American College of Cardiology

American Heart Association℠
Fighting Heart Disease and Stroke

ACC/AHA Pocket Guidelines

Management of Patients With Valvular Heart Disease

A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines

July 2000

ACC/AHA Pocket Guidelines for

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The following material was adapted from the *ACC/AHA Guidelines for the Management of Patients With Valvular Heart Disease.* (*JACC*, Vol. 32, No. 5, Nov. 1998: 1486-1588; and *Circulation*, Vol. 98, No. 18, Nov. 1998: 1949-1984). For a copy of the full report or executive summary as published in *JACC* and *Circulation*, visit our Web sites at *http://www.acc.org* or *http://www.americanheart.org* or call the ACC Resource Center at 1-800-253-4636, ext. 694.

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I. Introduction

Valvular heart disease is one of several cardiac disorders that affect a large number of people who require diagnostic procedures and long-term management. The *Pocket Guidelines for Management of Patients With Valvular Heart Disease* provides rapid prompts for 3 specific aspects of the management of patients with valvular heart disease. The pocket guide is derived from the full text of the *ACC/AHA Guidelines for the Management of Patients With Valvular Heart Disease,* published in the November 1998 issue of the *Journal of the American College of Cardiology.* The full text of the guidelines provides a more detailed explanation of the management of valvular heart disease, along with appropriate caveats and levels of evidence. The executive summary of the guidelines was published in the November 1, 1998 issue of *Circulation*. Both the full guidelines and the executive summary are available on-line as well, at http://www.acc.org or http://www.americanheart.org. Users of this pocket guide should consult those documents for additional information.

Scope of the Pocket Guide

The *Guidelines for the Management of Patients With Valvular Heart Disease* cannot be reproduced in their entirety in a pocket guide format. For this reason, the pocket guide focuses on the 3 aspects of management that are most frequently encountered in the practice of adult cardiology:

- Indications for echocardiography
- Indications for valvular surgery or percutaneous intervention
- Antithrombotic management of prosthetic heart valves

Recommendations are summarized in tables by the customary ACC/AHA classifications I, II, and III, which are as follows:

Class I	Conditions for which there is evidence and/or general agreement that a given procedure or treatment is useful and effective.
Class II	Conditions for which there is conflicting evidence and/or a divergence of opinion about the usefulness/efficacy of a procedure or treatment. **Class IIa** Weight of evidence/opinion is in favor of usefulness/efficacy. **Class IIb** Usefulness/efficacy is less well established by evidence/opinion.
Class III	Conditions for which there is evidence and/or general agreement that a procedure/treatment is not useful/effective and in some cases may be harmful.

The following abbreviations are used throughout this pocket guide:

AR	aortic regurgitation
AS	aortic stenosis
AVR	aortic valve replacement
CABG	coronary artery bypass grafting
ECG	electrocardiogram
EDD	end-diastolic dimension
EF	ejection fraction
ESD	end-systolic dimension
INR	International Normalized Ratio
LV	left ventricular
MR	mitral regurgitation
MS	mitral stenosis
MVA	mitral valve area
MVP	mitral valve prolapse
MVR	mitral valve replacement
NYHA	New York Heart Association
PA	pulmonary artery
PMBV	percutaneous mitral balloon valvotomy
TR	tricuspid regurgitation

II. Indications for 2-Dimensional and Doppler Echocardiography

A. Heart Murmurs

1. Asymptomatic patients

Class I

1. Diastolic or continuous murmurs.
2. Holosystolic or late systolic murmurs.
3. Grade 3 or higher midsystolic murmurs.

Class IIa

1. Murmurs associated with abnormal physical findings on cardiac palpation or auscultation.
2. Murmurs associated with an abnormal ECG or chest x-ray.

Class III

1. Grade 2 or softer midsystolic murmurs identified as innocent or functional by an experienced observer.
2. Detection of "silent" AR or MR in patients without cardiac murmurs.

2. Symptomatic patients

Class I

1. Symptoms or signs of heart failure, myocardial ischemia, or syncope.
2. Symptoms or signs consistent with infective endocarditis or thromboembolism.

Class IIa Symptoms or signs likely due to noncardiac disease with cardiac disease not excluded by standard cardiovascular evaluation.

Class III Symptoms or signs of noncardiac disease with an isolated midsystolic "innocent" murmur.

B. Aortic Stenosis

The 2-D echocardiogram is valuable for confirming the presence of aortic valve disease and determining LV size and function, the degree of hypertrophy, and the presence of other associated valve disease. In most patients, the severity of the stenotic lesion can be defined with Doppler echocardiographic measurements of a mean transvalvular pressure gradient and derived valve area.

Recommendations for Echocardiography in Aortic Stenosis

Class I

1. Diagnosis and assessment of severity of AS.
2. Assessment of LV size, function, and/or hemodynamics.
3. Reevaluation of patients with known AS with changing symptoms or signs.

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4. Assessment of changes in hemodynamic severity and ventricular function in patients with known AS during pregnancy.

5. Reevaluation of asymptomatic patients with severe AS.

Class IIa Reevaluation of asymptomatic patients with mild to moderate AS and evidence of LV dysfunction or hypertrophy.

Class III Routine reevaluation of asymptomatic adult patients with mild AS, stable physical signs, and normal LV size and function.

The natural history of AS and indications for valve surgery do not support the use of annual echocardiographic studies to assess changes in valve area. Serial echocardiograms are helpful, however, to assess changes in LV hypertrophy and function. Therefore, for patients with severe AS, a yearly echocardiogram may be appropriate. In patients with moderate AS, serial studies performed every 2 years or so are satisfactory; in patients with mild AS, serial studies can be performed every 5 years. Echocardiograms should be performed more frequently if there is a change in clinical findings.

C. Aortic Regurgitation

Echocardiography is indicated to confirm the diagnosis of AR when it is equivocal based on physical examination; to assess the etiology of AR and valve morphology; to provide a semiquantitative estimate of the severity of regurgitation; to assess LV dimension, mass, and systolic function; and to assess aortic root size.

Recommendations for Echocardiography in Aortic Regurgitation

Class I 1. Confirmation of the presence and severity of acute AR.

2. Diagnosis of chronic AR in patients with equivocal physical findings.

3. Assessment of the etiology of regurgitation (including valve morphology and aortic root size and morphology).

4. Assessment of LV hypertrophy, dimension (or volume), and systolic function.

5. Semiquantitative estimate of severity of AR.

6. Reevaluation of patients with mild, moderate, or severe regurgitation with new or changing symptoms.

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2-D and Doppler Echo

7. Reevaluation of LV size and function in asymptomatic patients with severe regurgitation.

8. Reevaluation of asymptomatic patients with mild, moderate, or severe regurgitation and enlarged aortic root.

Class III Yearly reevaluation of asymptomatic patients with mild to moderate AR, stable physical signs, and normal or near-normal LV chamber size.

Once the chronicity and stability of the process has been established, the frequency of clinical reevaluation and repeat noninvasive testing depends on the severity of AR, degree of LV dilatation, level of systolic function, and whether previous serial studies have revealed progressive changes in LV size or function *(see Figure 1)*. Repeat echocardiograms are also recommended at the onset of symptoms, when there is an equivocal history of changing symptoms or exercise tolerance, or when there are clinical findings that suggest worsening AR or progressive LV dilatation.

D. Mitral Stenosis

2-D echocardiography should be used to assess the morphologic appearance of the mitral valve apparatus, including leaflet mobility, leaflet thickness, leaflet calcification, and subvalvular and commissural fusion. These features may be important when considering the timing and type of intervention to

be performed. Chamber size and function as well as other structural valvular, myocardial, or pericardial abnormalities should also be assessed. Doppler echocardiography should be used to assess the hemodynamic severity of MS, to estimate PA systolic pressure from the TR velocity signal, and to assess the severity of concomitant MR or AR. Formal hemodynamic exercise testing can be done by using either a supine bicycle or upright treadmill with Doppler recordings of transmitral and tricuspid velocities.

1. Recommendations for Transthoracic Echocardiography in Mitral Stenosis

Class I

1. Diagnosis of MS, assessment of hemodynamic severity (mean gradient, MVA, PA pressure), and assessment of right ventricular size and function.

2. Assessment of valve morphology to determine suitability for PMBV.

3. Diagnosis and assessment of concomitant valvular lesions.

4. Reevaluation of patients with known MS with changing symptoms or signs.

Class IIa Assessment of the hemodynamic response of mean gradient and PA pressure by exercise Doppler echocardiography in patients with a discrepancy between resting hemodynamics and clinical findings.

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Class IIb Reevaluation of asymptomatic patients with moderate to severe MS to assess PA pressure.

Class III Routine reevaluation of the asymptomatic patient with mild MS and stable clinical findings.

2. Recommendations for Transesophageal Echocardiography in Mitral Stenosis

Class IIa 1. Assessment for the presence or absence of left atrial thrombus in patients being considered for PMBV or cardioversion.

2. Evaluation of mitral valve morphology and hemodynamics when transthoracic echocardiography provides suboptimal data.

Class III Routine evaluation of mitral valve morphology and hemodynamics when complete transthoracic echocardiographic data are satisfactory.

Serial follow-up testing of a patient with MS should be based on whether the results of a test will dictate either a change in therapy or a recommendation for a procedure. A yearly echocardiogram is not recommended unless there is a change in clinical status.

E. Mitral Valve Prolapse

2-D and Doppler echocardiography is the most useful noninvasive test for defining MVP. The M-mode echocardiographic definition of MVP includes ≥2 mm posterior displacement of one or both leaflets or holosystolic posterior "hammocking" >3 mm. On 2-D echocardiography, systolic displacement of one or both mitral leaflets in the parasternal long-axis view, particularly when they coapt on the atrial side of the annular plane, indicates a high likelihood of MVP. The diagnosis of MVP is even more certain when leaflet thickness is >5 mm. The echocardiographic criteria for MVP should include structural changes such as leaflet thickening, redundancy, annular dilatation, and chordal elongation.

Recommendations for Echocardiography in Mitral Valve Prolapse

Class I 1. Diagnosis, assessment of hemodynamic severity of MR, leaflet morphology, and ventricular compensation in patients with physical signs of MVP.

2. To exclude MVP in patients who have been given the diagnosis when there is no clinical evidence to support the diagnosis.

Class IIa 1. To exclude MVP in patients with first-degree relatives with known myxomatous valve disease.

2. Risk stratification of patients with physical signs of MVP or known MVP.

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2-D and Doppler Echo

Class III 1. To exclude MVP in the absence of physical findings suggestive of MVP or a positive family history.

2. Routine repetition of echocardiography in patients with MVP with mild or no regurgitation and no changes in clinical signs or symptoms.

Serial echocardiograms are not usually necessary in asymptomatic patients with MVP unless there are clinical indications of severe or worsening MR.

F. Mitral Regurgitation

2-D and Doppler echocardiography is indispensable in the management of patients with MR and should be used to assess LV and left atrial size, LV ejection fraction, severity of MR, and PA systolic pressure from the TR velocity signal. Echocardiography may also indicate the anatomic cause of MR.

1. Recommendations for Transthoracic Echocardiography in Mitral Regurgitation

Class I 1. For baseline evaluation to quantify severity of MR and LV function in any patient suspected of having MR.

2. For delineation of mechanism of MR.

3. For surveillance of LV function (estimated by EF and ESD) in asymptomatic severe MR.

2-D and Doppler Echo

4. To establish cardiac status after a change in symptoms.

5. For evaluation after MVR or mitral valve repair to establish baseline status.

Class III Routine follow-up evaluation of mild MR with normal LV size and systolic function.

2. Recommendations for Transesophageal Echocardiography in Mitral Regurgitation

Class I 1. Intraoperative transesophageal echocardiography to establish the anatomic basis for MR and to guide repair.

2. Evaluation of MR patients when transthoracic echocardiography provides nondiagnostic images regarding severity of MR, mechanism of MR, and/or status of LV function.

Class III Routine follow-up or surveillance of patients with native valve MR.

Asymptomatic patients with *mild* MR and no evidence of LV enlargement or dysfunction or pulmonary hypertension can be monitored on a yearly basis, but yearly echocardiograms are

not necessary unless there is clinical evidence that regurgitation has worsened. In patients with *moderate* MR, clinical evaluations and echocardiograms should be performed yearly. Patients with *severe* MR should be monitored with clinical evaluation and echocardiography every 6 to 12 months to assess symptoms or transition to asymptomatic LV dysfunction.

III. Indications for Valve Surgery or Percutaneous Intervention

A. Aortic Stenosis

AVR is clearly indicated in symptomatic patients. Management decisions are more controversial in asymptomatic patients. It is reasonable to attempt to identify patients who may be at especially high risk of sudden death without surgery, although data supporting this approach are limited. Patients with severe AS, with or without symptoms, who are undergoing CABG should undergo AVR at the time of revascularization. There is general consensus that patients with moderate AS (eg, mean pressure gradient ≥30 mm Hg) should undergo AVR at the time of CABG, but controversy persists regarding the indications for concomitant AVR at the time of CABG in patients with milder forms of AS.

Recommendations for Aortic Valve Replacement in Aortic Stenosis

Class I	1. Symptomatic patients with severe AS. 2. Patients with severe AS undergoing CABG. 3. Patients with severe AS undergoing surgery on the aorta or other heart valves.
Class IIa	1. Patients with moderate AS undergoing CABG or surgery on the aorta or other heart valves. 2. Asymptomatic patients with severe AS and ■ LV systolic dysfunction ■ Abnormal response to exercise (eg, hypotension)
Class IIb	Asymptomatic patients with severe AS and ■ Ventricular tachycardia ■ Marked or excessive LV hypertrophy (≥15 mm) ■ Valve area <0.6 cm^2
Class III	Prevention of sudden death in asymptomatic patients with none of the indications above.

B. Aortic Regurgitation

AVR is indicated for patients with chronic severe AR who have cardiac symptoms and for asymptomatic patients with LV systolic dysfunction at rest, marked LV dilatation, or severely dilated aortic roots *(see Figure 1)*.

Recommendations for Aortic Valve Replacement in Chronic Severe Aortic Regurgitation

Class I	1. Symptomatic patients with preserved LV systolic function, defined as normal EF at rest (EF ≥0.50). 2. Asymptomatic or symptomatic patients with mild to moderate LV dysfunction at rest (EF 0.25 to 0.49). 3. Patients undergoing CABG or surgery on the aorta or other heart valves.
Class IIa	Asymptomatic patients with normal LV systolic function (EF >0.50) but severe LV dilatation (EDD >75 mm or ESD >55 mm).*
Class IIb	1. Patients with severe LV dysfunction (EF <0.25). 2. Asymptomatic patients with normal systolic function at rest (EF >0.50) and progressive LV dilatation when the degree of dilatation is moderately severe (EDD 70 to 75 mm, ESD 50 to 55 mm).*
Class III	Asymptomatic patients with normal systolic function at rest (EF >0.50) and LV dilatation when the degree of dilatation is not severe (EDD <70 mm, ESD <50 mm).

**Consider lower threshold values for patients of small stature of either gender. Clinical judgment is required.*

C. Mitral Stenosis

Indications for intervention in patients with MS depend on symptoms, PA pressure, right ventricular function, and the feasibility of performing PMBV, as indicated in *Figure 2*.

If there is a discrepancy between symptoms and hemodynamic data, formal exercise testing or dobutamine stress may be useful to differentiate symptoms due to MS from other causes. Patients who are symptomatic with a significant elevation of PA pressure (>60 mm Hg), mean transmitral gradient (>15 mm Hg), or PA wedge pressure (≥25 mm Hg) with exertion have hemodynamically significant MS, and further intervention should be considered.

1. Recommendations for Percutaneous Mitral Balloon Valvotomy for Mitral Stenosis

Class I

Symptomatic patients (NYHA functional class II, III, or IV), moderate or severe MS (MVA ≤1.5 cm^2),* and valve morphology favorable for PMBV in the absence of left atrial thrombus or moderate to severe MR.

Class IIa

1. Asymptomatic patients with moderate or severe MS (MVA ≤1.5 cm^2)* and valve morphology favorable for PMBV who have pulmonary hypertension (PA systolic pressure >50 mm Hg at rest or >60 mm Hg with exercise) in the absence of left atrial thrombus or moderate to severe MR.

2. Patients with NYHA functional class III to IV symptoms, moderate or severe MS (MVA ≤1.5 cm^2),* and a nonpliable calcified valve who are at high risk for surgery in the absence of left atrial thrombus or moderate to severe MR.

Class IIb

1. Asymptomatic patients, moderate or severe MS (MVA ≤1.5 cm^2),* and valve morphology favorable for PMBV who have new-onset atrial fibrillation in the absence of left atrial thrombus or moderate to severe MR.

2. Patients in NYHA functional class III to IV, moderate or severe MS (MVA ≤1.5 cm^2)*, and a nonpliable calcified valve who are low-risk candidates for surgery.

Class III

Patients with mild MS.

**Because there may be variability in the measurement of MVA, it is important to consider the mean transmitral gradient, PA wedge pressure, and PA pressure.*

2. Recommendations for Surgical Mitral Valve Repair for Mitral Stenosis

Class I

1. Patients with NYHA functional class III to IV symptoms, moderate or severe MS (MVA ≤1.5 cm^2),* and valve morphology favorable for repair if PMBV is not available.

2. Patients with NYHA functional class III to IV symptoms, moderate or severe MS (MVA ≤1.5 cm^2),* and valve morphology favorable for repair if a left atrial thrombus is present despite anticoagulation.

3. Patients with NYHA functional class III to IV symptoms, moderate or severe MS (MVA ≤1.5 cm^2),* and a nonpliable or calcified valve, with the decision to proceed with either repair or replacement made at the time of surgery.

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Class IIb Patients in NYHA functional class I, with moderate or severe MS (MVA ≤1.5 cm^2)* and valve morphology favorable for repair who have had recurrent embolic events while on adequate anticoagulation.

Class III Patients with NYHA functional class II to IV symptoms and mild MS.

**Because there may be variability in the measurement of MVA, it is important to consider the mean transmitral gradient, PA wedge pressure, and PA pressure.*

3. Recommendations for Mitral Valve Replacement for Mitral Stenosis

Class I Patients with moderate or severe MS (MVA ≤1.5 cm^2)* and NYHA functional class III to IV symptoms who are not considered candidates for PMBV or mitral valve repair.

Class IIa Patients with severe MS (MVA ≤1 cm^2)* and severe pulmonary hypertension (PA systolic pressure >60 to 80 mm Hg) with NYHA functional class I to II symptoms who are not considered candidates for PMBV or mitral valve repair.

**Because there may be variability in the measurement of MVA, it is important to consider the mean transmitral gradient, PA wedge pressure, and PA pressure.*

D. Mitral Regurgitation

Factors influencing timing of surgery for MR include symptoms, LV ejection fraction, LV ESD, atrial fibrillation, and pulmonary hypertension *(see Figure 3)*. In most cases, mitral valve repair is the operation of choice for those with suitable valvular anatomy and when appropriate surgical skill and expertise are available.

In an asymptomatic patient with severe MR and normal LV function, mitral valve repair may be contemplated to preserve LV size and function and prevent the sequelae of chronic MR. Although there are no data with which to recommend this approach for all patients, the committee recognizes that some experienced centers have adopted this policy for patients for whom the likelihood of successful repair is high. This approach is often recommended for hemodynamically stable patients with newly acquired severe MR, such as that which might occur with ruptured chordae and flail leaflets. Surgery may also be recommended in an asymptomatic patient with chronic MR with recent onset of episodic or chronic atrial fibrillation and for whom there is a high likelihood of successful valve repair.

Recommendations for Mitral Valve Surgery in Nonischemic Severe Mitral Regurgitation

Class I

1. Acute symptomatic MR for which repair is likely.
2. Patients with NYHA functional class II, III, or IV symptoms with normal LV function defined as EF >0.60 and ESD <45 mm.
3. Symptomatic or asymptomatic patients with mild LV dysfunction, EF 0.50 to 0.60, and ESD 45 to 50 mm.
4. Symptomatic or asymptomatic patients with moderate LV dysfunction, EF 0.30 to 0.50, and/or ESD 50 to 55 mm.

Class IIa

1. Asymptomatic patients with preserved LV function and atrial fibrillation.
2. Asymptomatic patients with preserved LV function and pulmonary hypertension (PA systolic pressure >50 mm Hg at rest or >60 mm Hg with exercise).
3. Asymptomatic patients with EF 0.50 to 0.60 and ESD <45 mm and those with EF >0.60 and ESD 45 to 55 mm.
4. Patients with severe LV dysfunction (EF <0.30 and/or ESD >55 mm) in whom chordal preservation is highly likely.

Class IIb

1. Asymptomatic patients with chronic MR with preserved LV function for whom mitral valve repair is highly likely.
2. Patients with MVP and preserved LV function who have recurrent ventricular arrhythmias despite medical therapy.

Class III

Asymptomatic patients with preserved LV function for whom significant doubt exists about the feasibility of repair.

E. Infective Endocarditis

Surgery is indicated in patients with life-threatening congestive heart failure or cardiogenic shock due to surgically treatable valvular heart disease with or without proven infective endocarditis if the patient has a reasonable prospect of recovery with satisfactory quality of life after the operation. In the setting of acute infective endocarditis, surgery should not be delayed when congestive heart failure exists.

Indications for surgery for infective endocarditis in patients with stable hemodynamics are less clear. Surgery is recommended for patients with annular or aortic abscesses, those with infections resistant to antibiotic therapy, and those with fungal endocarditis.

1. Recommendations for Surgery for Native Valve Endocarditis*

Class I

1. Acute AR or MR with heart failure.
2. Acute AR with tachycardia and early closure of the mitral valve.
3. Fungal endocarditis.
4. Evidence of annular or aortic abscess, sinus or aortic true or false aneurysm.
5. Evidence of valve dysfunction and persistent infection after a prolonged period (7 to 10 days) of appropriate antibiotic therapy, as indicated by the presence of fever, leukocytosis, and bacteremia, provided there are no noncardiac causes for infection.

Class IIa

1. Recurrent emboli after appropriate antibiotic therapy.
2. Infection with gram-negative organisms or organisms that respond poorly to antibiotics in patients with evidence of valve dysfunction.

Class IIb

Mobile vegetations >10 mm.

Class III

1. Early infections of the mitral valve that can likely be repaired.
2. Persistent fever and leukocytosis with negative blood cultures.

**Criteria also apply to repaired mitral and aortic allograft or autograft valves. Endocarditis is defined by clinical criteria with or without laboratory verification; there must be evidence of impaired function of a cardiac valve.*

2. Recommendations for Surgery for Prosthetic Valve Endocarditis*

Class I

1. Early prosthetic valve endocarditis (≤2 months after surgery).
2. Heart failure with prosthetic valve dysfunction.
3. Fungal endocarditis.
4. Staphylococcal endocarditis not responding to antibiotic therapy.
5. Evidence of paravalvular leak, annular or aortic abscess, sinus or aortic true or false aneurysm, fistula formation, or new-onset conduction disturbances.
6. Infection with gram-negative organisms or organisms that respond poorly to antibiotics.

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Class IIa	1. Persistent bacteremia after a prolonged course (7 to 10 days) of appropriate antibiotic therapy without noncardiac causes for bacteremia. 2. Recurrent peripheral embolus despite therapy.
Class IIb	Vegetation of any size on or near the prosthesis.

**Criteria exclude repaired mitral valves or aortic allograft or autograft valves. Endocarditis is defined by clinical criteria with or without laboratory verification.*

F. Major Criteria for Valve Selection

In general, mitral valve repair is preferable to replacement, provided that it is feasible and the appropriate skill and experience are available to perform the procedure successfully.

The major advantages of a mechanical valve are an extremely low rate of structural deterioration and a better survival rate in younger patients. The major disadvantages are increased incidence of bleeding due to the need for antithrombotic therapy and the cost and disadvantages of antithrombotic therapy.

The major advantage of a bioprosthesis (whether porcine or pericardial) is the lack of need for antithrombotic therapy. In addition, the rate of structural valve deterioration in the aortic position in patients ≥65 years of age is lower than in patients <65 years. The major disadvantage is the increased rate of structural valve deterioration and hence the need for reoperation in patients <65 years, particularly those 50 or younger. Pericardial bioprostheses may have a lower rate of structural valve deterioration than porcine bioprostheses in patients ≥65 years. Factors associated with a particularly accelerated rate of structural valve deterioration include

- Adolescent patients who are still growing
- Renal failure, especially in patients on hemodialysis
- Hypercalcemia

Pregnancy poses a difficult problem. The disadvantages of a mechanical valve are the complications of warfarin or heparin therapy, which may affect the patient and/or fetus. The disadvantage of a bioprosthesis is the relatively higher rate of early structural valve deterioration. The Ross procedure (pulmonary autograft) or an aortic valve homograft is associated with a lower rate of such complications in young women and does not require anticoagulation. These procedures are strongly recommended for women who wish to become pregnant, provided that the necessary surgical skill and experience in performing these procedures are available.

If the patient needs antithrombotic therapy for any reason, eg, atrial fibrillation or the presence of a mechanical valve in another position, the major advantage of a biological valve is reduced substantially.

1. Recommendations for Valve Replacement With a Mechanical Prosthesis

Class I	1. Patients with an expected long life span. 2. Patients with a mechanical prosthetic valve already in place in a position different from that of the valve to be replaced.
Class IIa	1. Patients in renal failure, on hemodialysis, or with hypercalcemia. 2. Patients requiring warfarin therapy because of risk factors* for thromboembolism. 3. Patients ≤65 years for AVR and ≤70 years for MVR.†
Class IIb	Valve rereplacement for biological valve with thrombosis.
Class III	Patients who cannot or will not take warfarin therapy.

**Risk factors: atrial fibrillation, severe LV dysfunction, previous thromboembolism, and hypercoagulable condition.*

†The age at which patients may be considered for bioprosthetic valves is based on the major reduction in rate of structural valve deterioration after age 65 and the increased risk of bleeding in this age group.

2. Recommendations for Valve Replacement With a Bioprosthesis

Class I	1. Patients who cannot or will not take warfarin therapy. 2. Patients ≥65 years of age* who need AVR and do not have risk factors† for thromboembolism.
Class IIa	1. Patients considered to have possible compliance problems with warfarin therapy. 2. Patients >70 years of age* who need MVR and do not have risk factors† for thromboembolism.
Class IIb	1. Valve rereplacement for mechanical valve with thrombosis. 2. Patients <65 years of age.*
Class III	1. Patients in renal failure, on hemodialysis, or with hypercalcemia. 2. Adolescent patients who are still growing.

**The age at which patients should be considered for bioprosthetic valves is based on the major reduction in rate of structural valve deterioration after age 65 and the increased risk of bleeding in this age group.*

†Risk factors: atrial fibrillation, severe LV dysfunction, previous thromboembolism, and hypercoagulable condition.

IV. Antithrombotic Management of Prosthetic Heart Valves

A. Indications for Anticoagulation in Patients With Prosthetic Heart Valves

All patients with mechanical valves require warfarin therapy. The risk of embolism is greater with a valve in the mitral position (mechanical or biological) than in the aortic position. With either type of prosthesis or valve location, the risk of emboli is higher in the first few days and months after valve insertion.

Low-dose aspirin is recommended for all patients with prosthetic valves (*see Table 1*). For patients with mechanical valves, the addition of low-dose aspirin (80 to 100 mg/d) to warfarin therapy (INR 2.0 to 3.5) not only further decreases the risk of thromboembolism but also decreases mortality due to other cardiovascular diseases. A slight increase in risk of bleeding with this combination should be kept in mind.

Recommendations for Antithrombotic Therapy in Patients With Prosthetic Heart Valves

Class I	**1. First 3 months after valve replacement:**	Warfarin, INR 2.5 to 3.5
	2. 3 or more months after valve replacement:	
	A. Mechanical valve	
	■ AVR and no risk factor*:	
	▫ Bileaflet valve or Medtronic Hall valve	Warfarin, INR 2 to 3
	▫ Other disk valves or Starr-Edwards valve	Warfarin, INR 2.5 to 3.5
	■ AVR and risk factor*	Warfarin, INR 2.5 to 3.5
	■ MVR	Warfarin, INR 2.5 to 3.5
	B. Bioprosthesis	
	■ AVR and no risk factor*	Aspirin, 80 to 100 mg/d
	■ AVR and risk factor*	Warfarin, INR 2 to 3
	■ MVR and no risk factor*	Aspirin, 80 to 100 mg/d
	■ MVR and risk factor*	Warfarin, INR 2.5 to 3.5
Class IIa	**1. Addition of aspirin to warfarin:**	Aspirin, 80 to 100 mg daily
	2. High-risk patients for whom aspirin cannot be used:	Warfarin, INR 3.5 to 4.5

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Class IIb	**Starr–Edwards AVR and no risk factor***	Warfarin, INR 2 to 3
Class III	**1. Mechanical valve, no warfarin therapy.**	
	2. Mechanical valve, aspirin therapy only.	
	3. Bioprosthesis, no warfarin and no aspirin therapy.	

**Risk factors: atrial fibrillation, severe LV dysfunction, previous thromboembolism, and hypercoagulable condition.*

B. Embolic Events During Adequate Antithrombotic Therapy

For patients who have definite embolic episodes while on adequate antithrombotic therapy, the dosage of antithrombotic therapy should be increased as follows:

Warfarin, INR 2 to 3: increase warfarin dose to achieve an INR of 2.5 to 3.5

Warfarin, INR 2.5 to 3.5: may need to increase warfarin dose to achieve an INR of 3.5 to 4.5

Not on aspirin: Initiate aspirin, 80 to 100 mg/d

Warfarin plus aspirin 80 to 100 mg/d: may also need to increase aspirin dose to 325 mg/d if the higher dose of warfarin is not achieving the desired clinical result

Aspirin alone: may need to increase aspirin dose to 325 mg/d and/or add warfarin to achieve an INR of 2 to 3

C. Excessive Anticoagulation

In most patients with an INR above the therapeutic range, excessive anticoagulation can be managed by withholding warfarin and monitoring the level of anticoagulation with serial determinations of INR. Rapid decreases in INR to less than the therapeutic level increase the risk of thromboembolism. Patients with an INR of 5 to 10 who are not bleeding can be managed as follows:

- Withhold warfarin and administer 2.5 mg of oral vitamin K_1.
- Determine INR after 24 hours and subsequently as needed.
- Restart warfarin and adjust dose appropriately to ensure that INR is in the therapeutic range.
- In emergencies, use of fresh frozen plasma is preferable to high-dose vitamin K_1, especially parenteral vitamin K_1.

D. Antithrombotic Therapy in Patients Requiring Noncardiac Surgery/Dental Care

Antithrombotic therapy should not be stopped for procedures in which bleeding is unlikely or would be inconsequential if it occurred. When bleeding is likely or its potential consequences are severe, antithrombotic treatment should be altered (*see Table 2*).

1. Patients on aspirin:

- Discontinue aspirin 1 week before the procedure and restart it as soon as it is considered safe by the surgeon or dentist.

2. Patients on warfarin:

- Stop warfarin before the procedure so that the INR is ≤1.5, and restart it within 24 hours after the procedure.
- Admission to the hospital or a delay in discharge to give heparin is usually unnecessary.
- Heparin is usually reserved for patients with the following:
  - Recent thrombosis or embolus (arbitrarily within 1 year)
  - Demonstrated thrombotic problems when therapy was previously stopped
  - Björk-Shiley valve
  - ≥3 risk factors*
  - Mechanical valve in the mitral position with 1 risk factor*
- When used, administer heparin as follows:
  - Start heparin when INR falls below 2 (ie, usually 48 hours before surgery).
  - Stop heparin 4 to 6 hours before the procedure.
  - Restart heparin as early after surgery as bleeding stability allows; maintain the aPPT at 55 to 70 seconds until warfarin is restarted.
  - After an overlap of 3 to 5 days, heparin may be discontinued when the desired INR is achieved. To minimize time in the hospital, heparin (and warfarin) can be administered and managed at home.
  - Low-molecular-weight heparin is attractive, but in the absence of data in patients with prosthetic heart valves, it cannot be recommended at this time.
- Vitamin K_1 should not be given because it may create a hypercoagulable condition. For emergencies, fresh frozen plasma is preferable to high-dose vitamin K_1.

**Risk factors: atrial fibrillation, previous thromboembolism, hypercoagulable condition, LV dysfunction, and mechanical prosthesis.*

E. Thrombosis of Prosthetic Heart Valves

Thrombolytic therapy for a prosthetic valve obstructed by a thrombus is associated with significant risks and is often ineffective.

1. Indications for immediate reoperation:

- Patients with a large clot
- Patients with evidence of valve obstruction
- Patients with NYHA functional class III or IV symptoms due to prosthetic thrombosis

2. Thrombolytic therapy

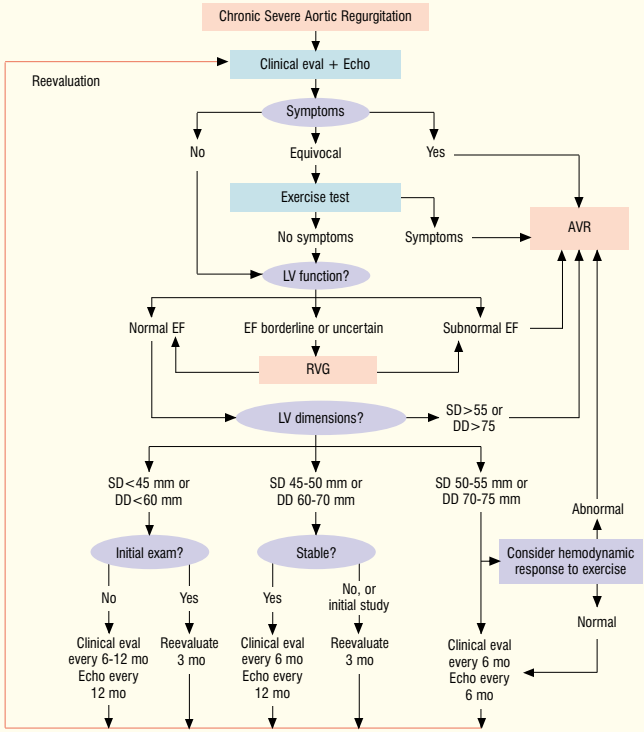
Thrombolytic therapy is reserved for patients for whom surgical intervention carries a high risk and those with contraindications to surgery.

- Duration of thrombolytic therapy depends on resolution of pressure gradients and valve areas to near normal by Doppler echocardiography.
- Stop thrombolytic therapy at 24 hours if there is no hemodynamic improvement or after 72 hours even if hemodynamic recovery is incomplete.
- If thrombolytic therapy is successful, administer intravenous heparin until warfarin achieves an INR of 3 to 4 for aortic prosthetic valves and 3.5 to 4.5 for mitral prosthetic valves.
- If partially successful, thrombolytic therapy may be followed by a combination of subcutaneous heparin twice daily (to achieve an aPTT of 55 to 80 seconds) plus warfarin (INR 2.5 to 3.5) for a 3-month period.

3. Patients with a small clot

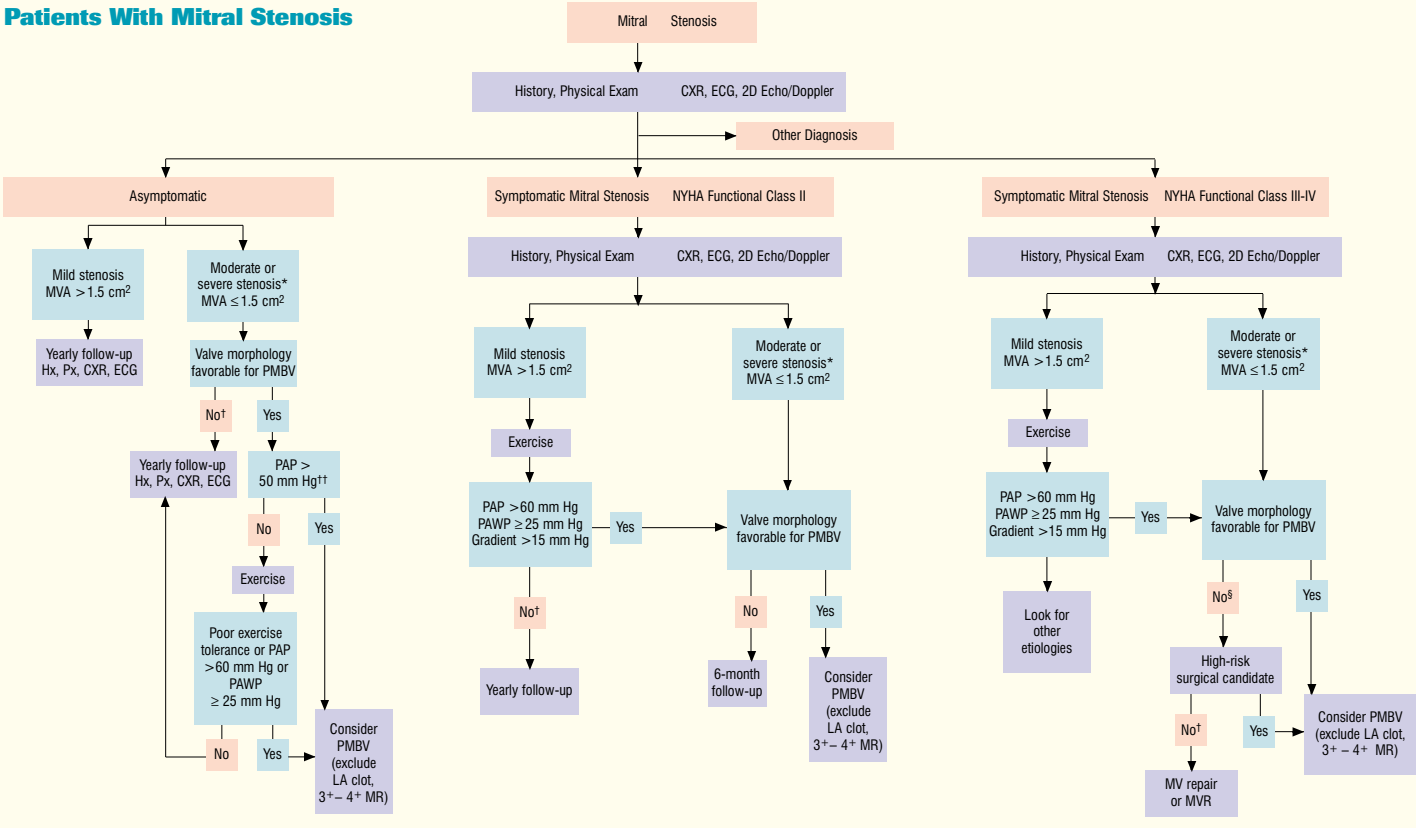
- Patients with a small clot who are in NYHA functional class I or II should receive in-hospital, short-term intravenous heparin therapy.
- If this is unsuccessful, give either
  - A trial of continuous-infusion thrombolytic therapy over several days, or
  - For patients who remain hemodynamically stable, combined therapy with subcutaneous heparin (twice daily to an aPTT of 55 to 80 seconds) and warfarin (INR 2.5 to 3.5) for 1 to 3 months on an outpatient basis
- If intravenous heparin, heparin/thrombolytic therapy, or heparin/warfarin is successful:
  - Increase warfarin doses to an INR of 3 to 4 (≈3.5) for prosthetic aortic valves and between 3.5 and 4.5 (≈4) for prosthetic mitral valves.
  - Add aspirin, 80 to 100 mg.

Figure 1: Management Strategy for Patients With Chronic Severe Aortic Regurgitation



Abbreviations: AVR = aortic valve replacement, DD = end-diastolic dimension, EF = ejection fraction, LV = left ventricular, RVG = radionuclide ventriculography, SD = end-systolic dimension.

Figure 2: Management Strategy for Patients With Mitral Stenosis



Abbreviations: CXR = chest x-ray, ECG = electrocardiogram, Hx = History, LA = left atrial, MR = mitral regurgitation, MV = mitral valve, MVA = mitral valve area, MVR = mitral valve replacement, NYHA = New York Heart Association, PAP = pulmonary artery pressure, PAWP = pulmonary artery wedge pressure, PMBV = percutaneous mitral balloon valvotomy, Px = physical examination

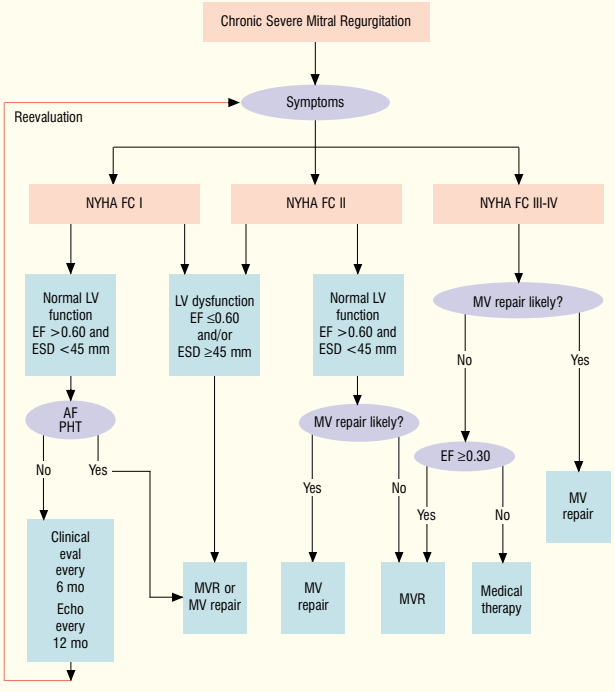
*Because there may be variability in the measurement of MVA, it is important to consider the mean transmitral gradient, PAWP, and PAP.

† There is controversy as to whether patients with severe MS (MVA <1.0 cm^2) and severe pulmonary hypertension (PAP >60 to 80 mm Hg) should undergo MVR to prevent right ventricular failure.

‡ Assuming no other cause for pulmonary hypertension is present.

§ There is controversy as to which patients with less favorable valve morphology should undergo PMBV rather than mitral valve surgery (see text).

Figure 3. Management Strategy for Patients With Chronic Severe Mitral Regurgitation



Abbreviations: AF = atrial fibrillation, EF = ejection fraction, ESD = end-systolic diameter, FC = functional class, LV = left ventricular, MV = mitral valve, MVR = mitral valve replacement, NYHA = New York Heart Association, PHT = pulmonary hypertension.

Table 1. Antithrombotic Therapy: Prosthetic Heart Valves

	Warfarin (INR 2-3)	Warfarin (INR 2.5-3.5)	Aspirin (80-100 mg)
Mechanical Prosthetic Valves			
A. First 3 months after replacement		+	+
B. After first 3 months:			
1. Aortic valve*	+		+
2. Aortic valve + "risk factor"†		+	+
3. Mitral valve		+	+
4. Mitral valve + "risk factor"		+	+
Biological Prosthetic Valves			
A. First 3 months after replacement		+	+
B. After first 3 months:			
1. Aortic valve*			+
2. Aortic valve + "risk factor"†	+		+
3. Mitral valve			+
4. Mitral valve + "risk factor"		+	+

Note: Depending on patient's clinical status, antithrombotic therapy must be individualized (see special situations in text).

* INR should be maintained between 2.5 and 3.5 for aortic disk valves and Starr-Edward valves.
† Risk factors: Atrial fibrillation, LV dysfunction, previous thromboembolism, and hypercoagulable condition.

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Table 2. Antithrombotic Therapy in Patients Requiring Noncardiac Surgery/Dental Care

Usual Approach

1. If patient on warfarin

- Stop 72 h before procedure
- Restart in the afternoon on the day of procedure or after control of active bleeding

2. If patient on aspirin

- Stop 1 wk before procedure
- Restart the day after procedure or after control of active bleeding

Unusual Circumstances

1. Very high risk of thrombosis if off warfarin*

- Stop warfarin 72 h before procedure
- Start heparin when INR falls below 2.0†
- Stop heparin 6 h before procedure
- Restart heparin within 24 h of procedure and continue until warfarin can be restarted and INR ≥2.0

2. Surgery complicated by postoperative bleeding

- Start heparin as soon after surgery as deemed safe and maintain PTT at 55-70 s until warfarin restarted and INR ≥2.0.

3. Very low risk from bleeding‡

- Continue antithrombotic therapy

*Clinical judgment: consider this approach if recent thromboembolus, Björk-Shiley valve, or 3 risk factors are present. Risk factors are atrial fibrillation, LV dysfunction, previous thromboembolism, hypercoagulable condition, and mechanical prosthesis. One risk factor is sufficient to consider heparin in patients with mechanical valves in mitral position. †Heparin can be given in outpatient setting before and after surgery. ‡Eg, local skin surgery, teeth cleaning, and treatment for caries. From McAnulty JH, Rahimtoola SH. Antithrombotic therapy in valvular heart disease. In: Schlant R, Alexander RW, eds. *Hurst's The Heart Arteries, and Veins.* 9th ed. New York, NY: McGraw-Hill Publishing Co; 1998:1867-1874. With permission.