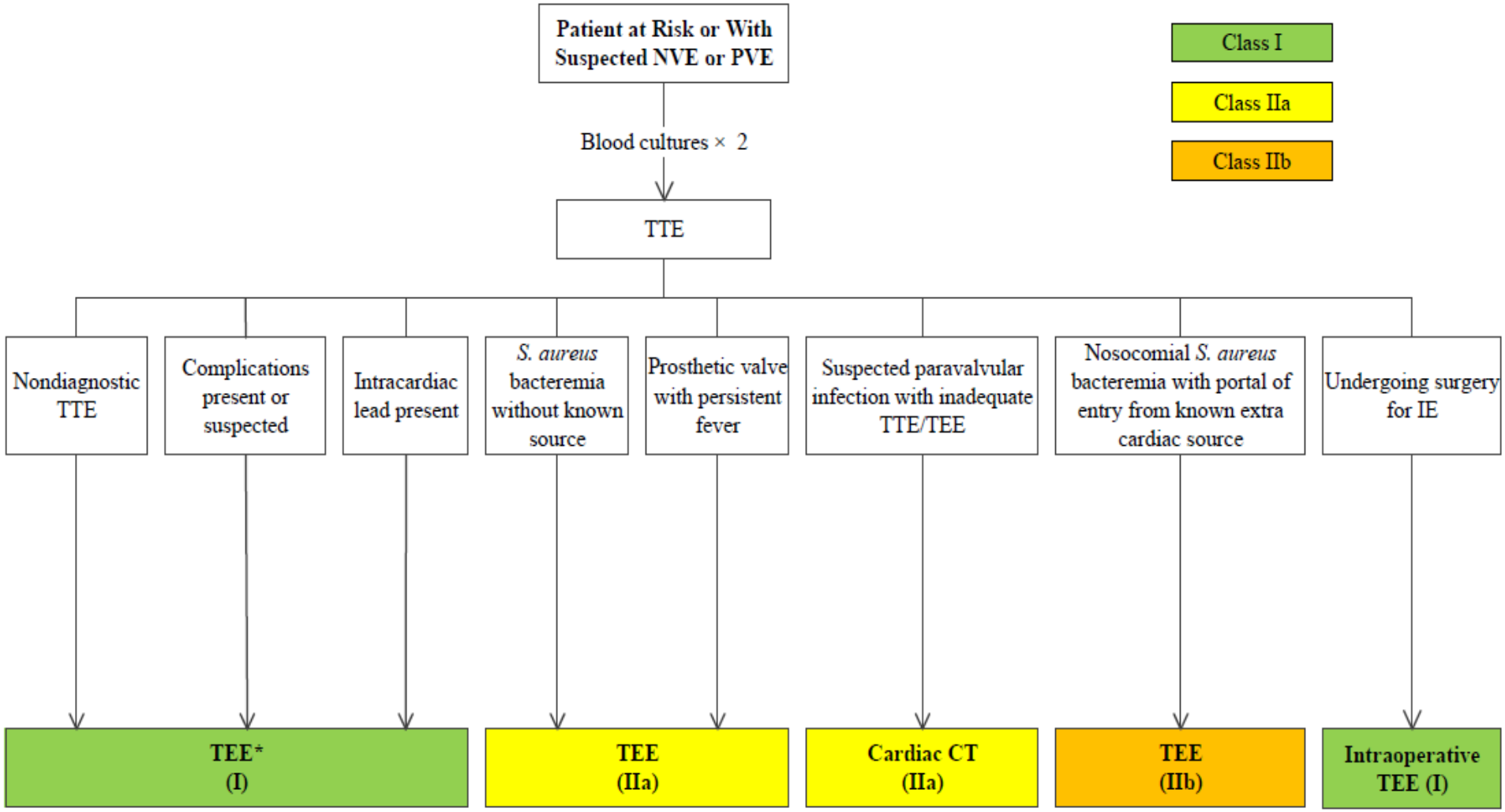
Prosthetic Valve Stenosis

Recommendations	COR	LOE
Repeat valve replacement is indicated for severe symptomatic prosthetic valve stenosis	I	C

Prosthetic Valve Regurgitation

Recommendations	COR	LOE
Surgery is recommended for operable patients with mechanical heart valves with intractable hemolysis or HF due to severe prosthetic or paraprosthetic regurgitation	I	B
Surgery is reasonable for operable patients with severe symptomatic or asymptomatic bioprosthetic regurgitation	IIa	C
Percutaneous repair of paravalvular regurgitation is reasonable in patients with prosthetic heart valves and intractable hemolysis or NYHA class III/IV HF who are at high risk for surgery and have anatomic features suitable for catheter-based therapy when performed in centers with expertise in the procedure	IIa	B

Imaging Studies in Native Valve Endocarditis and Prosthetic Valve Endocarditis



Infective Endocarditis: Diagnosis and Follow-Up

Recommendations	COR	LOE
At least 2 sets of blood cultures should be obtained in patients at risk for IE (e.g., those with congenital or acquired VHD, previous IE, prosthetic heart valves, certain congenital or heritable heart malformations, immunodeficiency states, or injection drug users) who have unexplained fever for more than 48 hours	I	B
At least 2 sets of blood cultures should be obtained in patients with newly diagnosed left-sided valve regurgitation	I	C
The Modified Duke Criteria should be used in evaluating a patient with suspected IE (Tables 24 and 25 in the full-text guideline)	I	B

Infective Endocarditis: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Patients with IE should be evaluated and managed with consultation of a multispecialty Heart Valve Team including an infectious disease specialist, cardiologist, and cardiac surgeon. In surgically managed patients, this team should also include a cardiac anesthesiologist	I	B
TTE is recommended in patients with suspected IE to identify vegetations, characterize the hemodynamic severity of valvular lesions, assess ventricular function and pulmonary pressures, and detect complications	I	B

Infective Endocarditis: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
TEE is recommended in all patients with known or suspected IE when TTE is nondiagnostic, when complications have developed or are clinically suspected, or when intracardiac device leads are present	I	B
TTE and/or TEE are recommended for reevaluation of patients with IE who have a change in clinical signs or symptoms (e.g., new murmur, embolism, persistent fever, HF, abscess, or atrioventricular heart block) and in patients at high risk of complications (e.g., extensive infected tissue/large vegetation on initial echocardiogram or staphylococcal, enterococcal, or fungal infections)	I	B

Infective Endocarditis: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Intraoperative TEE is recommended for patients undergoing valve surgery for IE	I	B
TEE is reasonable to diagnose possible IE in patients with *Staphylococcal aureus* bacteremia without a known source	IIa	B
TEE is reasonable to diagnose IE of a prosthetic valve in the presence of persistent fever without bacteremia or a new murmur	IIa	B

Infective Endocarditis: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Cardiac CT is reasonable to evaluate morphology/anatomy in the setting of suspected paravalvular infections when the anatomy cannot be clearly delineated by echocardiography	IIa	B
TEE might be considered to detect concomitant staphylococcal IE in nosocomial *Staphylococcal aureus* bacteremia with a known portal of entry from an extracardiac source	IIb	B

Infective Endocarditis: Medical Therapy

Recommendations	COR	LOE
Appropriate antibiotic therapy should be initiated and continued after blood cultures are obtained with guidance from antibiotic sensitivity data and infectious disease consultants	I	B
It is reasonable to temporarily discontinue anticoagulation in patients with IE who develop central nervous system symptoms compatible with embolism or stroke regardless of the other indications for anticoagulation	IIa	B

Infective Endocarditis: Medical Therapy (cont.)

Recommendations	COR	LOE
Temporary discontinuation of VKA anticoagulation might be considered in patients receiving VKA anticoagulation at the time of IE diagnosis	IIb	B
Patients with known VHD should not receive antibiotics before blood cultures are obtained for unexplained fever	III: Harm	C

Infective Endocarditis: Intervention

Recommendations	COR	LOE
Decisions about timing of surgical intervention should be made by a multispecialty Heart Valve Team of cardiology, cardiothoracic surgery, and infectious disease	I	B
Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) is indicated in patients with IE who present with valve dysfunction resulting in symptoms of HF	I	B

Infective Endocarditis: Intervention (cont.)

Recommendations	COR	LOE
Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) is indicated in patients with left-sided IE caused by *Staphylococcal aureus*, fungal, or other highly resistant organisms	I	B
Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) is indicated in patients with IE complicated by heart block, annular or aortic abscess, or destructive penetrating lesions	I	B

Infective Endocarditis: Intervention (cont.)

Recommendations	COR	LOE
Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) for IE is indicated in patients with evidence of persistent infection as manifested by persistent bacteremia or fevers lasting longer than 5 to 7 days after onset of appropriate antimicrobial therapy	I	B
Surgery is recommended for patients with prosthetic valve endocarditis and relapsing infection (defined as recurrence of bacteremia after a complete course of appropriate antibiotics and subsequently negative blood cultures) without other identifiable source for portal of infection	I	C

Infective Endocarditis: Intervention (cont.)

Recommendations	COR	LOE
Complete removal of pacemaker or defibrillator systems, including all leads and the generator, is indicated as part of the early management plan in patients with IE with documented infection of the device or leads	I	B
Complete removal of pacemaker or defibrillator systems, including all leads and the generator, is reasonable in patients with valvular IE caused by *Staphylococcal aureus* or fungi, even without evidence of device or lead infection	IIa	B

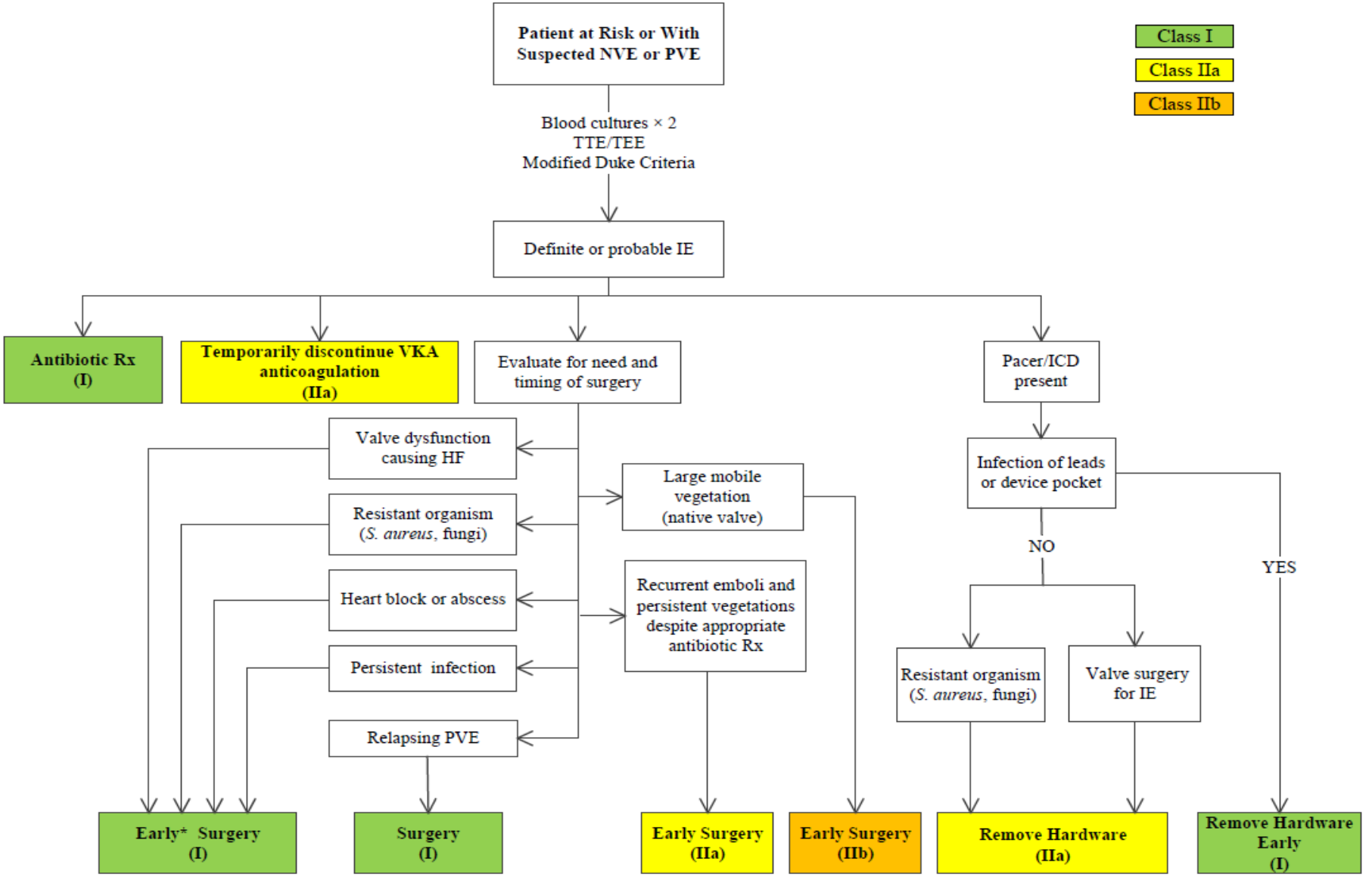
Infective Endocarditis: Intervention (cont.)

Recommendations	COR	LOE
Complete removal of pacemaker or defibrillator systems, including all leads and the generator, is reasonable in patients undergoing valve surgery for valvular IE	IIa	C
Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) is reasonable in patients with IE who present with recurrent emboli and persistent vegetations despite appropriate antibiotic therapy	IIa	B

Infective Endocarditis: Intervention (cont.)

Recommendations	COR	LOE
Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) may be considered in patients with native valve endocarditis who exhibit mobile vegetations greater than 10 mm in length (with or without clinical evidence of embolic phenomenon)	IIb	B

Diagnosis and Treatment of Infective Endocarditis



Native Valve Stenosis

Recommendations	COR	LOE
All patients with suspected valve stenosis should undergo a clinical evaluation and TTE before pregnancy	I	C
All patients with severe valve stenosis (stages C and D) should undergo prepregnancy counseling by a cardiologist with expertise in managing patients with VHD during pregnancy	I	C

Native Valve Stenosis (cont.)

Recommendations	COR	LOE
All patients referred for a valve operation before pregnancy should receive prepregnancy counseling by a cardiologist with expertise in managing patients with VHD during pregnancy about the risks and benefits of all options for operative interventions, including mechanical prosthesis, bioprosthesis, and valve repair	I	C
Pregnant patients with severe valve stenosis (stages C and D) should be monitored in a tertiary care center with a dedicated Heart Valve Team of cardiologists, surgeons, anesthesiologists, and obstetricians with expertise in the management of high-risk cardiac patients during pregnancy	I	C

Pregnancy and VHD: Diagnosis and Follow-Up

Recommendations	COR	LOE
Exercise testing is reasonable in asymptomatic patients with severe AS (aortic velocity ≥4 m per second or mean pressure gradient ≥40 mm Hg, stage C) before pregnancy	IIa	C

Pregnancy and VHD: Medical Therapy

Recommendations	COR	LOE
Anticoagulation should be given to pregnant patients with MS and AF unless contraindicated	I	C
Use of beta blockers as required for rate control is reasonable for pregnant patients with MS in the absence of contraindication if tolerated	IIa	C
Use of diuretics may be reasonable for pregnant patients with MS and HF symptoms (stage D)	IIb	C
ACE inhibitors and ARBs should not be given to pregnant patients with valve stenosis	III: Harm	B

Pregnancy and VHD: Intervention

Recommendations	COR	LOE
Valve intervention is recommended before pregnancy for symptomatic patients with severe AS (aortic velocity ≥4.0 m per second or mean pressure gradient ≥40 mm Hg, stage D)	I	C
Valve intervention is recommended before pregnancy for symptomatic patients with severe MS (mitral valve area ≤1.5 cm^2, stage D)	I	C
Percutaneous mitral balloon commissurotomy is recommended before pregnancy for asymptomatic patients with severe MS (mitral valve area ≤1.5 cm^2, stage C) who have valve morphology favorable for percutaneous mitral balloon commissurotomy	I	C

Pregnancy and VHD: Intervention (cont.)

Recommendations	COR	LOE
Valve intervention is reasonable before pregnancy for asymptomatic patients with severe AS (aortic velocity ≥4.0 m per second or mean pressure gradient ≥40 mm Hg, stage C)	IIa	C
Percutaneous mitral balloon commissurotomy is reasonable for pregnant patients with severe MS (mitral valve area ≤1.5 cm^2, stage D) with valve morphology favorable for percutaneous mitral balloon commissurotomy who remain symptomatic with NYHA class III to IV HF symptoms despite medical therapy	IIa	B

Pregnancy and VHD: Intervention (cont.)

Recommendations	COR	LOE
Valve intervention is reasonable for pregnant patients with severe MS (mitral valve area ≤1.5 cm^2, stage D) and valve morphology not favorable for percutaneous mitral balloon commissurotomy only if there are refractory NYHA class IV HF symptoms	IIa	C
Valve intervention is reasonable for pregnant patients with severe AS (mean pressure gradient ≥40 mm Hg, stage D) only if there is hemodynamic deterioration or NYHA class III to IV HF symptoms	IIa	B

Pregnancy and VHD: Intervention (cont.)

Recommendations	COR	LOE
Valve operation should not be performed in pregnant patients with valve stenosis in the absence of severe HF symptoms	III: Harm	C

Native Valve Regurgitation: Diagnosis and Follow-Up

Recommendations	COR	LOE
All patients with suspected valve regurgitation should undergo a clinical evaluation and TTE before pregnancy	I	C
All patients with severe valve regurgitation (stages C and D) should undergo prepregnancy counseling by a cardiologist with expertise in managing patients with VHD during pregnancy	I	C

Native Valve Regurgitation: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
All patients referred for a valve operation before pregnancy should receive prepregnancy counseling by a cardiologist with expertise in managing patients with VHD during pregnancy regarding the risks and benefits of all options for operative interventions, including mechanical prosthesis, bioprosthesis, and valve repair	I	C

Native Valve Regurgitation: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Pregnant patients with severe regurgitation (stages C and D) should be monitored in a tertiary care center with a dedicated Heart Valve Team of cardiologists, surgeons, anesthesiologists, and obstetricians with expertise in managing high-risk cardiac patients	I	C
Exercise testing is reasonable in asymptomatic patients with severe valve regurgitation (stage C) before pregnancy	IIa	C

Native Valve Regurgitation: Medical Therapy

Recommendations	COR	LOE
ACE inhibitors and ARBs should not be given to pregnant patients with valve	III: Harm	B

Native Valve Regurgitation: Intervention

Recommendations	COR	LOE
Valve repair or replacement is recommended before pregnancy for symptomatic women with severe valve regurgitation (stage D)	I	C
Valve operation for pregnant patients with severe valve regurgitation is reasonable only if there are refractory NYHA class IV HF symptoms (stage D)	IIa	C

Native Valve Regurgitation: Intervention (cont.)

Recommendations	COR	LOE
Valve repair before pregnancy may be considered in the asymptomatic patient with severe MR (stage C) and a valve suitable for valve repair, but only after detailed discussion with the patient about the risks and benefits of the operation and its outcome on future pregnancies	IIb	C
Valve operations should not be performed in pregnant patients with valve regurgitation in the absence of severe intractable HF symptoms	III: Harm	C

Prosthetic Valves in Pregnancy: Diagnosis and Follow-Up

Recommendations	COR	LOE
All patients with a prosthetic valve should undergo a clinical evaluation and baseline TTE before pregnancy	I	C
All patients with a prosthetic valve should undergo prepregnancy counseling by a cardiologist with expertise in managing patients with VHD during pregnancy.	I	C
TTE should be performed in all pregnant patients with a prosthetic valve if not done before pregnancy	I	C

Prosthetic Valves in Pregnancy: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Repeat TTE should be performed in all pregnant patients with a prosthetic valve who develop symptoms	I	C
TEE should be performed in all pregnant patients with a mechanical prosthetic valve who have prosthetic valve obstruction or experience an embolic event	I	C

Prosthetic Valves in Pregnancy: Diagnosis and Follow-Up (cont.)

Recommendations	COR	LOE
Pregnant patients with a mechanical prosthesis should be monitored in a tertiary care center with a dedicated Heart Valve Team of cardiologists, surgeons, anesthesiologists, and obstetricians with expertise in the management of high-risk cardiac patients	I	C

Prosthetic Valves in Pregnancy: Medical Therapy

Recommendations	COR	LOE
Therapeutic anticoagulation with frequent monitoring is recommended for all pregnant patients with a mechanical prosthesis	I	B
Warfarin is recommended in pregnant patients with a mechanical prosthesis to achieve a therapeutic INR in the second and third trimesters	I	B
Discontinuation of warfarin with initiation of intravenous UFH (with an activated partial thromboplastin time [aPTT] >2 times control) is recommended before planned vaginal delivery in pregnant patients with a mechanical prosthesis	I	C

Prosthetic Valves in Pregnancy: Medical Therapy (cont.)

Recommendations	COR	LOE
Low-dose aspirin (75 mg to 100 mg) once per day is recommended for pregnant patients in the second and third trimesters with either a mechanical prosthesis or bioprosthesis	I	C
Continuation of warfarin during the first trimester is reasonable for pregnant patients with a mechanical prosthesis if the dose of warfarin to achieve a therapeutic INR is 5 mg per day or less after full discussion with the patient about risks and benefits	IIa	B

Prosthetic Valves in Pregnancy: Medical Therapy (cont.)

Recommendations	COR	LOE
Dose-adjusted LMWH at least 2 times per day (with a target anti-Xa level of 0.8 U/mL to 1.2 U/mL, 4 to 6 hours postdose) during the first trimester is reasonable for pregnant patients with a mechanical prosthesis if the dose of warfarin is greater than 5 mg per day to achieve a therapeutic INR	IIa	B
Dose-adjusted continuous intravenous UFH (with an aPTT at least 2 times control) during the first trimester is reasonable for pregnant patients with a mechanical prosthesis if the dose of warfarin is greater than 5 mg per day to achieve a therapeutic INR	IIa	B

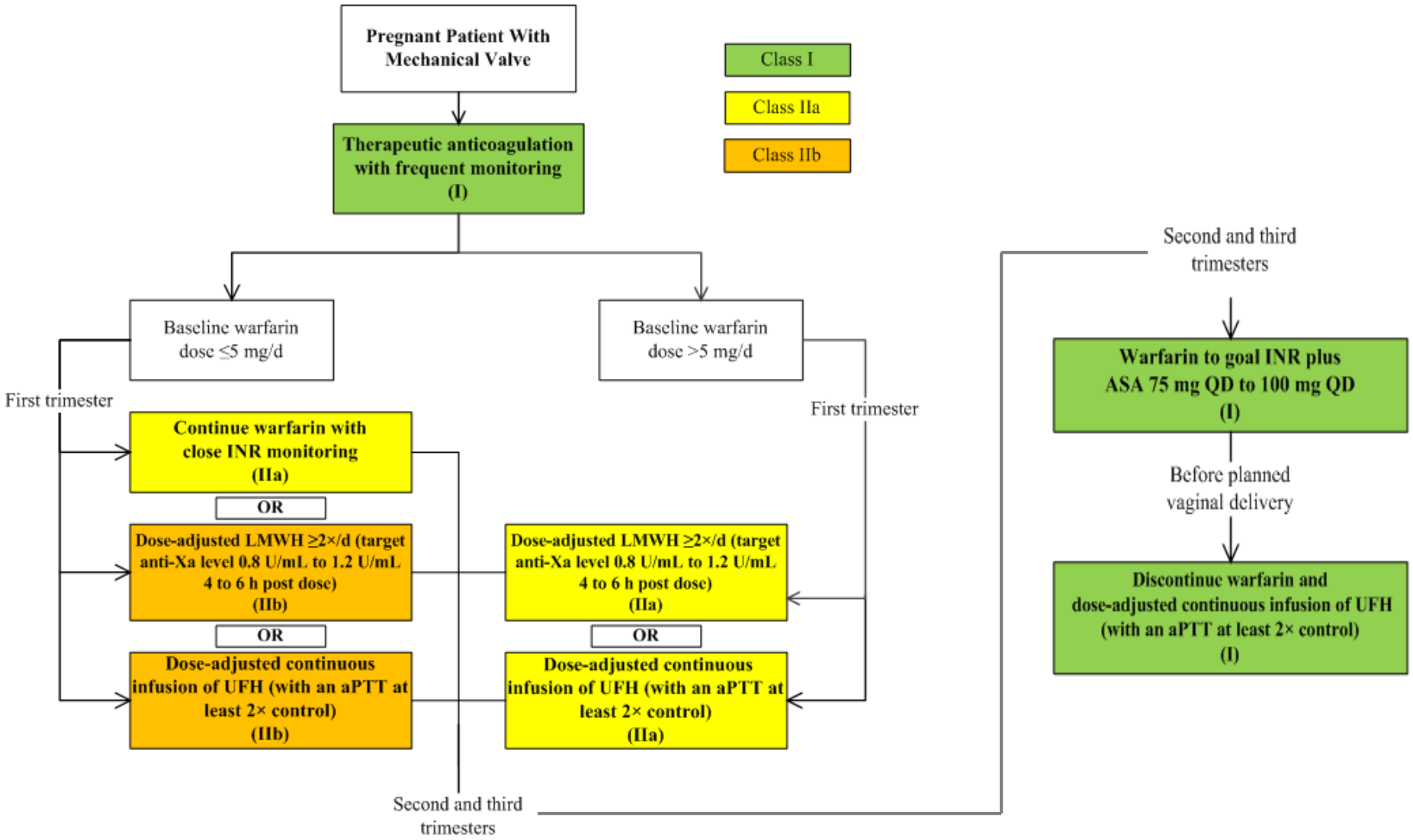
Prosthetic Valves in Pregnancy: Medical Therapy (cont.)

Recommendations	COR	LOE
Dose-adjusted LMWH at least 2 times per day (with a target anti-Xa level of 0.8 U/mL to 1.2 U/mL, 4 to 6 hours postdose) during the first trimester may be reasonable for pregnant patients with a mechanical prosthesis if the dose of warfarin is 5 mg per day or less to achieve a therapeutic INR	IIb	B
Dose-adjusted continuous infusion of UFH (with aPTT at least 2 times control) during the first trimester may be reasonable for pregnant patients with a mechanical prosthesis if the dose of warfarin is 5 mg per day or less to achieve a therapeutic INR	IIb	B

Prosthetic Valves in Pregnancy: Medical Therapy (cont.)

Recommendations	COR	LOE
LMWH should not be administered to pregnant patients with mechanical prostheses unless anti-Xa levels are monitored 4 to 6 hours after administration	III: Harm	B

Anticoagulation of Pregnant Patients With Mechanical Valves



Evaluation of Coronary Anatomy

Recommendations	COR	LOE
Coronary angiography is indicated before valve intervention in patients with symptoms of angina, objective evidence of ischemia, decreased LV systolic function, history of CAD, or coronary risk factors (including men age >40 years and postmenopausal women)	I	C
Coronary angiography should be performed as part of the evaluation of patients with chronic severe secondary MR	I	C

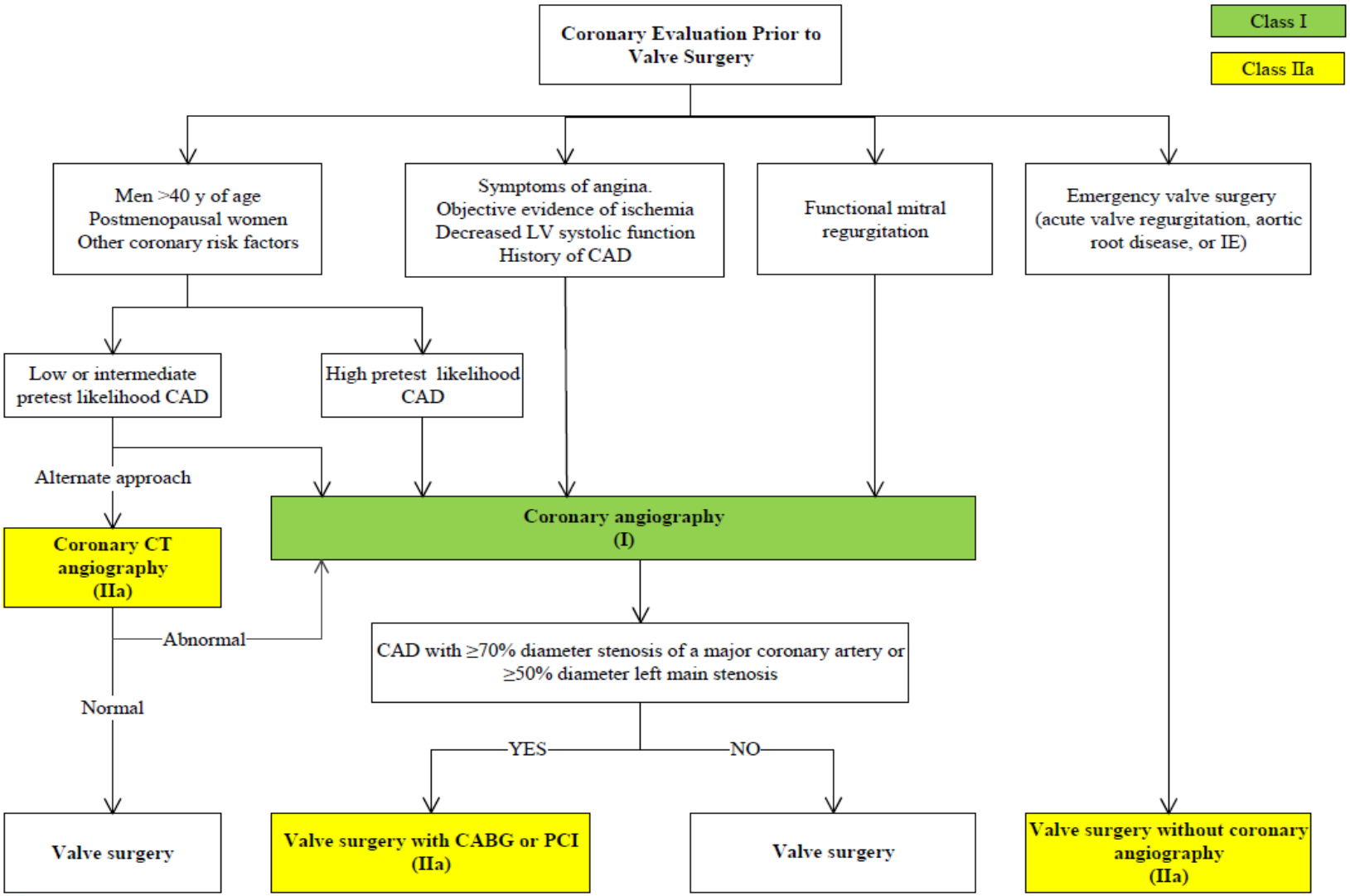
Evaluation of Coronary Anatomy (cont.)

Recommendations	COR	LOE
Surgery without coronary angiography is reasonable for patients having emergency valve surgery for acute valve regurgitation, disease of the aortic sinuses or ascending aorta, or IE	IIa	C
CT coronary angiography is reasonable to exclude the presence of significant obstructive CAD in selected patients with a low/intermediate pretest probability of CAD. A positive coronary CT angiogram (the presence of any epicardial CAD) can be confirmed with invasive coronary angiography	IIa	B

Coronary Artery Disease: Intervention

Recommendations	COR	LOE
CABG or percutaneous coronary intervention is reasonable in patients undergoing valve repair or replacement with significant CAD (≥70% reduction in luminal diameter in major coronary arteries or ≥50% reduction in luminal diameter in the left main coronary artery	IIa	C

Evaluation and Management of Coronary Artery Disease in Patients Undergoing Valve Surgery



Atrial Fibrillation: Intervention

Recommendations	COR	LOE
A concomitant maze procedure is reasonable at the time of mitral valve repair or replacement for treatment of chronic, persistent AF	IIa	C
A full bi-atrial maze procedure, when technically feasible, is reasonable at the time of mitral valve surgery, compared with a lesser ablation procedure, in patients with chronic, persistent AF	IIa	B
A concomitant maze procedure or pulmonary vein isolation may be considered at the time of mitral valve repair or replacement in patients with paroxysmal AF that is symptomatic or associated with a history of embolism on anticoagulation	IIb	C

Atrial Fibrillation: Intervention (cont.)

Recommendations	COR	LOE
Concomitant maze procedure or pulmonary vein isolation may be considered at the time of cardiac surgical procedures other than mitral valve surgery in patients with paroxysmal or persistent AF that is symptomatic or associated with a history of emboli on anticoagulation	IIb	C
Catheter ablation for AF should not be performed in patients with severe MR when mitral repair or replacement is anticipated, with preference for the combined maze procedure plus mitral valve repair	III: No Benefit	B

Noncardiac Surgery in Patients With VHD

Recommendations	COR	LOE
Moderate-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe AS	IIa	B
Moderate-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe MR	IIa	C

Noncardiac Surgery in Patients With VHD (cont.)

Recommendations	COR	LOE
Moderate-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe AR and a normal LVEF	IIa	C
Moderate-risk elective noncardiac surgery in patients with appropriate intraoperative and postoperative hemodynamic monitoring may be reasonable to perform in asymptomatic patients with severe MS if valve morphology is not favorable for percutaneous balloon mitral commissurotomy	IIb	C