Agency for Healthcare Research and Quality
Advancing Excellence in Health Care

NATIONAL GUIDELINE CLEARINGHOUSE

# General

## Guideline Title

2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines.

## Bibliographic Source(s)

Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Guyton RA, O'Gara PT, Ruiz CE, Skubas NJ, Sorajja P, Sundt TM, Thomas JD, American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2014 Jun 10;63(22):e57-185. PubMed

## Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr, Faxon DP, Freed MD, Gaasch WH, Lytle BW, Nishimura RA, O'Gara PT, O'Rourke RA, Otto CM, Shah PM, Shanewise JS, American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines [trunc]. J Am Coll Cardiol. 2008 Sep 23;52(13):e1-142. [1067 references]

# Regulatory Alert

## FDA Warning/Regulatory Alert

Note from the National Guideline Clearinghouse: This guideline references a drug(s) for which important revised regulatory and/or warning information has been released.

- December 14, 2016 – General anesthetic and sedation drugs: The U.S. Food and Drug Administration (FDA) is warning that repeated or lengthy use of general anesthetic and sedation drugs during surgeries or procedures in children younger than 3 years or in pregnant women during their third trimester may affect the development of children's brains. Consistent with animal studies, recent human studies suggest that a single, relatively short exposure to general anesthetic and sedation drugs in infants or toddlers is unlikely to have negative effects on behavior or learning. However, further research is needed to fully characterize how early life anesthetic exposure affects children's brain development.

# Recommendations

## Major Recommendations

Note from the National Guideline Clearinghouse (NGC) and the American College of Cardiology (ACC) and the American Heart Association (AHA): Two guidelines from the ACC, the AHA, and collaborating societies address the risk of aortic dissection in patients with bicuspid aortic valves and severe aortic enlargement: the "2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM Guidelines for the Diagnosis and Management of Patients With Thoracic Aortic Disease" and the "2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease." However, the 2 guidelines differ with regard to the recommended threshold of aortic root or ascending aortic dilatation that would justify surgical intervention in patients with bicuspid aortic valves. The ACC and AHA therefore convened a subcommittee representing members of the 2 guideline writing committees to review the evidence, reach consensus, and draft a statement of clarification for both guidelines. This statement of clarification uses the ACC/AHA revised structure for delineating the Class of Recommendation and Level of Evidence to provide recommendations that replace the intervention recommendations in the Bicuspid Aortic Valve section, below. See the ACC/AHA Statement of Clarification in the "Availability of Companion Documents" field.

Definitions for the levels of the evidence (A–C) and classes of recommendations (I–III) are provided at the end of the "Major Recommendations" field.

General Principles

Diagnosis and Follow-up

*Diagnostic Testing–Initial Diagnosis*

Class I

1. Transthoracic echocardiography (TTE) is recommended in the initial evaluation of patients with known or suspected valvular heart disease (VHD) to confirm the diagnosis, establish etiology, determine severity, assess hemodynamic consequences, determine prognosis, and evaluate for timing of intervention (Carabello et al., 1986; Currie et al., "Continuous-wave Doppler determination," 1985; Currie et al., "Continuous-wave Doppler echocardiographic," 1985; Dujardin et al., 1997; Enriquez-Sarano et al., 2005; Enriquez-Sarano et al., "Echocardiographic prediction of left ventricular function," 1994; Nishimura et al., 1994; Oh et al., 1988; Otto et al., 1997; Otto et al., 1991; Otto et al., 1986; Otto, Pearlman, & Gardner, 1989; Pellikka et al., 2005; Zile et al., 1984; Dujardin et al., 1999; Bonow et al., 1991). (*Level of Evidence: B*)

*Diagnostic Testing–Changing Signs or Symptoms*

Class I

1. TTE is recommended in patients with known VHD with any change in symptoms or physical examination findings. (*Level of Evidence: C*)

*Diagnostic Testing–Routine Follow-up*

Class I

1. Periodic monitoring with TTE is recommended in asymptomatic patients with known VHD at intervals depending on valve lesion, severity, ventricular size, and ventricular function. (*Level of Evidence: C*)

*Diagnostic Testing–Cardiac Catheterization*

Class I

1. 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. (*Level of Evidence: C*)

*Diagnostic Testing–Exercise Testing*

Class IIa

1. 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 (Aviles et al., 2001; Otto et al., 1992; Lancellotti et al., 2005; Marechaux et al., 2010; Messika-Zeitoun et al., 2006). (*Level of Evidence: B*)

Basic Principles of Medical Therapy

*Secondary Prevention of Rheumatic Fever*

Class I

1. Secondary prevention of rheumatic fever is indicated in patients with rheumatic heart disease, specifically mitral stenosis (MS) (see Tables 5 and 6 in the original guideline document) (Gerber et al., 2009). (*Level of Evidence: C*)

*Infective Endocarditis (IE) Prophylaxis*

Class IIa

1. Prophylaxis against IE is reasonable for the following patients at highest risk for adverse outcomes from IE before dental procedures that involve manipulation of gingival tissue, manipulation of the periapical region of teeth, or perforation of the oral mucosa (Horstkotte, 1987; Strom et al., 1998; Duval et al., 2006) (*Level of Evidence: B*):
    - Patients with prosthetic cardiac valves
    - Patients with previous IE
    - Cardiac transplant recipients with valve regurgitation due to a structurally abnormal valve
    - Patients with congenital heart disease with:
        - Unrepaired cyanotic congenital heart disease, including palliative shunts and conduits
        - Completely repaired congenital heart defect repaired with prosthetic material or device, whether placed by surgery or catheter intervention, during the first 6 months after the procedure
        - Repaired congenital heart disease with residual defects at the site or adjacent to the site of a prosthetic patch or prosthetic device

Class III: No Benefit

1. Prophylaxis against IE is not recommended in patients with VHD who are at risk of IE for nondental procedures (e.g., transesophageal echocardiography [TEE], esophagogastroduodenoscopy, colonoscopy, or cystoscopy) in the absence of active infection (Guarner-Argente et al., 2011). (*Level of Evidence: B*)

The Heart Valve Team and Heart Valve Centers of Excellence

Class I

1. Patients with severe VHD should be evaluated by a multidisciplinary Heart Valve Team when intervention is considered. (*Level of Evidence: C*)

Class IIa

1. 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. (*Level of Evidence: C*)

Aortic Stenosis (AS)

See Table 8 in the original guideline document for the stages of valvular AS.

Diagnosis and Follow-up

*Diagnostic Testing–Initial Diagnosis*

Class I

1. 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, left ventricular (LV) size, and systolic function, and for determining prognosis and timing of valve intervention (Oh et al., 1988; Otto et al., 1997; Galan, Zoghbi, & Quinones, 1991). (*Level of Evidence: B*)

Class IIa

1. Low-dose dobutamine stress testing using echocardiographic or invasive hemodynamic measurements is reasonable in patients with stage D2 AS with all of the following (Lin et al., 1998; Monin et al., 2001; Clavel et al., 2008) (*Level of Evidence: B*):
    a. Calcified aortic valve with reduced systolic opening
    b. Left ventricular ejection fraction (LVEF) <50%
    c. Calculated valve area ≤1.0 $cm^2$
    d. Aortic velocity <4.0 m per second or mean pressure gradient <40 mm Hg

*Diagnostic Testing–Exercise Testing*

Class IIa

1. 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) (Otto et al., 1997; Lancellotti et al., 2005; Marechaux et al., 2010; Das, Rimington, & Chambers, 2005). (*Level of Evidence: B*)

Class III: Harm

1. 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) (Atterhog, Jonsson, & Samuelsson, 1979). (*Level of Evidence: B*)

Medical Therapy

Class I

1. 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 guideline-directed medical therapy (GDMT), started at a low dose, and gradually titrated upward as needed with frequent clinical monitoring (O'Brien et al., 2004; Chockalingam et al., 2004; Nadir et al., 2011). (*Level of Evidence: B*)

Class IIb

1. 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. (*Level of Evidence: C*)

Class III: No Benefit

1. 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) (Rossebo et al., 2008; Cowell et al., 2005; Chan et al., 2010). (*Level of Evidence: A*)

Timing of Intervention

Class I

1. Aortic valve replacement (AVR) is recommended in symptomatic patients with severe AS (stage D1) with (Zoghbi et al., 2009; Otto & Pearlman, 1988; Turina et al., 1987; Kelly et al., 1988) (*Level of Evidence: B*):
    a. Decreased systolic opening of a calcified or congenitally stenotic aortic valve
    b. An aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher
    c. Symptoms of HF, syncope, exertional dyspnea, angina, or presyncope by history or on exercise testing
2. AVR is recommended for asymptomatic patients with severe AS (stage C2) and an LVEF less than 50% with decreased systolic opening of a calcified aortic valve with an aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher (Connolly et al., 1997; Tribouilloy et al., "Outcome," 2009). (*Level of Evidence: B*)
3. AVR is indicated for patients with severe AS (stage C or D) when undergoing cardiac surgery for other indications when there is decreased systolic opening of a calcified aortic valve and an aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher (Rosenhek et al., 2000; Smith et al., 2004). (*Level of Evidence: B*)

Class IIa

1. AVR is reasonable for asymptomatic patients with very severe AS (stage C1) with (Lancellotti et al., 2010; Rosenhek et al., 2010) (*Level of Evidence: B*):
    a. Decreased systolic opening of a calcified valve
    b. An aortic velocity 5.0 m per second or greater or mean pressure gradient 60 mm Hg or higher

   c. A low surgical risk
2. AVR is reasonable in apparently asymptomatic patients with severe AS (stage C1) with (Otto et al., 1997; Marechaux et al., 2010) (*Level of Evidence: B*):
   a. A calcified aortic valve
   b. An aortic velocity of 4.0 m per second to 4.9 m per second or mean pressure gradient of 40 mm Hg to 59 mm Hg
   c. An exercise test demonstrating decreased exercise tolerance or a fall in systolic blood pressure (BP)
3. AVR is reasonable in symptomatic patients with low-flow/low-gradient severe AS with reduced LVEF (stage D2) with a (Nishimura et al., 2002; Monin et al., 2003; Fougeres et al., 2012) (*Level of Evidence: B*):
   a. Calcified aortic valve with reduced systolic opening
   b. Resting valve area 1.0 $cm^2$ or less
   c. Aortic velocity less than 4 m per second or mean pressure gradient less than 40 mm Hg
   d. LVEF less than 50%
   e. A low-dose dobutamine stress study that shows an aortic velocity 4 m per second or greater or mean pressure gradient 40 mm Hg or higher with a valve area 1.0 $cm^2$ or less at any dobutamine dose
4. AVR is reasonable in symptomatic patients with low-flow/low-gradient severe AS (stage D3) with an LVEF 50% or greater, a calcified aortic valve with significantly reduced leaflet motion, and a valve area 1.0 $cm^2$ or less only if clinical, hemodynamic, and anatomic data support valve obstruction as the most likely cause of symptoms and data recorded when the patient is normotensive (systolic BP <140 mm Hg) indicate (*Level of Evidence: C*):
   a. An aortic velocity less than 4 m per second or mean pressure gradient less than 40 mm Hg
   b. A stroke volume index less than 35 $mL/m^2$
   c. An indexed valve area 0.6 $cm^2/m^2$ or less
5. AVR is reasonable for patients with moderate AS (stage B) with an aortic velocity between 3.0 m per second and 3.9 m per second or mean pressure gradient between 20 mm Hg and 39 mm Hg who are undergoing cardiac surgery for other indications. (*Level of Evidence: C*)

<u>Class IIb</u>

1. AVR may be considered for asymptomatic patients with severe AS (stage C1) with an aortic velocity 4.0 m per second or greater or mean pressure gradient 40 mm Hg or higher if the patient is at low surgical risk and serial testing shows an increase in aortic velocity 0.3 m per second or greater per year. (*Level of Evidence: C*)

Choice of Intervention

<u>Class I</u>

1. Surgical AVR is recommended in patients who meet an indication for AVR with low or intermediate surgical risk (O'Brien et al., 2009; Horstkotte & Loogen, 1988). (*Level of Evidence: A*)
2. For patients in whom transcatheter aortic valve replacement (TAVR) or high-risk surgical AVR is being considered, a Heart Valve Team consisting of an integrated, multidisciplinary group of healthcare professionals with expertise in VHD, cardiac imaging, interventional cardiology, cardiac anesthesia, and cardiac surgery should collaborate to provide optimal patient care. (*Level of Evidence: C*)
3. TAVR is recommended in patients who meet an indication for AVR who have a prohibitive risk for surgical AVR and a predicted post-TAVR survival greater than 12 months (Kodali et al., 2012; Leon et al., 2010). (*Level of Evidence: B*)

<u>Class IIa</u>

1. TAVR is a reasonable alternative to surgical AVR in patients who meet an indication for AVR and who have high surgical risk for surgical AVR (Makkar et al., 2012; Smith et al., 2011). (*Level of Evidence: B*)

<u>Class IIb</u>

1. Percutaneous aortic balloon dilation may be considered as a bridge to surgical AVR or TAVR in patients with severe symptomatic AS. (*Level of Evidence: C*)

<u>Class III: No Benefit</u>

1. TAVR is not recommended in patients in whom existing comorbidities would preclude the expected benefit from correction of AS (Kodali et al., 2012). (*Level of Evidence: B*)

Aortic Regurgitation (AR)

Chronic AR

*Diagnosis and Follow-up*

Diagnostic Testing–Initial Diagnosis

Class I

1. 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 (Bonow et al., 1991; Detaint et al., 2008; Pizarro et al., 2011; Teague et al., 1986; Bonow et al., 1983; Scognamiglio, Fasoli, & Dalla, 1986; Siemienczuk et al., 1989; Tornos et al., 1995; Ishii et al., 1996; Scognamiglio et al., 1994; Borer et al., 1998). (*Level of Evidence: B*)
2. 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 (Attenhofer et al., 2000). (*Level of Evidence: B*)
3. Cardiac magnetic resonance (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 (Gelfand et al., 2006; Cawley et al., 2013). (*Level of Evidence: B*)

*Medical Therapy*

Class I

1. 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) (Scognamiglio et al., 1994; Evangelista et al., 2005). (*Level of Evidence: B*)

Class IIa

1. 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 (Sondergaard et al., 2000; Elder et al., 2011). (*Level of Evidence: B*)

*Timing of Intervention*

Class I

1. AVR is indicated for symptomatic patients with severe AR regardless of LV systolic function (stage D) (Dujardin et al., 1999; Greves et al., 1981; Klodas et al., 1997). (*Level of Evidence: B*)
2. AVR is indicated for asymptomatic patients with chronic severe AR and LV systolic dysfunction (LVEF <50%) at rest (stage C2) if no other cause for systolic dysfunction is identified (Forman, Firth, & Barnard, 1980; Greves et al., 1981; Chaliki et al., 2002; Bhudia et al., 2007). (*Level of Evidence: B*)
3. AVR is indicated for patients with severe AR (stage C or D) while undergoing cardiac surgery for other indications. (*Level of Evidence: C*)

Class IIa

1. AVR is reasonable for asymptomatic patients with severe AR with normal LV systolic function (LVEF ≥50%) but with severe LV dilation (left ventricular end-systolic dimension [LVESD] >50 mm or indexed LVESD >25 mm/m$^2$) (stage C2) (Van Rossum et al., 1988; Bonow et al., 1988; Gaasch et al., 1983). (*Level of Evidence: B*)
2. AVR is reasonable in patients with moderate AR (stage B) while undergoing surgery on the ascending aorta, coronary artery bypass graft (CABG), or mitral valve surgery. (*Level of Evidence: C*)

Class IIb

1. AVR may be considered for asymptomatic patients with severe AR and normal LV systolic function at rest (LVEF ≥50%, stage C1) but with progressive severe LV dilatation (LV end-diastolic dimension >65 mm) if surgical risk is low. (*Level of Evidence: C*)

Bicuspid Aortic Valve and Aortopathy

Bicuspid Aortic Valve

*Diagnosis and Follow-up*

Diagnostic Testing–Initial Diagnosis

Class I

1. 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 (Pachulski, Weinberg, & Chan, 1991; Hahn et al., 1992; Nistri et al., 1999; Keane et al., 2000; Novaro et al., 2003; Schaefer et al., 2008). (*Level of Evidence: B*)
2. Aortic magnetic resonance angiography or computed tomography (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. (*Level of Evidence: C*)

Diagnostic Testing–Routine Follow-up

1. 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. (*Level of Evidence: C*)

*Intervention*

Note: The following 3 recommendations (Class I and Class IIa below) on surgery for aortic dilatation in patients with bicuspid aortic valves have been updated and replaced. See the ACC/AHA Statement of Clarification in the "Availability of Companion Documents" field for further information, including the updated recommendations.

Class I

1. 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 (Tzemos et al., 2008; Michelena et al., 2011; Davies et al., 2002). (*Level of Evidence: B*)

Class IIa

1. 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). (*Level of Evidence: C*)
2. 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 if the diameter of the ascending aorta is greater than 4.5 cm. (*Level of Evidence: C*)

Mitral Stenosis (MS)

Rheumatic MS

*Diagnosis and Follow-up*

Diagnostic Testing–Initial Diagnosis

Class I

1. 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) (Baumgartner et al., 2009; Sugeng et al., 2003; Schlosshan et al., 2011; Leavitt, Coat, & Falk, 1991; Chung, Karamanoglu, & Kovacs, 2004; Zoghbi et al., 2009; Wilkins et al., 1988; Abascal et al., 1990; Cannan et al., 1997; Thomas et al., 1988). (*Level of Evidence: B*)
2. 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 (MR) (Schlosshan et al., 2011; Ellis et al., 2006; Kronzon et al., 1990; Tessier et al., 1994). (*Level of Evidence: B*)

Diagnostic Testing–Exercise Testing

1. 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. (*Level of Evidence: C*)

*Medical Therapy*

Class I

1. Anticoagulation (vitamin K antagonist [VKA] or heparin) is indicated in patients with 1) MS and atrial fibrillation (AF) (paroxysmal, persistent, or permanent), 2) MS and a prior embolic event, or 3) MS and a left atrial thrombus (Wilson & Greenwood, 1954; Rowe et al., 1960; Olesen, 1962; Szekely, 1964; Perez-Gomez et al., 2004; Omran et al., 2000; Singer et al., 2008). (*Level of Evidence: B*)

Class IIa

1. Heart rate control can be beneficial in patients with MS and AF and fast ventricular response. (*Level of Evidence: C*)

Class IIb

1. Heart rate control may be considered for patients with MS in normal sinus rhythm and symptoms associated with exercise (Stoll et al., 1995; Monmeneu Menadas et al., 2002). (*Level of Evidence: B*)

*Intervention*

Class I

1. Percutaneous mitral balloon commissurotomy is recommended for symptomatic patients with severe MS (mitral valve area ≤1.5 $cm^2$, stage D) and favorable valve morphology in the absence of left atrial thrombus or moderate-to-severe MR (Arora et al., 1993; Turi et al., 1991; Patel et al., 1991; Ben Farhat et al., 1998; Cotrufo et al., 1999; Reyes et al., 1994; Bouleti et al., 2012). (*Level of Evidence: A*)
2. Mitral valve surgery (repair, commissurotomy, or valve replacement) is indicated in severely symptomatic patients (NYHA class III to IV) with severe MS (mitral valve area ≤1.5 $cm^2$, stage D) who are not high risk for surgery and who are not candidates for or who have failed previous percutaneous mitral balloon commissurotomy (Ellis et al., 1973; John et al., 1983; Finnegan et al., 1974; Mullin et al., 1974; Halseth et al., 1980; Gross et al., 1981). (*Level of Evidence: B*)
3. Concomitant mitral valve surgery is indicated for patients with severe MS (mitral valve area ≤1.5 $cm^2$, stage C or D) undergoing cardiac surgery for other indications. (*Level of Evidence: C*)

Class IIa

1. Percutaneous mitral balloon commissurotomy is reasonable for asymptomatic patients with very severe MS (mitral valve area ≤1.0 $cm^2$, stage C) and favorable valve morphology in the absence of left atrial thrombus or moderate-to-severe MR (Abascal et al., 1990; Iung et al., 1996; Arat et al., 2008; Vincens et al., 1995). (*Level of Evidence: C*)
2. Mitral valve surgery is reasonable for severely symptomatic patients (NYHA class III to IV) with severe MS (mitral valve area ≤1.5 $cm^2$, stage D), provided there are other operative indications (e.g., aortic valve disease, coronary artery disease [CAD], tricuspid regurgitation [TR], aortic aneurysm). (*Level of Evidence: C*)

Class IIb

1. Percutaneous mitral balloon commissurotomy may be considered for asymptomatic patients with severe MS (mitral valve area ≤1.5 $cm^2$, stage C) and valve morphology favorable for percutaneous mitral balloon commissurotomy in the absence of left atrial thrombus or moderate-to-severe MR who have new onset of AF. (*Level of Evidence: C*)
2. Percutaneous mitral balloon commissurotomy may be considered for symptomatic patients with mitral valve area greater than 1.5 $cm^2$ if there is evidence of hemodynamically significant MS based on pulmonary artery wedge pressure greater than 25 mm Hg or mean mitral valve gradient greater than 15 mm Hg during exercise. (*Level of Evidence: C*)
3. Percutaneous mitral balloon commissurotomy may be considered for severely symptomatic patients (NYHA class III to IV) with severe MS (mitral valve area ≤1.5 $cm^2$, stage D) who have a suboptimal valve anatomy and who are not candidates for surgery or at high risk for surgery. (*Level of Evidence: C*)

4. Concomitant mitral valve surgery may be considered for patients with moderate MS (mitral valve area 1.6 $cm^2$ to 2.0 $cm^2$) undergoing cardiac surgery for other indications. (*Level of Evidence: C*)
5. Mitral valve surgery and excision of the left atrial appendage may be considered for patients with severe MS (mitral valve area ≤1.5 $cm^2$, stages C and D) who have had recurrent embolic events while receiving adequate anticoagulation. (*Level of Evidence: C*)

Mitral Regurgitation

Chronic Primary MR

*Diagnosis and Follow-up*

Diagnostic Testing–Initial Diagnosis

Class I

1. 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 (Zoghbi et al., 2003; Enriquez-Sarano et al., 2005; Rosenhek et al., 2006; Recusani et al., 1991; Bargiggia et al., 1991; Rivera et al., 1992; Crawford et al., 1990; Enriquez-Sarano et al., "Echocardiographic prediction of survival," 1994; Tribouilloy et al., "Survival," 2009; Grigioni et al., 2008; Ghoreishi et al., 2011; Rozich et al., 1992; Tribouilloy et al., 1999; Pflugfelder et al., 1989; Pu et al., 2001; Pu et al., 1996; Lang et al., 2012; Witkowski et al., 2013; Magne et al., 2012). (*Level of Evidence: B*)
2. 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 (Pflugfelder et al., 1989; Ozdogan et al., 2009; Myerson, Francis, & Neubauer, 2010). (*Level of Evidence: B*)
3. Intraoperative TEE is indicated to establish the anatomic basis for chronic primary MR (stages C and D) and to guide repair (Dahm et al., 1987; Saiki et al., 1998). (*Level of Evidence: B*)
4. 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. (*Level of Evidence: C*)

Diagnostic Testing–Exercise Testing

Class IIa

1. 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) (Tischler et al., 1994; Magne et al., 2010). (*Level of Evidence: B*)
2. Exercise treadmill testing can be useful in patients with chronic primary MR to establish symptom status and exercise tolerance (stages B and C). (*Level of Evidence: C*)

*Medical Therapy*

Class IIa

1. 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 (Tsutsui et al., 1994; Varadarajan et al., 2008; Ahmed et al., 2012; Nemoto et al., 2002; Schon, 1994). (*Level of Evidence: B*)

Class III: No Benefit

1. Vasodilator therapy is not indicated for normotensive asymptomatic patients with chronic primary MR (stages B and C1) and normal systolic LV function (Schon, 1994; Tischler, Rowan, & LeWinter, 1998; Wisenbaugh et al., 1994; Dujardin et al., 2001; Harris, Aeppli, & Carey, 2005; Kizilbash et al., 1998). (*Level of Evidence: B*)

*Intervention*

Class I

1. Mitral valve surgery is recommended for symptomatic patients with chronic severe primary MR (stage D) and LVEF greater than 30% (Tribouilloy et al., 1999; Gillinov et al., 2010). (*Level of Evidence: B*)
2. Mitral valve surgery is recommended for asymptomatic patients with chronic severe primary MR and LV dysfunction (LVEF 30% to 60%

and/or LVESD ≥40 mm, stage C2) (Crawford et al., 1990; Enriquez-Sarano et al., Echocardiographic assessment of survival," 1994; Tribouilloy et al., "Survival," 2009; Grigioni et al., 2008; Grigioni et al., 1999; Schuler et al., 1979; Starling, 1995). (Level of Evidence: B)

3. Mitral valve repair is recommended in preference to MVR when surgical treatment is indicated for patients with chronic severe primary MR limited to the posterior leaflet (Gammie et al., 2009; Rozich et al., 1992; Rushmer, 1956; Hansen et al., 1989; Sarris et al., 1988; Goldman et al., 1987; David et al., 1984; Hennein et al., 1990; Cohn, 1988; Cosgrove et al., 1986; "STS online risk calculator," 2013; David et al., 1983; Horskotte et al., 1993; Vassileva et al., 2013; Braunberger et al., 2001; David et al., 2005; McClure et al., 2013). (*Level of Evidence: B*)
4. Mitral valve repair is recommended in preference to mitral valve replacement (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 (Bolling et al., 2010; Braunberger et al., 2001; David et al., 2005; McClure et al., 2013; Chikwe et al., 2011; Badhwar et al., 2012; Grossi et al., 1998; Chauvaud et al., 2001). (*Level of Evidence: B*)
5. Concomitant mitral valve repair or MVR is indicated in patients with chronic severe primary MR undergoing cardiac surgery for other indications (Gillinov et al., 2003). (*Level of Evidence: B*)

Class IIa

1. Mitral valve 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 greater than 95% with an expected mortality rate of less than 1% when performed at a Heart Valve Center of Excellence (Rosenhek et al., 2006; Bolling et al., 2010; Kang et al., 2009; Gillinov et al., 2008; Duran et al., 1994; Suri et al., 2013; Suri et al., 2009). (*Level of Evidence: B*)
2. Mitral valve repair is reasonable for asymptomatic patients with chronic severe nonrheumatic primary MR (stage C1) and preserved LV function (LVEF >60% and LVESD <40 mm) in whom there is a high likelihood of a successful and durable repair with 1) new onset of AF or 2) resting pulmonary hypertension (pulmonary artery systolic arterial pressure >50 mm Hg) (Ghoreishi et al., 2011; Kang et al., 2009; Ngaage et al., 2007; Raine, Dark, & Bourke, 2004; Cox, 1991; Kobayashi et al., 1996; Kawaguchi et al., 1996; Olasinska-Wisniewska et al., 2012). (*Level of Evidence: B*)
3. Concomitant mitral valve repair is reasonable in patients with chronic moderate primary MR (stage B) when undergoing cardiac surgery for other indications. (*Level of Evidence: C*)

Class IIb

1. Mitral valve surgery may be considered in symptomatic patients with chronic severe primary MR and LVEF less than or equal to 30% (stage D). (*Level of Evidence: C*)
2. Mitral valve 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 when the reliability of long-term anticoagulation management is questionable (Bolling et al., 2010; Vassileva et al., 2013; Chauvaud et al., 2001). (*Level of Evidence: B*)
3. Transcatheter mitral valve repair may be considered for severely symptomatic patients (NYHA class III to IV) with chronic severe primary MR (stage D) who have favorable anatomy for the repair procedure and a reasonable life expectancy but who have a prohibitive surgical risk because of severe comorbidities and remain severely symptomatic despite optimal GDMT for HF (Feldman et al., 2011). (*Level of Evidence: B*)

Class III: Harm

1. MVR should not be performed for the treatment of isolated severe primary MR limited to less than one half of the posterior leaflet unless mitral valve repair has been attempted and was unsuccessful (Gammie et al., 2009; Braunberger et al., 2001; David et al., 2005; McClure et al., 2013). (*Level of Evidence: B*)

Chronic Secondary MR

*Diagnosis and Follow-up*

Class I

1. 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. (*Level of Evidence: C*)
2. 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. (*Level of Evidence: C*)

*Medical Therapy*

Class I

1. Patients with chronic secondary MR (stages B–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 (Rowe et al., 1960; "Effect of enalapril," 1992; Granger et al., 2003; Eriksson et al., 1994; Pitt et al., 1999; Krum et al., 2003). (*Level of Evidence: A*)
2. Cardiac resynchronization therapy with biventricular pacing is recommended for symptomatic patients with chronic severe secondary MR (stages B–D) who meet the indications for device therapy (St John Sutton et al., 2003; van Bommel et al., 2011). (*Level of Evidence: A*)

*Intervention*

Class IIa

1. Mitral valve surgery is reasonable for patients with chronic severe secondary MR (stages C and D) who are undergoing CABG or AVR. (*Level of Evidence: C*)

Class IIb

1. Mitral valve repair or replacement may be considered for severely symptomatic patients (NYHA class III–IV) with chronic severe secondary MR (stage D) who have persistent symptoms despite optimal GDMT for HF (Grigioni et al., 2001; Lancellotti, Gerard, & Pierard, 2005; Trichon et al., 2003; Rossi et al., 2011; Fattouch et al., 2009; Mihaljevic et al., 2007; Wu et al., 2005; Harris et al., 2002; Benedetto et al., 2009; Deja et al., 2012; Cohn et al., 1995; Chan et al., 2012). (*Level of Evidence: B*)
2. Mitral valve repair may be considered for patients with chronic moderate secondary MR (stage B) who are undergoing other cardiac surgery. (*Level of Evidence: C*)

Tricuspid Valve Disease

Tricuspid Regurgitation

*Diagnosis and Follow-up*

Class I

1. 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. (*Level of Evidence: C*)

Class IIa

1. 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. (*Level of Evidence: C*)

Class IIb

1. CMR or real-time 3-dimensional (3D) 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 (2D) echocardiograms. (*Level of Evidence: C*)
2. Exercise testing may be considered for the assessment of exercise capacity in patients with severe TR with no or minimal symptoms (stage C). (*Level of Evidence: C*)

*Medical Therapy*

Class IIa

1. Diuretics can be useful for patients with severe TR and signs of right-sided HF (stage D). (*Level of Evidence: C*)

Class IIb

1. 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). (*Level of Evidence: C*)

*Intervention*

Class I

1. Tricuspid valve surgery is recommended for patients with severe TR (stages C and D) undergoing left-sided valve surgery. (*Level of Evidence: C*)

Class IIa

1. 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 (Dreyfus et al., 2005; Van de Veire et al., 2011; Benedetto et al., 2012; Chan et al., 2009; Calafiore et al., 2009; Di Mauro et al., 2009; Yilmaz et al., 2011; Calafiore et al., 2011; Navia et al., 2012; Kim et al., 2012). (*Level of Evidence: B*)
2. Tricuspid valve surgery can be beneficial for patients with symptoms due to severe primary TR that are unresponsive to medical therapy (stage D). (*Level of Evidence: C*)

Class IIb

1. 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. (*Level of Evidence: C*)
2. 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. (*Level of Evidence: C*)
3. 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. (*Level of Evidence: C*)

Tricuspid Stenosis (TS)

*Diagnosis and Follow-up*

Class I

1. 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. (*Level of Evidence: C*)

Class IIb

1. Invasive hemodynamic assessment of severity of TS may be considered in symptomatic patients when clinical and noninvasive data are discordant. (*Level of Evidence: C*)

*Intervention*

Class I

1. Tricuspid valve surgery is recommended for patients with severe TS at the time of operation for left-sided valve disease. (*Level of Evidence: C*)
2. Tricuspid valve surgery is recommended for patients with isolated, symptomatic severe TS. (*Level of Evidence: C*)

Class IIb

1. Percutaneous balloon tricuspid commissurotomy might be considered in patients with isolated, symptomatic severe TS without accompanying TR. (*Level of Evidence: C*)

Prosthetic Valves

Evaluation and Selection of Prosthetic Valves

*Diagnosis and Follow-up*

Class I

1. An initial TTE study is recommended in patients after prosthetic valve implantation for evaluation of valve hemodynamics (Burstow et al.,

1989; Baumgartner et al., 1992; Vandervoort et al., 1995; Dumesnil et al., 1990). (*Level of Evidence: B*)
2. Repeat TTE is recommended in patients with prosthetic heart valves if there is a change in clinical symptoms or signs suggesting valve dysfunction. (*Level of Evidence: C*)
3. TEE is recommended when clinical symptoms or signs suggest prosthetic valve dysfunction. (*Level of Evidence: C*)

Class IIa

1. 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. (*Level of Evidence: C*)

*Intervention*

Class I

1. The choice of valve intervention, that is, repair or replacement, as well as type of prosthetic heart valve, should be a shared decision-making process that accounts for the patient's values and preferences, with full disclosure of the indications for and risks of anticoagulant therapy and the potential need for and risk of reoperation. (*Level of Evidence: C*)
2. A bioprosthesis is recommended in patients of any age for whom anticoagulant therapy is contraindicated, cannot be managed appropriately, or is not desired. (*Level of Evidence: C*)

Class IIa

1. A mechanical prosthesis is reasonable for AVR or MVR in patients less than 60 years of age who do not have a contraindication to anticoagulation (Hammermeister et al., 2000; Badhwar et al., 2012; Weber et al., 2012). (*Level of Evidence: B*)
2. A bioprosthesis is reasonable in patients more than 70 years of age (Banbury et al., 2002; Dellgren et al., 2002; Borger et al., 2006; Myken & Bech-Hansen, 2009). (*Level of Evidence: B*)
3. Either a bioprosthetic or mechanical valve is reasonable in patients between 60 and 70 years of age (Oxenham et al., 2003; Stassano et al., 2009). (*Level of Evidence: B*)

Class IIb

1. 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. (*Level of Evidence: C*)

Antithrombotic Therapy for Prosthetic Valves

*Medical Therapy*

Class I

1. Anticoagulation with a VKA and international normalized ratio (INR) monitoring is recommended in patients with a mechanical prosthetic valve (Cannegieter, Rosendaal, & Briet, 1994; Stein et al., 2001; Schlitt et al., 2003). (*Level of Evidence: A*)
2. 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 (Torella et al., 2010; Hering et al., 2005; Acar et al., 1996). (*Level of Evidence: B*)
3. 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) (Horstkotte, Scharf, & Schultheiss, 1995). (*Level of Evidence: B*)
4. Anticoagulation with a VKA is indicated to achieve an INR of 3.0 in patients with a mechanical MVR (Horstkotte, Scharf, & Schultheiss, 1995; Pruefer, Dahm, & Dohmen, 2001). (*Level of Evidence: B*)
5. Aspirin 75 mg to 100 mg daily is recommended in addition to anticoagulation with a VKA in patients with a mechanical valve prosthesis (Meschengieser et al., 1997; Turpie et al., 1993). (*Level of Evidence: A*)

Class IIa

1. Aspirin 75 mg to 100 mg per day is reasonable in all patients with a bioprosthetic aortic or mitral valve (Heras et al., 1995; Colli et al., 2007; Aramendi et al., 2005; Nunez et al., 1984). (*Level of Evidence: B*)
2. Anticoagulation with a VKA is reasonable for the first 3 months after bioprosthetic MVR or repair to achieve an INR of 2.5 (Russo et al., 2008). (*Level of Evidence: C*)

Class IIb

1. Anticoagulation, with a VKA, to achieve an INR of 2.5 may be reasonable for the first 3 months after bioprosthetic AVR (Merie et al., 2012). (*Level of Evidence: B*)
2. 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. (*Level of Evidence: C*)

Class III: Harm

1. Anticoagulant therapy with oral direct thrombin inhibitors or anti-Xa agents should not be used in patients with mechanical valve prostheses ("FDA Drug Safety Communication," 2012; Van de Werf et al., 2012; Eikelboom et al., 2013). (*Level of Evidence: B*)

Bridging Therapy for Prosthetic Valves

*Medical Therapy*

Class I

1. 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. (*Level of Evidence: C*)
2. 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. (*Level of Evidence: C*)
3. 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. (*Level of Evidence: C*)

Class IIa

1. 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. (*Level of Evidence: C*)

Excessive Anticoagulation and Serious Bleeding with Prosthetic Valves

Class IIa

1. Administration of fresh frozen plasma or prothrombin complex concentrate is reasonable in patients with mechanical valves and uncontrollable bleeding who require reversal of anticoagulation (Weibert et al., 1997; Yiu et al., 2006). (*Level of Evidence: B*)

Prosthetic Valve Thrombosis

*Diagnosis and Follow-up*

Class I

1. TTE is indicated in patients with suspected prosthetic valve thrombosis to assess hemodynamic severity and follow resolution of valve dysfunction (Barbetseas et al., 1998; Tong et al., 2004). (*Level of Evidence: B*)
2. TEE is indicated in patients with suspected prosthetic valve thrombosis to assess thrombus size and valve motion (Tong et al., 2004; Roudaut, Serri, & Lafitte, 2007; Deviri et al., 1991). (*Level of Evidence: B*)

Class IIa

1. Fluoroscopy or CT is reasonable in patients with suspected valve thrombosis to assess valve motion. (*Level of Evidence: C*)

*Medical Therapy*

Class IIa

1. 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 (<0.8 $cm^2$) (Tong et al., 2004; Roudaut et al., 2003). (*Level of Evidence: B*)

2. Fibrinolytic therapy is reasonable for thrombosed right-sided prosthetic heart valves (Keuleers et al., 2011; Caceres-Loriga et al., 2006). (*Level of Evidence: B*)

*Intervention*

Class I

1. Emergency surgery is recommended for patients with a thrombosed left-sided prosthetic heart valve with NYHA class III to IV symptoms (Roudaut et al., 2009; Keuleers et al., 2011; Karthikeyan et al., 2013). (*Level of Evidence: B*)

Class IIa

1. Emergency surgery is reasonable for patients with a thrombosed left-sided prosthetic heart valve with a mobile or large thrombus (>0.8 $cm^2$) (Tong et al., 2004; Deviri et al., 1991; Roudaut et al., 2009). (*Level of Evidence: C*)

Prosthetic Valve Stenosis

*Intervention*

Class I

1. Repeat valve replacement is indicated for severe symptomatic prosthetic valve stenosis. (*Level of Evidence: C*)

Prosthetic Valve Regurgitation

*Intervention*

Class I

1. Surgery is recommended for operable patients with mechanical heart valves with intractable hemolysis or HF due to severe prosthetic or paraprosthetic regurgitation (Miller et al., 1995; Akins et al., 2005). (*Level of Evidence: B*)

Class IIa

1. Surgery is reasonable for operable patients with severe symptomatic or asymptomatic bioprosthetic regurgitation. (*Level of Evidence: C*)
2. 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 (Sorajja et al., "Percutaneous," 2011; Ruiz et al., 2011; Sorajja et al., "Long-term," 2011). (*Level of Evidence: B*)

Infective Endocarditis

Diagnosis and Follow-up

Class I

1. 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 (Lopez et al., 2013) (*Level of Evidence: B*) or patients with newly diagnosed left-sided valve regurgitation. (*Level of Evidence: C*)
2. The Modified Duke Criteria should be used in evaluating a patient with suspected IE (see Tables 24 and 25 in the original guideline document) (Durack, Lukes, & Bright, 1994; Kupferwasser et al., 2001; Li et al., 2000; Perez-Vazquez et al., 2000). (*Level of Evidence: B*)
3. 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 (Botelho-Nevers et al., 2009). (*Level of Evidence: B*)
4. 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 (Mugge et al., 1989; Burger et al., 1991; Irani, Grayburn, & Afridi, 1996; Liu et al., 2009; Kemp, Citrin, & Byrd, 1999). (*Level of Evidence: B*)
5. 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 (Erbel et al., 1988; Daniel et al., 1991; Sochowski & Chan, 1993;

Shively et al., 1991; Pedersen et al., 1991; Ronderos et al., 2004; Roe et al., 2000; Karalis et al., 1992; El-Ahdab et al., 2005). (*Level of Evidence: B*)

6. TTE and/or TEE are recommended for re-evaluation 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, fungal infections) (Rohmann et al., 1991; Mylonakis & Calderwood, 2001). (*Level of Evidence: B*)
7. Intraoperative TEE is recommended for patients undergoing valve surgery for IE (Shapira et al., 2007; Yao et al., 2009). (*Level of Evidence: B*)

Class IIa

1. TEE is reasonable to diagnose possible IE in patients with *Staphylococcal aureus* (*S. aureus*) bacteremia without a known source (Watanakunakorn, 1994; Abraham et al., 2004; Kaasch et al., 2011). (*Level of Evidence: B*)
2. TEE is reasonable to diagnose IE of a prosthetic valve in the presence of persistent fever without bacteremia or a new murmur (San Martin et al., 2010; Knudsen et al., 2011). (*Level of Evidence: B*)
3. Cardiac CT is reasonable to evaluate morphology/anatomy in the setting of suspected paravalvular infections when the anatomy cannot be clearly delineated by echocardiography (Fagman et al., 2012; Feuchtner et al., 2009; Gahide et al., 2010; Lentini et al., 2009). (*Level of Evidence: B*)

Class IIb

1. TEE might be considered to detect concomitant staphylococcal IE in nosocomial *S. aureus* bacteremia with a known portal of entry from an extracardiac source (Rasmussen et al., 2011; Fowler et al., 1997; Sullenberger, Avedissian, & Kent, 2005). (*Level of Evidence: B*)

*Medical Therapy*

Class I

1. Appropriate antibiotic therapy should be initiated and continued after blood cultures are obtained with guidance from antibiotic sensitivity data and infectious disease consultants (Lopez et al., 2013). (*Level of Evidence: B*)

Class IIa

1. 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 (Masuda et al., 1992; Tornos, et al., 1999; Carpenter & McAllister, 1983; Lieberman et al., 1978; Wilson et al., 1978; Ananthasubramaniam et al., 2001). (*Level of Evidence: B*)

Class IIb

1. Temporary discontinuation of VKA anticoagulation might be considered in patients receiving VKA anticoagulation at the time of IE diagnosis (Tornos et al., 1999; Pruitt et al., 1978; Chan et al., 2008; Fang et al., 2007; Rasmussen et al., 2009). (*Level of Evidence: B*)

Class III: Harm

1. Patients with known VHD should not receive antibiotics before blood cultures are obtained for unexplained fever. (*Level of Evidence: C*)

*Intervention*

Class I

1. Decisions about timing of surgical intervention should be made by a multispecialty Heart Valve Team of cardiology, cardiothoracic surgery, and infectious disease specialists (Botelho-Nevers et al., 2009). (*Level of Evidence: B*)
2. 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 (Jault et al., 1997; Hasbun et al., 2003; Kiefer et al., 2011; Tornos et al., 1992; Gordon et al., 2000; Wang et al., 2007). (*Level of Evidence: B*)
3. Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) is indicated in patients with left-sided IE caused by *S. aureus*, fungal, or other highly resistant organisms (Wang et al., 2007; Remadi et al., 2007; Hill et al., "Infective," 2007; Aksoy et al., 2007; Ellis et al., 2001; Wolff et al., 1995; Chirouze et al., 2004; Melgar et al., 1997). (*Level of Evidence: B*)
4. 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 (Wang et al., 2007; Wang et al., 1972; Middlemost et al., 1991; Chan, 2002; Jault et al., 1993; Anguera et al., 2005). (*Level of Evidence: B*)

5. 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 (Wang et al., 2007; Wolff et al., 1995; Chirouze et al., 2004; Klieverik et al., 2009; Hill et al., "Abscess," 2007; Manne et al., 2012). (*Level of Evidence: B*)
6. Surgery is recommended for patients with prosthetic valve endocarditis (PVE) 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. (*Level of Evidence: C*)
7. 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 (Sohail et al., 2008; Athan et al., 2012; Rundstrom et al., 2004; Ho et al., 2010). (*Level of Evidence: B*)

Class IIa

1. Complete removal of pacemaker or defibrillator systems, including all leads and the generator, is reasonable in patients with valvular IE caused by *S. aureus* or fungi, even without evidence of device or lead infection (Sohail et al., 2008; Athan et al., 2012; Rundstrom et al., 2004; Ho et al., 2010). (*Level of Evidence: B*)
2. Complete removal of pacemaker or defibrillator systems, including all leads and the generator, is reasonable in patients undergoing valve surgery for valvular IE. (*Level of Evidence: C*)
3. 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 (Mugge et al., 1989; Thuny et al., 2005; Kang et al., 2012). (*Level of Evidence: B*)

Class IIb

1. Early surgery (during initial hospitalization before completion of a full therapeutic course of antibiotics) may be considered in patients with native valve endocarditis (NVE) who exhibit mobile vegetations greater than 10 mm in length (with or without clinical evidence of embolic phenomenon) (Mugge et al., 1989; Thuny et al., 2005; Kang et al., 2012). (*Level of Evidence: B*)

Pregnancy and VHD

Native Valve Stenosis

Class I

1. All patients with suspected valve stenosis should undergo a clinical evaluation and TTE before pregnancy. (*Level of Evidence: C*)
2. 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. (*Level of Evidence: C*)
3. 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. (*Level of Evidence: C*)
4. 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. (*Level of Evidence: C*)

*Diagnosis and Follow-up*

Class IIa

1. Exercise testing is reasonable in asymptomatic patients with severe AS (aortic velocity ≥4.0 m per second or mean pressure gradient ≥40 mm Hg, stage C) before pregnancy. (*Level of Evidence: C*)

*Medical Therapy*

Class I

1. Anticoagulation should be given to pregnant patients with MS and AF unless contraindicated. (*Level of Evidence: C*)

Class IIa

1. Use of beta blockers as required for rate control is reasonable for pregnant patients with MS in the absence of contraindication if tolerated. (*Level of Evidence: C*)

Class IIb

1. Use of diuretics may be reasonable for pregnant patients with MS and HF symptoms (stage D). (*Level of Evidence: C*)

Class III: Harm

1. ACE inhibitors and ARBs should not be given to pregnant patients with valve stenosis (Schaefer, 2003; Cooper et al., 2006; Shotan et al., 1994). (*Level of Evidence: B*)

*Intervention*

Class I

1. 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). (*Level of Evidence: C*)
2. Valve intervention is recommended before pregnancy for symptomatic patients with severe MS (mitral valve area ≤1.5 $cm^2$, stage D). (*Level of Evidence: C*)
3. 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. (*Level of Evidence: C*)

Class IIa

1. 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). (*Level of Evidence: C*)
2. 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 (Abouzied et al., 2001; Ben Farhat et al., 1997; de Souza et al., 2001; Glantz et al., 1993; Iung et al., 1994). (*Level of Evidence: B*)
3. 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. (*Level of Evidence: C*)
4. 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 (Tzemos et al., 2009; Banning, Pearson, & Hall, 1993; Easterling et al., 1988; Lao et al., 1993; McIvor, 1991; Myerson et al., 2005; Tumelero et al., 2004). (*Level of Evidence: B*)

Class III: Harm

1. Valve operation should not be performed in pregnant patients with valve stenosis in the absence of severe HF symptoms. (*Level of Evidence: C*)

Native Valve Regurgitation

*Diagnosis and Follow-up*

Class I

1. All patients with suspected valve regurgitation should undergo a clinical evaluation and TTE before pregnancy. (*Level of Evidence: C*)
2. 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. (*Level of Evidence: C*)
3. 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. (*Level of Evidence: C*)
4. 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. (*Level of*

*Evidence: C*)

Class IIa

1. Exercise testing is reasonable in asymptomatic patients with severe valve regurgitation (stage C) before pregnancy. (*Level of Evidence: C*)

*Medical Therapy*

Class III: Harm

1. ACE inhibitors and ARBs should not be given to pregnant patients with valve regurgitation (Schaefer, 2003; Cooper et al., 2006; Shotan et al., 1994). (*Level of Evidence: B*)

*Intervention*

Class I

1. Valve repair or replacement is recommended before pregnancy for symptomatic women with severe valve regurgitation (stage D). (*Level of Evidence: C*)

Class IIa

1. Valve operation for pregnant patients with severe valve regurgitation is reasonable only if there are refractory NYHA class IV HF symptoms (stage D). (*Level of Evidence: C*)

Class IIb

1. 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. (*Level of Evidence: C*)

Class III: Harm

1. Valve operations should not be performed in pregnant patients with valve regurgitation in the absence of severe intractable HF symptoms. (*Level of Evidence: C*)

Prosthetic Valves in Pregnancy

*Diagnosis and Follow-up*

Class I

1. All patients with a prosthetic valve should undergo a clinical evaluation and baseline TTE before pregnancy. (*Level of Evidence: C*)
2. All patients with a prosthetic valve should undergo prepregnancy counseling by a cardiologist with expertise in managing patients with VHD during pregnancy. (*Level of Evidence: C*)
3. TTE should be performed in all pregnant patients with a prosthetic valve if not done before pregnancy. (*Level of Evidence: C*)
4. Repeat TTE should be performed in all pregnant patients with a prosthetic valve who develop symptoms. (*Level of Evidence: C*)
5. TEE should be performed in all pregnant patients with a mechanical prosthetic valve who have prosthetic valve obstruction or experience an embolic event. (*Level of Evidence: C*)
6. 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. (*Level of Evidence: C*)

*Medical Therapy*

Class I

1. Therapeutic anticoagulation with frequent monitoring is recommended for all pregnant patients with a mechanical prosthesis (Chan, Anand, & Ginsberg, 2000; Meschengieser et al., 1999). (*Level of Evidence: B*)
2. Warfarin is recommended in pregnant patients with a mechanical prosthesis to achieve a therapeutic INR in the second and third trimesters (Abildgaard et al., 2009; McLintock, McCowan, & North, 2009; Oran, Lee-Parritz, & Ansell, 2004; Quinn et al., 2009; Sillesen et al.,

2011; DeSanto et al., 2012). (*Level of Evidence: B*)
3. 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. (*Level of Evidence: C*)
4. 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. (*Level of Evidence: C*)

Class IIa

1. 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 (Chan, Anand, & Ginsberg, 2000; Meschengieser et al., 1999; Sillesen et al., 2011; DeSanto et al., 2012; Salazar et al., 1996; Vitale, De Feo, & Cotrufo, 2002). (*Level of Evidence: B*)
2. 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 (Abildgaard et al., 2009; McLintock, McCowan, & North, 2009; Oran, Lee-Parritz, & Ansell, 2004; Quinn et al., 2009; Rowan et al., 2001; James et al., 2006). (*Level of Evidence: B*)
3. 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 (Chan, Anand, & Ginsberg, 2000; Meschengieser et al., 1999; Salazar et al., 1996). (*Level of Evidence: B*)

Class IIb

1. 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 (Abildgaard et al., 2009; McLintock, McCowan, & North, 2009; Oran, Lee-Parritz, & Ansell, 2004; Quinn et al., 2009; Rowan et al., 2001; James et al., 2006; Yinon et al., 2009). (*Level of Evidence: B*)
2. 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 (Chan, Anand, & Ginsberg, 2000; Meschengieser et al., 1999; Salazar et al., 1996). (*Level of Evidence: B*)

Class III: Harm

1. LMWH should not be administered to pregnant patients with mechanical prostheses unless anti-Xa levels are monitored 4 to 6 hours after administration (McLintock, McCowan, & North, 2009; Oran, Lee-Parritz, & Ansell, 2004; Ginsberg et al., 2003; Rowan et al., 2001; James et al., 2006). (*Level of Evidence: B*)

Surgical Considerations

Evaluation of Coronary Anatomy

Class I

1. 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). (*Level of Evidence: C*)
2. Coronary angiography should be performed as part of the evaluation of patients with chronic severe secondary MR. (*Level of Evidence: C*)

Class IIa

1. 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. (*Level of Evidence: C*)
2. 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) is confirmed with invasive coronary angiography (American College of Cardiology Foundation Task Force on Expert Consensus Documents et al., 2010; Gilard et al., 2006; Manghat et al., 2006; Meijboom et al., 2006; Reant et al., 2006; Scheffel et al., 2007; Galas et al., 2012). (*Level of Evidence: B*)

Concomitant Procedures

*Intervention for CAD*

Class IIa

1. CABG or percutaneous coronary intervention (PCI) 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). (*Level of Evidence: C*)

*Intervention for AF*

Class IIa

1. A concomitant maze procedure is reasonable at the time of mitral valve repair or replacement for treatment of chronic, persistent AF. (*Level of Evidence: C*)
2. A full biatrial 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 (Doukas et al., 2005; Blomstrom-Lundqvist et al., 2007). (*Level of Evidence: B*)

Class IIb

1. 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. (*Level of Evidence: C*)
2. 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. (*Level of Evidence: C*)

Class III: No Benefit

1. 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 (Liu et al., 2010). (*Level of Evidence: B*)

Noncardiac Surgery in Patients with VHD

Intervention

Class IIa

1. Moderate-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe AS (Agarwal et al., 2013; Zahid et al., 2005; Torsher et al., 1998; Calleja et al., 2010). (*Level of Evidence: B*)
2. Moderate-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe MR. (*Level of Evidence: C*)
3. 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. (*Level of Evidence: C*)

Class IIb

1. 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. (*Level of Evidence: C*)

Definitions:

Applying Classification of Recommendations and Level of Evidence

| | **Size of Treatment Effect** | | | | | |
|---|---|---|---|---|---|---|
| | CLASS I<br>*Benefit >>> Risk*<br>Procedure/Treatment SHOULD be performed/ administered | CLASS IIa<br>*Benefit >> Risk*<br>*Additional studies with focused objectives needed*<br>IT IS REASONABLE to perform procedure/administer treatment | CLASS IIb<br>*Benefit ≥ Risk*<br>*Additional studies with broad objectives needed; additional registry data would be helpful*<br>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 |

| | | | Size of Treatment Effect | | COR III: Harm | Excess cost without benefit or harmful | Harmful to patients |
|---|---|---|---|---|---|---|---|
| **Estimate of Certainty (Precision) of Treatment Effect** | LEVEL A<br><br>Multiple populations evaluated*<br><br>Data derived from multiple randomized clinical trials or meta-analyses | • Recommendation that procedure or treatment is useful/effective<br>• Sufficient evidence from multiple randomized trials or meta-analyses | • Recommendation in favor of treatment or procedure being useful/effective<br>• Some conflicting evidence from multiple randomized trials or meta-analyses | • Recommendation's usefulness/efficacy less well established<br>• Greater conflicting evidence from multiple randomized trials or meta-analyses | • Recommendation that procedure or treatment is not useful/effective and may be harmful<br>• Sufficient evidence from multiple randomized trials or meta-analyses | | |
| | LEVEL B<br><br>Limited populations evaluated*<br><br>Data derived from a single randomized trial or nonrandomized studies | • Recommendation that procedure or treatment is useful/effective<br>• Evidence from single randomized trial or nonrandomized studies | • Recommendation in favor of treatment or procedure being useful/effective<br>• Some conflicting evidence from single randomized trial or nonrandomized studies | • Recommendation's usefulness/efficacy less well established<br>• Greater conflicting evidence from single randomized trial or nonrandomized studies | • Recommendation that procedure or treatment is not useful/effective and may be harmful<br>• Evidence from single randomized trial or nonrandomized studies | | |
| | LEVEL C<br><br>Very limited populations evaluated*<br><br>Only consensus opinion of experts, case studies, or standard of care | • Recommendation that procedure or treatment is useful/effective<br>• Only expert opinion, case studies, or standard of care | • Recommendation in favor of treatment or procedure being useful/effective<br>• Only diverging expert opinion, case studies, or standard of care | • Recommendation's usefulness/efficacy less well established<br>• Only diverging expert opinion, case studies, or standard of care | • Recommendation that procedure or treatment is not useful/effective and may be harmful<br>• Only expert opinion, case studies, or standard of care | | |

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, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

## Clinical Algorithm(s)

The following algorithms are provided in the original guideline document:

- Indications for AVR in Patients with AS
- Indications for AVR for Chronic AR
- Indications for Intervention for Rheumatic MS
- Indications for Surgery for MR
- Indications for Surgery
- Anticoagulation for Prosthetic Valves
- Evaluation and Management of Suspected Prosthetic Valve Thrombosis
- Diagnosis and Treatment of IE
- Anticoagulation of Pregnant Patients with Mechanical Valves
- Evaluation and Management of CAD in Patients Undergoing Valve Surgery

# Scope

## Disease/Condition(s)

Valvular heart disease (VHD) and associated disorders:

- Aortic stenosis (AS)
- Aortic regurgitation (AR)
- Bicuspid aortic valve and aortopathy
- Mitral stenosis (MS)
- Mitral regurgitation (MR)
- Tricuspid valve disease
- Prosthetic valve thrombosis, stenosis, and regurgitation
- Infective endocarditis (IE)
- VHD during pregnancy

## Guideline Category

Diagnosis

Evaluation

Management

Prevention

Risk Assessment

Treatment

## Clinical Specialty

Anesthesiology

Cardiology

Critical Care

Emergency Medicine

Family Practice

Internal Medicine

Obstetrics and Gynecology

Radiology

Thoracic Surgery

## Intended Users

Advanced Practice Nurses

Physician Assistants

Physicians

## Guideline Objective(s)

- To assist clinicians in clinical decision making by describing a range of generally acceptable approaches to the diagnosis, management, and prevention of valvular heart disease (VHD) and related disorders
- To define practices that meet the needs of most patients in most circumstances
- To provide the clinician with concise, evidence-based, contemporary recommendations and the supporting documentation to encourage their use

## Target Population

Adult patients with suspected or confirmed valvular heart disease (VHD)

Note: Management of patients with congenital heart disease and infants and children with valve disease are not addressed in this guideline.

## Interventions and Practices Considered

Diagnosis/Evaluation

1. Transthoracic echocardiography (TTE)
2. Cardiac catheterization for hemodynamic assessment
3. Transesophageal echocardiography (TEE)
4. Aortic magnetic resonance angiography (MRA) or computed tomography angiography (CTA)
5. Noninvasive imaging (stress nuclear/positron emission tomography, cardiac magnetic resonance [CMR] imaging, or stress echocardiography)
6. Exercise testing/stress testing
7. Invasive measurement of pulmonary artery pressures and pulmonary vascular resistance for tricuspid regurgitation (TR)
8. Blood cultures and modified Duke criteria for infective endocarditis (IE)
9. Evaluation by Heart Valve Team

Management/Treatment

1. General
    - Secondary prevention of rheumatic fever
    - IE prophylaxis
    - Referral to Heart Valve Center of Excellence
2. Aortic stenosis (AS)
    - Medical therapy for hypertension
    - Vasodilator therapy
    - Statin therapy (not recommended)
    - Aortic valve replacement (AVR; surgical or transcatheter approach)
3. Aortic regurgitation (AR)
    - Medical therapy for hypertension: dihydropyridine calcium channel blockers or angiotensin-converting enzyme (ACE) inhibitors/angiotensin-receptor blockers (ARBs)
    - AVR: timing of intervention
    - Aortic valve repair in selected patients
4. Bicuspid aortic valve and aortopathy: operative intervention to repair the aortic sinuses or replace the ascending aorta
5. Mitral stenosis (MS)
    - Anticoagulation (vitamin K antagonist [VKA] or heparin)
    - Medical therapy for heart rate control
    - Mitral valve surgery: repair, percutaneous mitral balloon commissurotomy, or valve replacement
    - Excision of left atrial appendage
6. Mitral regurgitation (MR)
    - Medical therapy for systolic dysfunction/heart failure
    - Cardiac resynchronization therapy
    - Vasodilator therapy (not recommended)
    - Mitral valve surgery: repair or replacement
7. Tricuspid regurgitation
    - Diuretics
    - Tricuspid valve repair or replacement
8. Tricuspid stenosis
    - Tricuspid valve surgery
    - Percutaneous balloon tricuspid commissurotomy
9. Prosthetic valves
    - Choice of valve intervention: repair or replacement
    - Choice of prosthetic heart valve: bioprosthesis or mechanical valve
    - Pulmonary autograft
    - Antithrombotic therapy for prosthetic valve (VKA with international normalized ratio [INR] monitoring, aspirin, clopidogrel)
    - Bridging therapy for prosthetic valves
    - Management of excessive anticoagulation and serious bleeding (fresh frozen plasma, prothrombin complex concentrate)
    - Management of prosthetic valve thrombosis (emergency surgery, fibrinolysis)
    - Management of prosthetic valve stenosis (repeat valve replacement)

    - Management of prosthetic valve regurgitation (surgery)
10. Infective endocarditis
    - Appropriate antibiotic therapy
    - Temporary discontinuation of anticoagulation therapy
    - Surgical intervention
    - Removal of pacemaker or defibrillator systems
11. Pregnancy and valvular heart disease (VHD)
    - Clinical evaluation and TTE before pregnancy
    - Prepregnancy counseling concerning risks and benefits of operative interventions
    - Management and monitoring by dedicated Heart Valve Team
    - Exercise testing
    - Medical therapy: anticoagulation, beta-blockers, diuretics, avoidance of ACE inhibitors and ARBs
    - Valve interventions before and during pregnancy
    - Discontinuation of warfarin and initiation of unfractionated heparin (UFH) before delivery
    - Use of low-molecular-weight heparin (LMWH) with mechanical prosthesis with monitoring of anti-Xa levels
12. Surgical considerations
    - Coronary evaluation prior to valve surgery (coronary angiography, coronary CT angiography)
    - Valve surgery with or without coronary artery bypass graft (CABG) or percutaneous coronary intervention (PCI)
    - Interventions for atrial fibrillation: concomitant maze procedure or pulmonary vein isolation at the time of mitral valve surgery
    - Noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring

## Major Outcomes Considered

- Sensitivity and specificity of tests for evaluating heart valve disorders
- Functional status (New York Heart Association)
- Progression rate
- Exercise tolerance
- Mortality/death
- Survival rate
- Restenosis rate
- Freedom from reoperation
- Freedom from recurrent valve disease
- Valve-related complications

# Methodology

## Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

## Description of Methods Used to Collect/Select the Evidence

An extensive review was conducted on literature published through November 2012, and other selected references through October 2013 were reviewed by the guideline writing committee. Searches were extended to studies, reviews, and other evidence conducted on human subjects and that were published in English from PubMed, EMBASE, Cochrane, Agency for Healthcare Research and Quality Reports, and other selected databases relevant to this guideline. Key search words included but were not limited to the following: *valvular heart disease, aortic stenosis, aortic regurgitation, bicuspid aortic valve, mitral stenosis, mitral regurgitation, tricuspid stenosis, tricuspid regurgitation, pulmonic stenosis, pulmonic regurgitation, prosthetic valves, anticoagulation therapy, infective endocarditis, cardiac surgery*, and *transcatheter aortic valve replacement*. Additionally, the committee reviewed documents related to the subject matter previously published by the American College of Cardiology (ACC) and American Heart Association (AHA). The references selected and published in this document are representative and not all-inclusive.

## Number of Source Documents

Not stated

## Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

## Rating Scheme for the Strength of the Evidence

Applying Classification of Recommendations and Level of Evidence

| | | Size of Treatment Effect | | | | | |
|---|---|---|---|---|---|---|---|
| | | CLASS I<br>*Benefit >>> Risk*<br>Procedure/Treatment SHOULD be performed/ administered | CLASS IIa<br>*Benefit >> Risk*<br>*Additional studies with focused objectives needed*<br>IT IS REASONABLE to perform procedure/administer treatment | CLASS IIb<br>*Benefit ≥ Risk*<br>*Additional studies with broad objectives needed; additional registry data would be helpful*<br>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 without benefit or harmful | Harmful to patients |
| **Estimate of Certainty (Precision) of Treatment Effect** | LEVEL A<br>Multiple populations evaluated*<br>Data derived from multiple randomized clinical trials or meta-analyses | • Recommendation that procedure or treatment is useful/effective<br>• Sufficient evidence from multiple randomized trials or meta-analyses | • Recommendation in favor of treatment or procedure being useful/effective<br>• Some conflicting evidence from multiple randomized trials or meta-analyses | • Recommendation's usefulness/efficacy less well established<br>• Greater conflicting evidence from multiple randomized trials or meta-analyses | • Recommendation that procedure or treatment is not useful/effective and may be harmful<br>• Sufficient evidence from multiple randomized trials or meta-analyses | | |
| | LEVEL B<br>Limited populations evaluated*<br>Data derived from a single randomized trial or nonrandomized studies | • Recommendation that procedure or treatment is useful/effective<br>• Evidence from single randomized trial or nonrandomized studies | • Recommendation in favor of treatment or procedure being useful/effective<br>• Some conflicting evidence from single randomized trial or nonrandomized studies | • Recommendation's usefulness/efficacy less well established<br>• Greater conflicting evidence from single randomized trial or nonrandomized studies | • Recommendation that procedure or treatment is not useful/effective and may be harmful<br>• Evidence from single randomized trial or nonrandomized studies | | |
| | LEVEL C<br>Very limited populations evaluated*<br>Only consensus opinion of experts, case studies, or standard of care | • Recommendation that procedure or treatment is useful/effective<br>• Only expert opinion, case studies, or standard of care | • Recommendation in favor of treatment or procedure being useful/effective<br>• Only diverging expert opinion, case studies, or standard of care | • Recommendation's usefulness/efficacy less well established<br>• Only diverging expert opinion, case studies, or standard of care | • Recommendation that procedure or treatment is not useful/effective and may be harmful<br>• Only expert opinion, case studies, or standard of care | | |

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, history of prior myocardial infarction, history of heart failure, and prior aspirin use.

## Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

## Description of the Methods Used to Analyze the Evidence

In analyzing the data and developing recommendations and supporting text, the writing committee uses evidence-based methodologies developed by the Task Force. The Level of Evidence (LOE) is an estimate of the certainty or precision of the treatment effect. The writing committee reviews and ranks evidence supporting each recommendation, with the weight of evidence ranked as LOE A, B, or C, according to specific definitions that are included in the "Rating Scheme for the Strength of the Evidence" field. Studies are identified as observational, retrospective, prospective, or

randomized where appropriate.

## Methods Used to Formulate the Recommendations

Expert Consensus

## Description of Methods Used to Formulate the Recommendations

Experts in the subject under consideration are selected from both the American College of Cardiology (ACC) and the American Heart Association (AHA) to examine subject-specific data and write guidelines. Writing committees are specifically charged with performing a literature review; weighing the strength of evidence for or against particular tests, treatments, or procedures; and including estimates of expected health outcomes where such data exist. Patient-specific modifiers, comorbidities, and issues of patient preference that may influence the choice of tests or therapies are considered, as well as frequency of follow-up and cost effectiveness. When available, information from studies on cost is considered; however, a review of data on efficacy and outcomes constitutes the primary basis for preparing recommendations in this guideline.

In analyzing the data and developing recommendations and supporting text, the writing committee uses evidence-based methodologies developed by the Task Force. The Class of Recommendation (COR) is an estimate of the size of the treatment effect, with consideration given to risks versus benefits, as well as evidence and/or agreement that a given treatment or procedure is or is not useful/effective or in some situations may cause harm. The writing committee reviews and ranks evidence supporting each recommendation, with the weight of evidence ranked as Level of Evidence (LOE) A, B, or C, according to specific definitions that are included in the "Rating Scheme for the Strength of the Evidence" field. Studies are identified as observational, retrospective, prospective, or randomized, as appropriate. For certain conditions for which inadequate data are available, recommendations are based on expert consensus and clinical experience and are ranked as LOE C. When recommendations at LOE C are supported by historical clinical data, appropriate references (including clinical reviews) are cited if available. For issues with sparse available data, a survey of current practice among the clinician members of the writing committee is the basis for LOE C recommendations and no references are cited.

A new addition to this methodology is separation of the Class III recommendations to delineate whether the recommendation is determined to be of "no benefit" or is associated with "harm" to the patient. In addition, in view of the increasing number of comparative effectiveness studies, comparator verbs and suggested phrases for writing recommendations for the comparative effectiveness of one treatment or strategy versus another are included for COR I and IIa, LOE A or B only.

In view of the advances in medical therapy across the spectrum of cardiovascular diseases, the Task Force has designated the term guideline-directed medical therapy (GDMT) to represent optimal medical therapy as defined by ACC/AHA guideline (primarily Class I)-recommended therapies. This new term, GDMT, is used herein and throughout subsequent guidelines.

Because the ACC/AHA practice guidelines address patient populations (and clinicians) residing in North America, drugs that are not currently available in North America are discussed in the text without a specific COR. For studies performed in large numbers of subjects outside North America, each writing committee reviews the potential impact of different practice patterns and patient populations on the treatment effect and relevance to the ACC/AHA target population to determine whether the findings should inform a specific recommendation.

Organization of the Writing Committee

The committee was composed of clinicians, who included cardiologists, interventionalists, surgeons, and anesthesiologists. The committee also included representatives from the American Association for Thoracic Surgery, American Society of Echocardiography (ASE), Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons (STS).

## Rating Scheme for the Strength of the Recommendations

See the "Rating Scheme for the Strength of the Evidence" field.

## Cost Analysis

The guideline developers reviewed published cost analyses.

## Method of Guideline Validation

External Peer Review

Internal Peer Review

## Description of Method of Guideline Validation

The document was reviewed by 2 official reviewers each nominated by both the American College of Cardiology (ACC) and the American Heart Association (AHA), as well as 1 reviewer each from the American Association for Thoracic Surgery, American Society of Echocardiography (ASE), Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, Society of Thoracic Surgeons (STS), and 39 individual content reviewers (which included representatives from the following ACC committees and councils: Adult Congenital and Pediatric Cardiology Section, Association of International Governors, Council on Clinical Practice, Cardiovascular Section Leadership Council, Geriatric Cardiology Section Leadership Council, Heart Failure and Transplant Council, Interventional Council, Lifelong Learning Oversight Committee, Prevention of Cardiovascular Disease Committee, and Surgeon Council).

This document was approved for publication by the governing bodies of the ACC and AHA and endorsed by the American Association for Thoracic Surgery, ASE, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Anesthesiologists, and STS.

# Evidence Supporting the Recommendations

## References Supporting the Recommendations


Abascal VM, Wilkins GT, OShea JP, Choong CY, Palacios IF, Thomas JD, Rosas E, Newell JB, Block PC, Weyman AE. Prediction of successful outcome in 130 patients undergoing percutaneous balloon mitral valvotomy. Circulation. 1990 Aug;82(2):448-56. PubMed

Abildgaard U, Sandset PM, HammerstrÃ¸m J, Gjestvang FT, Tveit A. Management of pregnant women with mechanical heart valve prosthesis: thromboprophylaxis with low molecular weight heparin. Thromb Res Suppl. 2009 Jul;124(3):262-7. PubMed

Abouzied AM, Al Abbady M, Al Gendy MF, Magdy A, Soliman H, Faheem F, Ramadan T, Yehia A. Percutaneous balloon mitral commissurotomy during pregnancy. Angiology. 2001 Mar;52(3):205-9. PubMed

Abraham J, Mansour C, Veledar E, Khan B, Lerakis S. Staphylococcus aureus bacteremia and endocarditis: the Grady Memorial Hospital experience with methicillin-sensitive S aureus and methicillin-resistant S aureus bacteremia. Am Heart J. 2004 Mar;147(3):536-9. PubMed

Acar J, Iung B, Boissel JP, Samama MM, Michel PL, Teppe JP, Pony JC, Breton HL, Thomas D, Isnard R, de Gevigney G, Viguier E, Sfihi A, Hanania G, Ghannem M, Mirode A, Nemoz C. AREVA: multicenter randomized comparison of low-dose versus standard-dose anticoagulation in patients with mechanical prosthetic heart valves. Circulation. 1996 Nov 1;94(9):2107-12. PubMed

Agarwal S, Rajamanickam A, Bajaj NS, Griffin BP, Catacutan T, Svensson LG, Anabtawi AG, Tuzcu EM, Kapadia SR. Impact of aortic stenosis on postoperative outcomes after noncardiac surgeries. Circ Cardiovasc Qual Outcomes. 2013 Mar 1;6(2):193-200. PubMed

Ahmed MI, Aban I, Lloyd SG, Gupta H, Howard G, Inusah S, Peri K, Robinson J, Smith P, McGiffin DC, Schiros CG, Denney T, DellItalia LJ. A randomized controlled phase IIb trial of beta(1)-receptor blockade for chronic degenerative mitral regurgitation. J Am Coll Cardiol. 2012 Aug 28;60(9):833-8. PubMed

Akins CW, Bitondo JM, Hilgenberg AD, Vlahakes GJ, Madsen JC, MacGillivray TE. Early and late results of the surgical correction of cardiac prosthetic paravalvular leaks. J Heart Valve Dis. 2005 Nov;14(6):792-9; discussion 799-800. PubMed

Aksoy O, Sexton DJ, Wang A, Pappas PA, Kourany W, Chu V, Fowler VG, Woods CW, Engemann JJ, Corey GR, Harding T, Cabell CH. Early surgery in patients with infective endocarditis: a propensity score analysis. Clin Infect Dis. 2007 Feb 1;44(3):364-72. PubMed

American College of Cardiology Foundation Task Force on Expert Consensus Documents, Mark DB, Berman DS, Budoff MJ, Carr JJ, Gerber TC, Hecht HS, Hlatky MA, Hodgson JM, Lauer MS, Miller JM, Morin RL, Mukherjee D, Poon M, Rubin GD, Schwartz RS. ACCF/ACR/AHA/NASCI/SAIP/SCAI/SCCT 2010 expert consensus document on coronary computed tomographic angiography: a report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents. J Am Coll Cardiol. 2010 Jun 8;55(23):2663-99. PubMed

Ananthasubramaniam K, Beattie JN, Rosman HS, Jayam V, Borzak S. How safely and for how long can warfarin therapy be withheld in prosthetic heart valve patients hospitalized with a major hemorrhage?. Chest. 2001 Feb;119(2):478-84. PubMed

Anguera I, Miro JM, Vilacosta I, Almirante B, Anguita M, MuÃ±oz P, Roman JA, de Alarcon A, Ripoll T, Navas E, Gonzalez-Juanatey C, Cabell CH, Sarria C, Garcia-Bolao I, FariÃ±as MC, Leta R, Rufi G, Miralles F, Pare C, Evangelista A, Fowler VG, Mestres CA, de Lazzari E, Guma JR, Aorto-cavitary Fistula in Endocarditis Working Group. Aorto-cavitary fistulous tract formation in infective endocarditis: clinical and echocardiographic features of 76 cases and risk factors for mortality. Eur Heart J. 2005 Feb;26(3):288-97. PubMed

Aramendi JI, Mestres CA, Mestres CA, Martinez-LeÃ³n J, Campos V, MuÃ±oz G, Navas C. Triflusal versus oral anticoagulation for primary prevention of thromboembolism after bioprosthetic valve replacement (trac): prospective, randomized, co-operative trial. Eur J Cardiothorac Surg. 2005 May;27(5):854-60. PubMed

Arat N, Altay H, Korkmaz S, Ilkay E. The effect of baseline pulmonary artery pressure on right ventricular functions after mitral balloon valvuloplasty for rheumatic mitral stenosis: a tissue Doppler imaging study. Turk Kardiyol Dern Ars. 2008 Jun;36(4):223-30. PubMed

Arora R, Nair M, Kalra GS, Nigam M, Khalilullah M. Immediate and long-term results of balloon and surgical closed mitral valvotomy: a randomized comparative study. Am Heart J. 1993 Apr;125(4):1091-4. PubMed

Athan E, Chu VH, Tattevin P, SeltonSuty C, Jones P, Naber C, MirÃ³ JM, Ninot S, FernÃ¡ndezHidalgo N, DuranteMangoni E, Spelman D, Hoen B, LejkoZupanc T, Cecchi E, Thuny F, Hannan MM, Pappas P, Henry M, Fowler VG, Crowley AL, Wang A, ICE-PCS Investigators. Clinical characteristics and outcome of infective endocarditis involving implantable cardiac devices. JAMA. 2012 Apr 25;307(16):1727-35. PubMed

Attenhofer Jost CH, Turina J, Mayer K, Seifert B, Amann FW, Buechi M, Facchini M, BrunnerLa Rocca HP, Jenni R. Echocardiography in the evaluation of systolic murmurs of unknown cause. Am J Med. 2000 Jun 1;108(8):614-20. PubMed

AtterhÃ¶g JH, Jonsson B, Samuelsson R. Exercise testing: a prospective study of complication rates. Am Heart J. 1979 Nov;98(5):572-9. PubMed

Aviles RJ, Nishimura RA, Pellikka PA, Andreen KM, Holmes DR. Utility of stress Doppler echocardiography in patients undergoing percutaneous mitral balloon valvotomy. J Am Soc Echocardiogr. 2001 Jul;14(7):676-81. PubMed

Badhwar V, Ofenloch JC, Rovin JD, van Gelder HM, Jacobs JP. Noninferiority of closely monitored mechanical valves to bioprostheses overshadowed by early mortality benefit in younger patients. Ann Thorac Surg. 2012 Mar;93(3):748-53. PubMed

Badhwar V, Peterson ED, Jacobs JP, He X, Brennan JM, OBrien SM, Dokholyan RS, George KM, Bolling SF, Shahian DM, Grover FL, Edwards FH, Gammie JS. Longitudinal outcome of isolated mitral repair in older patients: results from 14,604 procedures performed from 1991 to 2007. Ann Thorac Surg. 2012 Dec;94(6):1870-7; discussion 1877-9. PubMed

Banbury MK, Cosgrove DM, Thomas JD, Blackstone EH, Rajeswaran J, Okies JE, Frater RM. Hemodynamic stability during 17 years of the Carpentier-Edwards aortic pericardial bioprosthesis. Ann Thorac Surg. 2002 May;73(5):1460-5. PubMed

Banning AP, Pearson JF, Hall RJ. Role of balloon dilatation of the aortic valve in pregnant patients with severe aortic stenosis. Br Heart J. 1993 Dec;70(6):544-5. PubMed

Barbetseas J, Nagueh SF, Pitsavos C, Toutouzas PK, QuiÃ±ones MA, Zoghbi WA. Differentiating thrombus from pannus formation in obstructed mechanical prosthetic valves: an evaluation of clinical, transthoracic and transesophageal echocardiographic parameters. J Am Coll Cardiol. 1998 Nov;32(5):1410-7. PubMed

Bargiggia GS, Tronconi L, Sahn DJ, Recusani F, Raisaro A, De Servi S, ValdesCruz LM, Montemartini C. A new method for quantitation of mitral regurgitation based on color flow Doppler imaging of flow convergence proximal to regurgitant orifice. Circulation. 1991 Oct;84(4):1481-9. PubMed

Baumgartner H, Hung J, Bermejo J, Chambers JB, Evangelista A, Griffin BP, Iung B, Otto CM, Pellikka PA, QuiÃ±ones M, EAE/ASE. Echocardiographic assessment of valve stenosis: EAE/ASE recommendations for clinical practice. Eur J Echocardiogr. 2009 Jan;10(1):1-25. PubMed

Baumgartner H, Khan S, DeRobertis M, Czer L, Maurer G. Effect of prosthetic aortic valve design on the Doppler-catheter gradient correlation: an in vitro study of normal St. Jude, Medtronic-Hall, Starr-Edwards and Hancock valves. J Am Coll Cardiol. 1992 Feb;19(2):324-32. PubMed

Ben Farhat M, Ayari M, Maatouk F, Betbout F, Gamra H, Jarra M, Tiss M, Hammami S, Thaalbi R, Addad F. Percutaneous balloon versus surgical closed and open mitral commissurotomy: seven-year follow-up results of a randomized trial. Circulation. 1998 Jan 27;97(3):245-50. PubMed

Ben Farhat M, Gamra H, Betbout F, Maatouk F, Jarrar M, Addad F, Tiss M, Hammami S, Chahbani I, Thaalbi R. Percutaneous balloon mitral commissurotomy during pregnancy. Heart. 1997 Jun;77(6):564-7. PubMed

Benedetto U, Melina G, Angeloni E, Refice S, Roscitano A, Comito C, Sinatra R. Prophylactic tricuspid annuloplasty in patients with dilated tricuspid annulus undergoing mitral valve surgery. J Thorac Cardiovasc Surg. 2012 Mar;143(3):632-8. PubMed

Benedetto U, Melina G, Roscitano A, Fiorani B, Capuano F, Sclafani G, Comito C, Nucci GD, Sinatra R. Does combined mitral valve surgery improve survival when compared to revascularization alone in patients with ischemic mitral regurgitation? A meta-analysis on 2479 patients. J Cardiovasc Med (Hagerstown). 2009 Feb;10(2):109-14. PubMed

Bhudia SK, McCarthy PM, Kumpati GS, Helou J, Hoercher KJ, Rajeswaran J, Blackstone EH. Improved outcomes after aortic valve surgery for chronic aortic regurgitation with severe left ventricular dysfunction. J Am Coll Cardiol. 2007 Apr 3;49(13):1465-71. PubMed

BlomstrÃ¶m-Lundqvist C, Johansson B, Berglin E, Nilsson L, Jensen SM, Thelin S, Holmgren A, Edvardsson N, KÃ¤llner G, BlomstrÃ¶m P. A randomized double-blind study of epicardial left atrial cryoablation for permanent atrial fibrillation in patients undergoing mitral valve surgery: the SWEDish Multicentre Atrial Fibrillation study (SWEDMAF). Eur Heart J. 2007 Dec;28(23):2902-8. PubMed

Bolling SF, Li S, OBrien SM, Brennan JM, Prager RL, Gammie JS. Predictors of mitral valve repair: clinical and surgeon factors. Ann Thorac Surg. 2010 Dec;90(6):1904-11; discussion 1912. PubMed

Bonow RO, Dodd JT, Maron BJ, O'Gara PT, White GG, McIntosh CL, Clark RE, Epstein SE. Long-term serial changes in left ventricular function and reversal of ventricular dilatation after valve replacement for chronic aortic regurgitation. Circulation. 1988 Nov;78(5 Pt 1):1108-20. PubMed

Bonow RO, Lakatos E, Maron BJ, Epstein SE. Serial long-term assessment of the natural history of asymptomatic patients with chronic aortic regurgitation and normal left ventricular systolic function. Circulation. 1991 Oct;84(4):1625-35. PubMed

Bonow RO, Rosing DR, McIntosh CL, Jones M, Maron BJ, Lan KK, Lakatos E, Bacharach SL, Green MV, Epstein SE. The natural history of asymptomatic patients with aortic regurgitation and normal left ventricular function. Circulation. 1983 Sep;68(3):509-17. PubMed

Borer JS, Hochreiter C, Herrold EM, Supino P, Aschermann M, Wencker D, Devereux RB, Roman MJ, Szulc M, Kligfield P, Isom OW. Prediction of indications for valve replacement among asymptomatic or minimally symptomatic patients with chronic aortic regurgitation and normal left ventricular performance. Circulation. 1998 Feb 17;97(6):525-34. PubMed

Borger MA, Ivanov J, Armstrong S, Christie-Hrybinsky D, Feindel CM, David TE. Twenty-year results of the Hancock II bioprosthesis. J Heart Valve Dis. 2006 Jan;15(1):49-55; discussion 55-6. PubMed

Botelho-Nevers E, Thuny F, Casalta JP, Richet H, Gouriet F, Collart F, Riberi A, Habib G, Raoult D. Dramatic reduction in infective endocarditis-related mortality with a management-based approach. Arch Intern Med. 2009 Jul 27;169(14):1290-8. PubMed

Bouleti C, Iung B, Laouenan C, Himbert D, Brochet E, Messika-Zeitoun D, Detaint D, Garbarz E, Cormier B, Michel PL, Mentre F, Vahanian A. Late results of percutaneous mitral commissurotomy up to 20 years: development and validation of a risk score predicting late functional results from a series of 912 patients. Circulation. 2012 May 1;125(17):2119-27. PubMed

Braunberger E, Deloche A, Berrebi A, Abdallah F, Celestin JA, Meimoun P, Chatellier G, Chauvaud S, Fabiani JN, Carpentier A. Very long-term results (more than 20 years) of valve repair with carpentier's techniques in nonrheumatic mitral valve insufficiency. Circulation. 2001 Sep 18;104(12 Suppl 1):I8-11. PubMed

Burger AJ, Peart B, Jabi H, Touchon RC. The role of two-dimensional echocardiology in the diagnosis of infective endocarditis [corrected]. Angiology. 1991 Jul;42(7):552-60. PubMed

Burstow DJ, Nishimura RA, Bailey KR, Reeder GS, Holmes DR, Seward JB, Tajik AJ. Continuous wave Doppler echocardiographic measurement of prosthetic valve gradients. A simultaneous Doppler-catheter correlative study. Circulation. 1989 Sep;80(3):504-14. PubMed

CÃ¡ceres-LÃ³riga FM, PÃ©rez-LÃ³pez H, Morlans-HernÃ¡ndez K, Facundo-SÃ¡nchez H, Santos-Gracia J, Valiente-Mustelier J, Rodiles-Aldana F, Marrero-Mirayaga MA, Betancourt BY, LÃ³pez-Saura P. Thrombolysis as first choice therapy in prosthetic heart valve thrombosis. A study of 68 patients. J Thromb Thrombolysis. 2006 Apr;21(2):185-90. PubMed

Calafiore AM, Gallina S, IacÃ² AL, Contini M, Bivona A, Gagliardi M, Bosco P, Di Mauro M. Mitral valve surgery for functional mitral regurgitation: should moderate-or-more tricuspid regurgitation be treated? a propensity score analysis. Ann Thorac Surg. 2009 Mar;87(3):698-703. PubMed

Calafiore AM, IacÃ² AL, Romeo A, Scandura S, Meduri R, Varone E, Di Mauro M. Echocardiographic-based treatment of functional tricuspid regurgitation. J Thorac Cardiovasc Surg. 2011 Aug;142(2):308-13. PubMed

Calleja AM, Dommaraju S, Gaddam R, Cha S, Khandheria BK, Chaliki HP. Cardiac risk in patients aged >75 years with asymptomatic, severe aortic stenosis undergoing noncardiac surgery. Am J Cardiol. 2010 Apr 15;105(8):1159-63. PubMed

Cannan CR, Nishimura RA, Reeder GS, Ilstrup DR, Larson DR, Holmes DR, Tajik AJ. Echocardiographic assessment of commissural calcium: a simple predictor of outcome after percutaneous mitral balloon valvotomy. J Am Coll Cardiol. 1997 Jan;29(1):175-80. PubMed

Cannegieter SC, Rosendaal FR, Briet E. Thromboembolic and bleeding complications in patients with mechanical heart valve prostheses. Circulation. 1994 Feb;89(2):635-41. [60 references] PubMed

Carabello BA, Williams H, Gash AK, Kent R, Belber D, Maurer A, Siegel J, Blasius K, Spann JF. Hemodynamic predictors of outcome in patients undergoing valve replacement. Circulation. 1986 Dec;74(6):1309-16. PubMed

Carpenter JL, McAllister CK. Anticoagulation in prosthetic valve endocarditis. South Med J. 1983 Nov;76(11):1372-5. PubMed

Cawley PJ, Hamilton-Craig C, Owens DS, Krieger EV, Strugnell WE, Mitsumori L, DJang CL, Schwaegler RG, Nguyen KQ, Nguyen B, Maki JH, Otto CM. Prospective comparison of valve regurgitation quantitation by cardiac magnetic resonance imaging and transthoracic echocardiography. Circ Cardiovasc Imaging. 2013 Jan 1;6(1):48-57. PubMed

Chaliki HP, Mohty D, Avierinos JF, Scott CG, Schaff HV, Tajik AJ, Enriquez-Sarano M. Outcomes after aortic valve replacement in patients with severe aortic regurgitation and markedly reduced left ventricular function. Circulation. 2002 Nov 19;106(21):2687-93. PubMed

Chan KL, Tam J, Dumesnil JG, Cujec B, Sanfilippo AJ, Jue J, Turek M, Robinson T, Williams K. Effect of long-term aspirin use on embolic events in infective endocarditis. Clin Infect Dis. 2008 Jan 1;46(1):37-41. PubMed

Chan KL, Teo K, Dumesnil JG, Ni A, Tam J, ASTRONOMER Investigators. Effect of Lipid lowering with rosuvastatin on progression of aortic stenosis: results of the aortic stenosis progression observation: measuring effects of rosuvastatin (ASTRONOMER) trial. Circulation. 2010 Jan 19;121(2):306-14. PubMed

Chan KL. Early clinical course and long-term outcome of patients with infective endocarditis complicated by perivalvular abscess. CMAJ. 2002 Jul 9;167(1):19-24. PubMed

Chan KM, Punjabi PP, Flather M, Wage R, Symmonds K, Roussin I, Rahman-Haley S, Pennell DJ, Kilner PJ, Dreyfus GD, Pepper JR, RIME Investigators. Coronary artery bypass surgery with or without mitral valve annuloplasty in moderate functional ischemic mitral regurgitation: final results of the Randomized Ischemic Mitral Evaluation (RIME) trial. Circulation. 2012 Nov 20;126(21):2502-10. PubMed

Chan V, Burwash IG, Lam BK, Auyeung T, Tran A, Mesana TG, Ruel M. Clinical and echocardiographic impact of functional tricuspid regurgitation repair at the time of mitral valve replacement. Ann Thorac Surg. 2009 Oct;88(4):1209-15. PubMed

Chan WS, Anand S, Ginsberg JS. Anticoagulation of pregnant women with mechanical heart valves: a systematic review of the literature. Arch Intern Med. 2000 Jan 24;160(2):191-6. PubMed

Chauvaud S, Fuzellier JF, Berrebi A, Deloche A, Fabiani JN, Carpentier A. Long-term (29 years) results of reconstructive surgery in rheumatic mitral valve insufficiency. Circulation. 2001 Sep 18;104(12 Suppl 1):I12-5. PubMed

Chikwe J, Goldstone AB, Passage J, Anyanwu AC, Seeburger J, Castillo JG, Filsoufi F, Mohr FW, Adams DH. A propensity score-adjusted retrospective comparison of early and mid-term results of mitral valve repair versus replacement in octogenarians. Eur Heart J. 2011 Mar;32(5):618-26. PubMed

Chirouze C, Cabell CH, Fowler VG, Khayat N, Olaison L, Miro JM, Habib G, Abrutyn E, Eykyn S, Corey GR, Selton-Suty C, Hoen B, International Collaboration on Endocarditis Study Group. Prognostic factors in 61 cases of Staphylococcus aureus prosthetic valve infective endocarditis from the International Collaboration on Endocarditis merged database. Clin Infect Dis. 2004 May 1;38(9):1323-7. PubMed

Chockalingam A, Venkatesan S, Subramaniam T, Jagannathan V, Elangovan S, Alagesan R, Gnanavelu G, Dorairajan S, Krishna BP, Chockalingam V, Symptomatic Cardiac Obstruction-Pilot Study of Enalapril in Aortic Stenosis. Safety and efficacy of angiotensin-converting enzyme inhibitors in symptomatic severe aortic stenosis: Symptomatic Cardiac Obstruction-Pilot Study of Enalapril in Aortic Stenosis (SCOPE-AS). Am Heart J. 2004 Apr;147(4):E19. PubMed

Chung CS, Karamanoglu M, KovÃ¡cs SJ. Duration of diastole and its phases as a function of heart rate during supine bicycle exercise. Am J Physiol Heart Circ Physiol. 2004 Nov;287(5):H2003-8. PubMed

Clavel MA, Fuchs C, Burwash IG, Mundigler G, Dumesnil JG, Baumgartner H, BerglerKlein J, Beanlands RS, Mathieu P, Magne J, Pibarot

P. Predictors of outcomes in low-flow, low-gradient aortic stenosis: results of the multicenter TOPAS Study. Circulation. 2008 Sep 30;118(14 Suppl):S234-42. PubMed

Cohn LH, Rizzo RJ, Adams DH, Couper GS, Sullivan TE, Collins JJ, Aranki SF. The effect of pathophysiology on the surgical treatment of ischemic mitral regurgitation: operative and late risks of repair versus replacement. Eur J Cardiothorac Surg. 1995;9(10):568-74. PubMed

Cohn LH. Surgery for mitral regurgitation. JAMA. 1988 Nov 18;260(19):2883-7. PubMed

Colli A, Mestres CA, Castella M, Gherli T. Comparing warfarin to aspirin (WoA) after aortic valve replacement with the St. Jude Medical Epic heart valve bioprosthesis: results of the WoA Epic pilot trial. J Heart Valve Dis. 2007 Nov;16(6):667-71. PubMed

Connolly HM, Oh JK, Orszulak TA, Osborn SL, Roger VL, Hodge DO, Bailey KR, Seward JB, Tajik AJ. Aortic valve replacement for aortic stenosis with severe left ventricular dysfunction. Prognostic indicators. Circulation. 1997 May 20;95(10):2395-400. PubMed

Cooper WO, Hernandez-Diaz S, Arbogast PG, Dudley JA, Dyer S, Gideon PS, Hall K, Ray WA. Major congenital malformations after first-trimester exposure to ACE inhibitors. N Engl J Med. 2006 Jun 8;354(23):2443-51. PubMed

Cosgrove DM, Chavez AM, Lytle BW, Gill CC, Stewart RW, Taylor PC, Goormastic M, Borsh JA, Loop FD. Results of mitral valve reconstruction. Circulation. 1986 Sep;74(3 Pt 2):I82-7. PubMed

Cotrufo M, Renzulli A, Ismeno G, Caruso A, Mauro C, Caso P, De Simone L, Violini R. Percutaneous mitral commissurotomy versus open mitral commissurotomy: a comparative study. Eur J Cardiothorac Surg. 1999 May;15(5):646-51; discussion 651-2. PubMed

Cowell SJ, Newby DE, Prescott RJ, Bloomfield P, Reid J, Northridge DB, Boon NA, Scottish Aortic Stenosis and Lipid Lowering Trial, Impact on Regression (SALTIRE) Investigators. A randomized trial of intensive lipid-lowering therapy in calcific aortic stenosis. N Engl J Med. 2005 Jun 9;352(23):2389-97. PubMed

Cox JL. The surgical treatment of atrial fibrillation. IV. Surgical technique. J Thorac Cardiovasc Surg. 1991 Apr;101(4):584-92. PubMed

Crawford MH, Souchek J, Oprian CA, Miller DC, Rahimtoola S, Giacomini JC, Sethi G, Hammermeister KE. Determinants of survival and left ventricular performance after mitral valve replacement. Department of Veterans Affairs Cooperative Study on Valvular Heart Disease. Circulation. 1990 Apr;81(4):1173-81. PubMed

Currie PJ, Seward JB, Chan KL, Fyfe DA, Hagler DJ, Mair DD, Reeder GS, Nishimura RA, Tajik AJ. Continuous wave Doppler determination of right ventricular pressure: a simultaneous Doppler-catheterization study in 127 patients. J Am Coll Cardiol. 1985 Oct;6(4):750-6. PubMed

Currie PJ, Seward JB, Reeder GS, Vlietstra RE, Bresnahan DR, Bresnahan JF, Smith HC, Hagler DJ, Tajik AJ. Continuous-wave Doppler echocardiographic assessment of severity of calcific aortic stenosis: a simultaneous Doppler-catheter correlative study in 100 adult patients. Circulation. 1985 Jun;71(6):1162-9. PubMed

Dahm M, Iversen S, Schmid FX, Drexler M, Erbel R, Oelert H. Intraoperative evaluation of reconstruction of the atrioventricular valves by transesophageal echocardiography. Thorac Cardiovasc Surg. 1987 Nov;35(Spec No 2):140-2. PubMed

Daniel WG, MÃ¼gge A, Martin RP, Lindert O, Hausmann D, Nonnast-Daniel B, Laas J, Lichtlen PR. Improvement in the diagnosis of abscesses associated with endocarditis by transesophageal echocardiography. N Engl J Med. 1991 Mar 21;324(12):795-800. PubMed

Das P, Rimington H, Chambers J. Exercise testing to stratify risk in aortic stenosis. Eur Heart J. 2005 Jul;26(13):1309-13. PubMed

David TE, Burns RJ, Bacchus CM, Druck MN. Mitral valve replacement for mitral regurgitation with and without preservation of chordae tendineae. J Thorac Cardiovasc Surg. 1984 Nov;88(5 Pt 1):718-25. PubMed

David TE, Ivanov J, Armstrong S, Christie D, Rakowski H. A comparison of outcomes of mitral valve repair for degenerative disease with posterior, anterior, and bileaflet prolapse. J Thorac Cardiovasc Surg. 2005 Nov;130(5):1242-9. PubMed

David TE, Uden DE, Strauss HD. The importance of the mitral apparatus in left ventricular function after correction of mitral regurgitation. Circulation. 1983 Sep;68(3 Pt 2):II76-82. PubMed

Davies RR, Goldstein LJ, Coady MA, Tittle SL, Rizzo JA, Kopf GS, Elefteriades JA. Yearly rupture or dissection rates for thoracic aortic aneurysms: simple prediction based on size. Ann Thorac Surg. 2002 Jan;73(1):17-27; discussion 27-8. PubMed

De Santo LS, Romano G, Della Corte A, D'Oria V, Nappi G, Giordano S, Cotrufo M, De Feo M. Mechanical aortic valve replacement in young women planning on pregnancy: maternal and fetal outcomes under low oral anticoagulation, a pilot observational study on a comprehensive pre-operative counseling protocol. J Am Coll Cardiol. 2012 Mar 20;59(12):1110-5. PubMed

de Souza JA, Martinez EE, Ambrose JA, Alves CM, Born D, Buffolo E, Carvalho AC. Percutaneous balloon mitral valvuloplasty in comparison with open mitral valve commissurotomy for mitral stenosis during pregnancy. J Am Coll Cardiol. 2001 Mar 1;37(3):900-3. PubMed

Deja MA, Grayburn PA, Sun B, Rao V, She L, Krejca M, Jain AR, Leng Chua Y, Daly R, Senni M, Mokrzycki K, Menicanti L, Oh JK, Michler R, WrÃ³bel K, Lamy A, Velazquez EJ, Lee KL, Jones RH. Influence of mitral regurgitation repair on survival in the surgical treatment for ischemic heart failure trial. Circulation. 2012 May 29;125(21):2639-48. PubMed

Dellgren G, David TE, Raanani E, Armstrong S, Ivanov J, Rakowski H. Late hemodynamic and clinical outcomes of aortic valve replacement with the Carpentier-Edwards Perimount pericardial bioprosthesis. J Thorac Cardiovasc Surg. 2002 Jul;124(1):146-54. PubMed

Detaint D, Messika-Zeitoun D, Maalouf J, Tribouilloy C, Mahoney DW, Tajik AJ, Enriquez-Sarano M. Quantitative echocardiographic determinants of clinical outcome in asymptomatic patients with aortic regurgitation: a prospective study. JACC Cardiovasc Imaging. 2008 Jan;1(1):1-11. PubMed

Deviri E, Sareli P, Wisenbaugh T, Cronje SL. Obstruction of mechanical heart valve prostheses: clinical aspects and surgical management. J Am Coll Cardiol. 1991 Mar 1;17(3):646-50. PubMed

Di Mauro M, Bivona A, IacÃ² AL, Contini M, Gagliardi M, Varone E, Gallina S, Calafiore AM. Mitral valve surgery for functional mitral regurgitation: prognostic role of tricuspid regurgitation. Eur J Cardiothorac Surg. 2009 Apr;35(4):635-9; discussion 639-40. PubMed

Doukas G, Samani NJ, Alexiou C, Oc M, Chin DT, Stafford PG, Ng LL, Spyt TJ. Left atrial radiofrequency ablation during mitral valve surgery for continuous atrial fibrillation: a randomized controlled trial. JAMA. 2005 Nov 9;294(18):2323-9.

Dreyfus GD, Corbi PJ, Chan KM, Bahrami T. Secondary tricuspid regurgitation or dilatation: which should be the criteria for surgical repair?. Ann Thorac Surg. 2005 Jan;79(1):127-32. PubMed

Dujardin KS, Enriquez-Sarano M, Bailey KR, Seward JB, Tajik AJ. Effect of losartan on degree of mitral regurgitation quantified by echocardiography. Am J Cardiol. 2001 Mar 1;87(5):570-6. PubMed

Dujardin KS, Enriquez-Sarano M, Schaff HV, Bailey KR, Seward JB, Tajik AJ. Mortality and morbidity of aortic regurgitation in clinical practice. A long-term follow-up study. Circulation. 1999 Apr 13;99(14):1851-7. PubMed

Dujardin KS, Seward JB, Orszulak TA, Schaff HV, Bailey KR, Tajik AJ, Enriquez-Sarano M. Outcome after surgery for mitral regurgitation. Determinants of postoperative morbidity and mortality. J Heart Valve Dis. 1997 Jan;6(1):17-21. PubMed

Dumesnil JG, Honos GN, Lemieux M, Beauchemin J. Validation and applications of indexed aortic prosthetic valve areas calculated by Doppler echocardiography. J Am Coll Cardiol. 1990 Sep;16(3):637-43. PubMed

Durack DT, Lukes AS, Bright DK. New criteria for diagnosis of infective endocarditis: utilization of specific echocardiographic findings. Duke Endocarditis Service. Am J Med. 1994 Mar;96(3):200-9. PubMed

Duran CM, Gometza B, Saad E. Valve repair in rheumatic mitral disease: an unsolved problem. J Card Surg. 1994 Mar;9(2 Suppl):282-5. PubMed

Duval X, Alla F, Hoen B, Danielou F, Larrieu S, Delahaye F, Leport C, BrianÃ§on S. Estimated risk of endocarditis in adults with predisposing cardiac conditions undergoing dental procedures with or without antibiotic prophylaxis. Clin Infect Dis. 2006 Jun 15;42(12):e102-7. PubMed

Easterling TR, Chadwick HS, Otto CM, Benedetti TJ. Aortic stenosis in pregnancy. Obstet Gynecol. 1988 Jul;72(1):113-8. PubMed

Effect of enalapril on mortality and the development of heart failure in asymptomatic patients with reduced left ventricular ejection fractions. The SOLVD Investigators. N Engl J Med. 1992 Sep 3;327(10):685-91. PubMed

Eikelboom JW, Connolly SJ, Brueckmann M, Granger CB, Kappetein AP, Mack MJ, Blatchford J, Devenny K, Friedman J, Guiver K, Harper R, Khder Y, Lobmeyer MT, Maas H, Voigt JU, Simoons ML, Van de Werf F, RE-ALIGN Investigators. Dabigatran versus warfarin in patients with mechanical heart valves. N Engl J Med. 2013 Sep 26;369(13):1206-14. PubMed

El-Ahdab F, Benjamin DK Jr, Wang A, Cabell CH, Chu VH, Stryjewski ME, Corey GR, Sexton DJ, Reller LB, Fowler VG Jr. Risk of endocarditis among patients with prosthetic valves and Staphylococcus aureus bacteremia. Am J Med. 2005 Mar;118(3):225-9. PubMed

Elder DH, Wei L, Szwejkowski BR, Libianto R, Nadir A, Pauriah M, Rekhraj S, Lim TK, George J, Doney A, Pringle SD, Choy AM, Struthers AD, Lang CC. The impact of renin-angiotensin-aldosterone system blockade on heart failure outcomes and mortality in patients identified to have aortic regurgitation: a large population cohort study. J Am Coll Cardiol. 2011 Nov 8;58(20):2084-91. PubMed

Ellis K, Ziada KM, Vivekananthan D, Latif AA, Shaaraoui M, Martin D, Grimm RA. Transthoracic echocardiographic predictors of left atrial appendage thrombus. Am J Cardiol. 2006 Feb 1;97(3):421-5. PubMed

Ellis LB, Singh JB, Morales DD, Harken DE. Fifteen-to twenty-year study of one thousand patients undergoing closed mitral valvuloplasty. Circulation. 1973 Aug;48(2):357-64. PubMed

Ellis ME, Al-Abdely H, Sandridge A, Greer W, Ventura W. Fungal endocarditis: evidence in the world literature, 1965-1995. Clin Infect Dis. 2001 Jan;32(1):50-62. PubMed

Enriquez-Sarano M, Avierinos JF, Messika-Zeitoun D, Detaint D, Capps M, Nkomo V, Scott C, Schaff HV, Tajik AJ. Quantitative determinants of the outcome of asymptomatic mitral regurgitation. N Engl J Med. 2005 Mar 3;352(9):875-83. PubMed

Enriquez-Sarano M, Tajik AJ, Schaff HV, Orszulak TA, Bailey KR, Frye RL. Echocardiographic prediction of survival after surgical correction of organic mitral regurgitation. Circulation. 1994 Aug;90(2):830-7. PubMed

Enriquez-Sarano M, Tajik AJ, Schaff HV, Orszulak TA, McGoon MD, Bailey KR, Frye RL. Echocardiographic prediction of left ventricular

function after correction of mitral regurgitation: results and clinical implications. J Am Coll Cardiol. 1994 Nov 15;24(6):1536-43. PubMed

Erbel R, Rohmann S, Drexler M, Mohr-Kahaly S, Gerharz CD, Iversen S, Oelert H, Meyer J. Improved diagnostic value of echocardiography in patients with infective endocarditis by transoesophageal approach. A prospective study. Eur Heart J. 1988 Jan;9(1):43-53. PubMed

Eriksson SV, Eneroth P, Kjekshus J, Offstad J, Swedberg K. Neuroendocrine activation in relation to left ventricular function in chronic severe congestive heart failure: a subgroup analysis from the Cooperative North Scandinavian Enalapril Survival Study (CONSENSUS). Clin Cardiol. 1994 Nov;17(11):603-6. PubMed

Evangelista A, Tornos P, Sambola A, Permanyer-Miralda G, Soler-Soler J. Long-term vasodilator therapy in patients with severe aortic regurgitation. N Engl J Med. 2005 Sep 29;353(13):1342-9. PubMed

Fagman E, Perrotta S, Bech-Hanssen O, Flinck A, Lamm C, Olaison L, Svensson G. ECG-gated computed tomography: a new role for patients with suspected aortic prosthetic valve endocarditis. Eur Radiol. 2012 Nov;22(11):2407-14. PubMed

Fang MC, Go AS, Chang Y, Hylek EM, Henault LE, Jensvold NG, Singer DE. Death and disability from warfarin-associated intracranial and extracranial hemorrhages. Am J Med. 2007 Aug;120(8):700-5. PubMed

Fattouch K, Guccione F, Sampognaro R, Panzarella G, Corrado E, Navarra E, Calvaruso D, Ruvolo G. POINT: Efficacy of adding mitral valve restrictive annuloplasty to coronary artery bypass grafting in patients with moderate ischemic mitral valve regurgitation: a randomized trial. J Thorac Cardiovasc Surg. 2009 Aug;138(2):278-85. PubMed

FDA Drug Safety Communication: Pradaxa (dabigatran etexilate mesylate) should not be used in patients with mechanical prosthetic heart valves. [internet]. U.S. Food and Drug Administration (FDA); 2012 [accessed 2014 Feb 20].

Feldman T, Foster E, Glower DG, Kar S, Rinaldi MJ, Fail PS, Smalling RW, Siegel R, Rose GA, Engeron E, Loghin C, Trento A, Skipper ER, Fudge T, Letsou GV, Massaro JM, Mauri L, the EVEREST II Investigators. Percutaneous Repair or Surgery for Mitral Regurgitation. N Engl J Med. 2011 Apr 14;364(15):1395-406. PubMed

Feuchtner GM, Stolzmann P, Dichtl W, Schertler T, Bonatti J, Scheffel H, Mueller S, Plass A, Mueller L, Bartel T, Wolf F, Alkadhi H. Multislice computed tomography in infective endocarditis: comparison with transesophageal echocardiography and intraoperative findings. J Am Coll Cardiol. 2009 Feb 3;53(5):436-44. PubMed

Finnegan JO, Gray DC, MacVaugh H, Joyner CR, Johnson J. The open approach to mitral commissurotomy. J Thorac Cardiovasc Surg. 1974 Jan;67(1):75-82. PubMed

Forman R, Firth BG, Barnard MS. Prognostic significance of preoperative left ventricular ejection fraction and valve lesion in patients with aortic valve replacement. Am J Cardiol. 1980 Jun;45(6):1120-5. PubMed

FougÃ¨res E, Tribouilloy C, Monchi M, Petit-Eisenmann H, Baleynaud S, Pasquet A, Chauvel C, Metz D, Adams C, Rusinaru D, GuÃ©ret P, Monin JL. Outcomes of pseudo-severe aortic stenosis under conservative treatment. Eur Heart J. 2012 Oct;33(19):2426-33. PubMed

Fowler VG Jr, Li J, Corey GR, Boley J, Marr KA, Gopal AK, Kong LK, Gottlieb G, Donovan CL, Sexton DJ, Ryan T. Role of echocardiography in evaluation of patients with Staphylococcus aureus bacteremia: experience in 103 patients. J Am Coll Cardiol. 1997 Oct;30(4):1072-8. PubMed

Gaasch WH, Carroll JD, Levine HJ, Criscitiello MG. Chronic aortic regurgitation: prognostic value of left ventricular end-systolic dimension and end-diastolic radius/thickness ratio. J Am Coll Cardiol. 1983 Mar;1(3):775-82. PubMed

Gahide G, Bommart S, Demaria R, Sportouch C, Dambia H, Albat B, Vernhet-Kovacsik H. Preoperative evaluation in aortic endocarditis: findings on cardiac CT. AJR Am J Roentgenol. 2010 Mar;194(3):574-8. PubMed

Galan A, Zoghbi WA, QuiÃ±ones MA. Determination of severity of valvular aortic stenosis by Doppler echocardiography and relation of findings to clinical outcome and agreement with hemodynamic measurements determined at cardiac catheterization. Am J Cardiol. 1991 May 1;67(11):1007-12. PubMed

Galas A, Hryniewiecki T, Kepka C, Michalowska I, Abramczuk E, Orlowska Baranowska E, Demkow M, Ruzyllo W. May dual-source computed tomography angiography replace invasive coronary angiography in the evaluation of patients referred for valvular disease surgery?. Kardiol Pol. 2012;70(9):877-82. PubMed

Gammie JS, Sheng S, Griffith BP, Peterson ED, Rankin JS, O'Brien SM, Brown JM. Trends in mitral valve surgery in the United States: results from the Society of Thoracic Surgeons Adult Cardiac Surgery Database. Ann Thorac Surg. 2009 May;87(5):1431-7; discussion 1437-9. PubMed

Gelfand EV, Hughes S, Hauser TH, Yeon SB, Goepfert L, Kissinger KV, Rofsky NM, Manning WJ. Severity of mitral and aortic regurgitation as assessed by cardiovascular magnetic resonance: optimizing correlation with Doppler echocardiography. J Cardiovasc Magn Resonance. 2006;8(3):503-7. PubMed

Gerber MA, Baltimore RS, Eaton CB, Gewitz M, Rowley AH, Shulman ST, Taubert KA. Prevention of rheumatic fever and diagnosis and treatment of acute streptococcal pharyngitis: a scientific statement from the AHA Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee of the Council on Cardiovascular Disease in the Young [trunc]. Circulation. 2009 Mar 24;119(11):1541-51. PubMed

Ghoreishi M, Evans CF, DeFilippi CR, Hobbs G, Young CA, Griffith BP, Gammie JS. Pulmonary hypertension adversely affects short- and long-term survival after mitral valve operation for mitral regurgitation: implications for timing of surgery. J Thorac Cardiovasc Surg. 2011 Dec;142(6):1439-52. PubMed

Gilard M, Cornily JC, Pennec PY, Joret C, Le Gal G, Mansourati J, Blanc JJ, Boschat J. Accuracy of multislice computed tomography in the preoperative assessment of coronary disease in patients with aortic valve stenosis. J Am Coll Cardiol. 2006 May 16;47(10):2020-4. PubMed

Gillinov AM, Blackstone EH, Cosgrove DM, White J, Kerr P, Marullo A, McCarthy PM, Lytle BW. Mitral valve repair with aortic valve replacement is superior to double valve replacement. J Thorac Cardiovasc Surg. 2003 Jun;125(6):1372-87. PubMed

Gillinov AM, Blackstone EH, Nowicki ER, Slisatkorn W, Al-Dossari G, Johnston DR, George KM, Houghtaling PL, Griffin B, Sabik JF, Svensson LG. Valve repair versus valve replacement for degenerative mitral valve disease. J Thorac Cardiovasc Surg. 2008 Apr;135(4):885-93, 893.e1-2. PubMed

Gillinov AM, Mihaljevic T, Blackstone EH, George K, Svensson LG, Nowicki ER, Sabik JF, Houghtaling PL, Griffin B. Should patients with severe degenerative mitral regurgitation delay surgery until symptoms develop?. Ann Thorac Surg. 2010 Aug;90(2):481-8. PubMed

Ginsberg JS, Chan WS, Bates SM, Kaatz S. Anticoagulation of pregnant women with mechanical heart valves. Arch Intern Med. 2003 Mar 24;163(6):694-8. PubMed

Glantz JC, Pomerantz RM, Cunningham MJ, Woods JR. Percutaneous balloon valvuloplasty for severe mitral stenosis during pregnancy: a review of therapeutic options. Obstet Gynecol Surv. 1993 Jul;48(7):503-8. PubMed

Goldman ME, Mora F, Guarino T, Fuster V, Mindich BP. Mitral valvuloplasty is superior to valve replacement for preservation of left ventricular function: an intraoperative two-dimensional echocardiographic study. J Am Coll Cardiol. 1987 Sep;10(3):568-75. PubMed

Gordon SM, Serkey JM, Longworth DL, Lytle BW, Cosgrove DM. Early onset prosthetic valve endocarditis: the Cleveland Clinic experience 1992-1997. Ann Thorac Surg. 2000 May;69(5):1388-92. PubMed

Granger CB, McMurray JJ, Yusuf S, Held P, Michelson EL, Olofsson B, Ostergren J, Pfeffer MA, Swedberg K. Effects of candesartan in patients with chronic heart failure and reduced left-ventricular systolic function intolerant to angiotensin-converting-enzyme inhibitors: the CHARM-Alternative trial. Lancet. 2003 Sep 6;362(9386):772-6. PubMed

Greves J, Rahimtoola SH, McAnulty JH, DeMots H, Clark DG, Greenberg B, Starr A. Preoperative criteria predictive of late survival following valve replacement for severe aortic regurgitation. Am Heart J. 1981 Mar;101(3):300-8. PubMed

Grigioni F, Enriquez-Sarano M, Ling LH, Bailey KR, Seward JB, Tajik AJ, Frye RL. Sudden death in mitral regurgitation due to flail leaflet. J Am Coll Cardiol. 1999 Dec;34(7):2078-85. PubMed

Grigioni F, Enriquez-Sarano M, Zehr KJ, Bailey KR, Tajik AJ. Ischemic mitral regurgitation: long-term outcome and prognostic implications with quantitative Doppler assessment. Circulation. 2001 Apr 3;103(13):1759-64. PubMed

Grigioni F, Tribouilloy C, Avierinos JF, Barbieri A, Ferlito M, Trojette F, Tafanelli L, Branzi A, Szymanski C, Habib G, Modena MG, Enriquez-Sarano M, MIDA Investigators. Outcomes in mitral regurgitation due to flail leaflets a multicenter European study. JACC Cardiovasc Imaging. 2008 Mar;1(2):133-41. PubMed

Gross RI, Cunningham JN, Snively SL, Catinella FP, Nathan IM, Adams PX, Spencer FC. Long-term results of open radical mitral commissurotomy: ten year follow-up study of 202 patients. Am J Cardiol. 1981 Apr;47(4):821-5. PubMed

Grossi EA, Galloway AC, Miller JS, Ribakove GH, Culliford AT, Esposito R, Delianides J, Buttenheim PM, Baumann FG, Spencer FC, Colvin SB. Valve repair versus replacement for mitral insufficiency: when is a mechanical valve still indicated?. J Thorac Cardiovasc Surg. 1998 Feb;115(2):389-94; discussion 394-6. PubMed

Guarner-Argente C, Shah P, Buchner A, Ahmad NA, Kochman ML, Ginsberg GG. Use of antimicrobials for EUS-guided FNA of pancreatic cysts: a retrospective, comparative analysis. Gastrointest Endosc. 2011 Jul;74(1):81-6.

Hahn RT, Roman MJ, Mogtader AH, Devereux RB. Association of aortic dilation with regurgitant, stenotic and functionally normal bicuspid aortic valves. J Am Coll Cardiol. 1992 Feb;19(2):283-8. PubMed

Halseth WL, Elliott DP, Walker EL, Smith EA. Open mitral commissurotomy. A modern re-evaluation. J Thorac Cardiovasc Surg. 1980 Dec;80(6):842-8. PubMed

Hammermeister K, Sethi GK, Henderson WG, Grover FL, Oprian C, Rahimtoola SH. Outcomes 15 years after valve replacement with a mechanical versus a bioprosthetic valve: final report of the Veterans Affairs randomized trial. J Am Coll Cardiol. 2000 Oct;36(4):1152-8.

Hansen DE, Sarris GE, Niczyporuk MA, Derby GC, Cahill PD, Miller DC. Physiologic role of the mitral apparatus in left ventricular regional mechanics, contraction synergy, and global systolic performance. J Thorac Cardiovasc Surg. 1989 Apr;97(4):521-33. PubMed

Harris KM, Aeppli DM, Carey CF. Effects of angiotensin-converting enzyme inhibition on mitral regurgitation severity, left ventricular size, and functional capacity. Am Heart J. 2005 Nov;150(5):1106. PubMed

Harris KM, Sundt TM 3rd, Aeppli D, Sharma R, Barzilai B. Can late survival of patients with moderate ischemic mitral regurgitation be impacted by intervention on the valve. Ann Thorac Surg. 2002 Nov;74(5):1468-75. PubMed

Hasbun R, Vikram HR, Barakat LA, Buenconsejo J, Quagliarello VJ. Complicated left-sided native valve endocarditis in adults: risk classification for mortality. JAMA. 2003 Apr 16;289(15):1933-40. PubMed

Hennein HA, Swain JA, McIntosh CL, Bonow RO, Stone CD, Clark RE. Comparative assessment of chordal preservation versus chordal resection during mitral valve replacement. J Thorac Cardiovasc Surg. 1990 May;99(5):828-36; discussion 836-7. PubMed

Heras M, Chesebro JH, Fuster V, Penny WJ, Grill DE, Bailey KR, Danielson GK, Orszulak TA, Pluth JR, Puga FJ. High risk of thromboemboli early after bioprosthetic cardiac valve replacement. J Am Coll Cardiol. 1995 Apr;25(5):1111-9. PubMed

Hering D, Piper C, Bergemann R, Hillenbach C, Dahm M, Huth C, Horstkotte D. Thromboembolic and bleeding complications following St. Jude Medical valve replacement: results of the German Experience With Low-Intensity Anticoagulation Study. Chest. 2005 Jan;127(1):53-9. PubMed

Hill EE, Herijgers P, Claus P, Vanderschueren S, Herregods MC, Peetermans WE. Infective endocarditis: changing epidemiology and predictors of 6-month mortality: a prospective cohort study. Eur Heart J. 2007 Jan;28(2):196-203. PubMed

Hill EE, Herijgers P, Claus P, Vanderschueren S, Peetermans WE, Herregods MC. Abscess in infective endocarditis: the value of transesophageal echocardiography and outcome: a 5-year study. Am Heart J. 2007 Nov;154(5):923-8. PubMed

Ho HH, Siu CW, Yiu KH, Tse HF, Chui WH, Chow WH. Prosthetic valve endocarditis in a multicenter registry of Chinese patients. Asian Cardiovasc Thorac Ann. 2010 Oct;18(5):430-4. PubMed

Horskotte D, Schulte HD, Bircks W, Strauer BE. The effect of chordal preservation on late outcome after mitral valve replacement: a randomized study. J Heart Valve Dis. 1993 Mar;2(2):150-8. PubMed

Horstkotte D, Loogen F. The natural history of aortic valve stenosis. Eur Heart J. 1988 Apr;9(Suppl E):57-64. PubMed

Horstkotte D, Scharf RE, Schultheiss HP. Intracardiac thrombosis: patient-related and device-related factors. J Heart Valve Dis. 1995 Mar;4(2):114-20. PubMed

Horstkotte D. Contribution for choosing the optimal prophylaxis of bacterial endocarditis. Eur Heart J. 1987;:379-81.

Irani WN, Grayburn PA, Afridi I. A negative transthoracic echocardiogram obviates the need for transesophageal echocardiography in patients with suspected native valve active infective endocarditis. Am J Cardiol. 1996 Jul 1;78(1):101-3. PubMed

Ishii K, Hirota Y, Suwa M, Kita Y, Onaka H, Kawamura K. Natural history and left ventricular response in chronic aortic regurgitation. Am J Cardiol. 1996 Aug 1;78(3):357-61. PubMed

Iung B, Cormier B, Ducimetiere P, Porte JM, Nallet O, Michel PL, Acar J, Vahanian A. Functional results 5 years after successful percutaneous mitral commissurotomy in a series of 528 patients and analysis of predictive factors. J Am Coll Cardiol. 1996 Feb;27(2):407-14. PubMed

Iung B, Cormier B, Elias J, Michel PL, Nallet O, Porte JM, Sananes S, Uzan S, Vahanian A, Acar J. Usefulness of percutaneous balloon commissurotomy for mitral stenosis during pregnancy. Am J Cardiol. 1994 Feb 15;73(5):398-400. PubMed

James AH, Brancazio LR, Gehrig TR, Wang A, Ortel TL. Low-molecular-weight heparin for thromboprophylaxis in pregnant women with mechanical heart valves. J Matern Fetal Neonatal Med. 2006 Sep;19(9):543-9. PubMed

Jault F, Gandjbakhch I, Chastre JC, Levasseur JP, Bors V, Gibert C, Pavie A, Cabrol C. Prosthetic valve endocarditis with ring abscesses. Surgical management and long-term results. J Thorac Cardiovasc Surg. 1993 Jun;105(6):1106-13. PubMed

Jault F, Gandjbakhch I, Rama A, Nectoux M, Bors V, Vaissier E, Nataf P, Pavie A, Cabrol C. Active native valve endocarditis: determinants of operative death and late mortality. Ann Thorac Surg. 1997 Jun;63(6):1737-41. PubMed

John S, Bashi VV, Jairaj PS, Muralidharan S, Ravikumar E, Rajarajeswari T, Krishnaswami S, Sukumar IP, Rao PS. Closed mitral valvotomy: early results and long-term follow-up of 3724 consecutive patients. Circulation. 1983 Nov;68(5):891-6. PubMed

Kaasch AJ, Fowler VG, Rieg S, Peyerl-Hoffmann G, Birkholz H, Hellmich M, Kern WV, Seifert H. Use of a simple criteria set for guiding echocardiography in nosocomial Staphylococcus aureus bacteremia. Clin Infect Dis. 2011 Jul 1;53(1):1-9. PubMed

Kang DH, Kim JH, Rim JH, Kim MJ, Yun SC, Song JM, Song H, Choi KJ, Song JK, Lee JW. Comparison of early surgery versus conventional treatment in asymptomatic severe mitral regurgitation. Circulation. 2009 Feb 17;119(6):797-804. PubMed

Kang DH, Kim YJ, Kim SH, Sun BJ, Kim DH, Yun SC, Song JM, Choo SJ, Chung CH, Song JK, Lee JW, Sohn DW. Early surgery versus conventional treatment for infective endocarditis. N Engl J Med. 2012 Jun 28;366(26):2466-73. PubMed

Karalis DG, Bansal RC, Hauck AJ, Ross JJ, Applegate PM, Jutzy KR, Mintz GS, Chandrasekaran K. Transesophageal echocardiographic recognition of subaortic complications in aortic valve endocarditis. Clinical and surgical implications. Circulation. 1992 Aug;86(2):353-62. PubMed

Karthikeyan G, Senguttuvan NB, Joseph J, Devasenapathy N, Bahl VK, Airan B. Urgent surgery compared with fibrinolytic therapy for the treatment of left-sided prosthetic heart valve thrombosis: a systematic review and meta-analysis of observational studies. Eur Heart J. 2013 Jun;34(21):1557-66. PubMed

Kawaguchi AT, Kosakai Y, Sasako Y, Eishi K, Nakano K, Kawashima Y. Risks and benefits of combined maze procedure for atrial fibrillation associated with organic heart disease. J Am Coll Cardiol. 1996 Oct;28(4):985-90. PubMed

Keane MG, Wiegers SE, Plappert T, Pochettino A, Bavaria JE, Sutton MG. Bicuspid aortic valves are associated with aortic dilatation out of proportion to coexistent valvular lesions. Circulation. 2000 Nov 7;102(19 Suppl 3):III35-9. PubMed

Kelly TA, Rothbart RM, Cooper CM, Kaiser DL, Smucker ML, Gibson RS. Comparison of outcome of asymptomatic to symptomatic patients older than 20 years of age with valvular aortic stenosis. Am J Cardiol. 1988 Jan 1;61(1):123-30. PubMed

Kemp WE, Citrin B, Byrd BF. Echocardiography in infective endocarditis. South Med J. 1999 Aug;92(8):744-54. PubMed

Keuleers S, Herijgers P, Herregods MC, Budts W, Dubois C, Meuris B, Verhamme P, Flameng W, Van de Werf F, Adriaenssens T. Comparison of thrombolysis versus surgery as a first line therapy for prosthetic heart valve thrombosis. Am J Cardiol. 2011 Jan 15;107(2):275-9. PubMed

Kiefer T, Park L, Tribouilloy C, Cortes C, Casillo R, Chu V, Delahaye F, Durante-Mangoni E, Edathodu J, Falces C, Logar M, MirÃ³ JM, Naber C, Tripodi MF, Murdoch DR, Moreillon P, Utili R, Wang A. Association between valvular surgery and mortality among patients with infective endocarditis complicated by heart failure. JAMA. 2011 Nov 23;306(20):2239-47. PubMed

Kim JB, Yoo DG, Kim GS, Song H, Jung SH, Choo SJ, Chung CH, Lee JW. Mild-to-moderate functional tricuspid regurgitation in patients undergoing valve replacement for rheumatic mitral disease: the influence of tricuspid valve repair on clinical and echocardiographic outcomes. Heart. 2012 Jan;98(1):24-30. PubMed

Kizilbash AM, Willett DL, Brickner ME, Heinle SK, Grayburn PA. Effects of afterload reduction on vena contracta width in mitral regurgitation. J Am Coll Cardiol. 1998 Aug;32(2):427-31. PubMed

Klieverik LM, Yacoub MH, Edwards S, Bekkers JA, Roos-Hesselink JW, Kappetein AP, Takkenberg JJ, Bogers AJ. Surgical treatment of active native aortic valve endocarditis with allografts and mechanical prostheses. Ann Thorac Surg. 2009 Dec;88(6):1814-21. PubMed

Klodas E, Enriquez-Sarano M, Tajik AJ, Mullany CJ, Bailey KR, Seward JB. Optimizing timing of surgical correction in patients with severe aortic regurgitation: role of symptoms. J Am Coll Cardiol. 1997 Sep;30(3):746-52. PubMed

Knudsen JB, Fuursted K, Petersen E, Wierup P, MÃ¸lgaard H, Poulsen SH, Egeblad H. Failure of clinical features of low probability endocarditis. The early echo remains essential. Scand Cardiovasc J. 2011 Jun;45(3):133-8. PubMed

Kobayashi J, Kosakai Y, Isobe F, Sasako Y, Nakano K, Eishi K, Kawashima Y. Rationale of the Cox maze procedure for atrial fibrillation during redo mitral valve operations. J Thorac Cardiovasc Surg. 1996 Nov;112(5):1216-21; discussion 1222. PubMed

Kodali SK, Williams MR, Smith CR, Svensson LG, Webb JG, Makkar RR, Fontana GP, Dewey TM, Thourani VH, Pichard AD, Fischbein M, Szeto WY, Lim S, Greason KL, Teirstein PS, Malaisrie SC, Douglas PS, Hahn RT, Whisenant B, Zajarias A, Wang D, Akin JJ, Anderson WN, Leon MB, PARTNER Trial Investigators. Two-year outcomes after transcatheter or surgical aortic-valve replacement. N Engl J Med. 2012 May 3;366(18):1686-95. PubMed

Kronzon I, Tunick PA, Glassman E, Slater J, Schwinger M, Freedberg RS. Transesophageal echocardiography to detect atrial clots in candidates for percutaneous transseptal mitral balloon valvuloplasty. J Am Coll Cardiol. 1990 Nov;16(5):1320-2. PubMed

Krum H, Roecker EB, Mohacsi P, Rouleau JL, Tendera M, Coats AJ, Katus HA, Fowler MB, Packer M, Carvedilol Prospective Randomized Cumulative Survival (COPERNICUS) Study Group. Effects of initiating carvedilol in patients with severe chronic heart failure: results from the COPERNICUS Study. JAMA. 2003 Feb 12;289(6):712-8. PubMed

Kupferwasser LI, Darius H, MÃ¼ller AM, Martin C, Mohr-Kahaly S, Erbel R, Meyer J. Diagnosis of culture-negative endocarditis: the role of the Duke criteria and the impact of transesophageal echocardiography. Am Heart J. 2001 Jul;142(1):146-52. PubMed

Lancellotti P, Donal E, Magne J, Moonen M, OConnor K, Daubert JC, Pierard LA. Risk stratification in asymptomatic moderate to severe aortic stenosis: the importance of the valvular, arterial and ventricular interplay. Heart. 2010 Sep;96(17):1364-71. PubMed

Lancellotti P, GÃ©rard PL, PiÃ©rard LA. Long-term outcome of patients with heart failure and dynamic functional mitral regurgitation. Eur Heart J. 2005 Aug;26(15):1528-32. PubMed

Lancellotti P, Lebois F, Simon M, Tombeux C, Chauvel C, Pierard LA. Prognostic importance of quantitative exercise Doppler echocardiography in asymptomatic valvular aortic stenosis. Circulation. 2005 Aug 30;112(9 Suppl):I377-82. PubMed

Lang RM, Badano LP, Tsang W, Adams DH, Agricola E, Buck T, Faletra FF, Franke A, Hung J, de Isla LP, Kamp O, Kasprzak JD, Lancellotti P, Marwick TH, McCulloch ML, Monaghan MJ, Nihoyannopoulos P, Pandian NG, Pellikka PA, Pepi M, Roberson DA, Shernan SK, Shirali GS, Sugeng L, Ten Cate FJ, Vannan MA, Zamorano JL, Zoghbi WA, American Society of Echocardiography, European Association of Echocardiography. EAE/ASE recommendations for image acquisition and display using three-dimensional echocardiography. J Am Soc Echocardiogr. 2012 Jan;25(1):3-46. PubMed

Lao TT, Adelman AG, Sermer M, Colman JM. Balloon valvuloplasty for congenital aortic stenosis in pregnancy. Br J Obstet Gynaecol. 1993 Dec;100(12):1141-2. PubMed

Leavitt JI, Coats MH, Falk RH. Effects of exercise on transmitral gradient and pulmonary artery pressure in patients with mitral stenosis or a

prosthetic mitral valve: a Doppler echocardiographic study. J Am Coll Cardiol. 1991 Jun;17(7):1520-6. PubMed

Lentini S, Monaco F, Tancredi F, Savasta M, Gaeta R. Aortic valve infective endocarditis: could multi-detector CT scan be proposed for routine screening of concomitant coronary artery disease before surgery?. Ann Thorac Surg. 2009 May;87(5):1585-7. PubMed

Leon MB, Smith CR, Mack M, Miller DC, Moses JW, Svensson LG, Tuzcu EM, Webb JG, Fontana GP, Makkar RR, Brown DL, Block PC, Guyton RA, Pichard AD, Bavaria JE, Herrmann HC, Douglas PS, Petersen JL, Akin JJ, Anderson WN, Wang D, Pocock S. Transcatheter aortic-valve implantation for aortic stenosis in patients who cannot undergo surgery. N Engl J Med. 2010 Oct 21;363(17):1597-607. PubMed

Li JS, Sexton DJ, Mick N, Nettles R, Fowler VG, Ryan T, Bashore T, Corey GR. Proposed modifications to the Duke criteria for the diagnosis of infective endocarditis. Clin Infect Dis. 2000 Apr;30(4):633-8. PubMed

Lieberman A, Hass WK, Pinto R, Isom WO, Kupersmith M, Bear G, Chase R. Intracranial hemorrhage and infarction in anticoagulated patients with prosthetic heart valves. Stroke. 1978 Jan-Feb;9(1):18-24. PubMed

Lin SS, Roger VL, Pascoe R, Seward JB, Pellikka PA. Dobutamine stress Doppler hemodynamics in patients with aortic stenosis: feasibility, safety, and surgical correlations. Am Heart J. 1998 Dec;136(6):1010-6. PubMed

Liu X, Tan HW, Wang XH, Shi HF, Li YZ, Li F, Zhou L, Gu JN. Efficacy of catheter ablation and surgical CryoMaze procedure in patients with long-lasting persistent atrial fibrillation and rheumatic heart disease: a randomized trial. Eur Heart J. 2010 Nov;31(21):2633-41. PubMed

Liu YW, Tsai WC, Hsu CH, Lin LJ, Li WT, Chen CH, Chen JH. Judicious use of transthoracic echocardiography in infective endocarditis screening. Can J Cardiol. 2009 Dec;25(12):703-5. PubMed

LÃ³pez J, Sevilla T, Vilacosta I, SarriÃ¡ C, Revilla A, Ortiz C, Ferrera C, Olmos C, GÃ³mez I, San RomÃ¡n JA. Prognostic role of persistent positive blood cultures after initiation of antibiotic therapy in left-sided infective endocarditis. Eur Heart J. 2013 Jun;34(23):1749-54. PubMed

Magne J, Lancellotti P, PiÃ©rard LA. Exercise-induced changes in degenerative mitral regurgitation. J Am Coll Cardiol. 2010 Jul 20;56(4):300-9. PubMed

Magne J, Mahjoub H, Pierard LA, OConnor K, Pirlet C, Pibarot P, Lancellotti P. Prognostic importance of brain natriuretic peptide and left ventricular longitudinal function in asymptomatic degenerative mitral regurgitation. Heart. 2012 Apr;98(7):584-91. PubMed

Makkar RR, Fontana GP, Jilaihawi H, Kapadia S, Pichard AD, Douglas PS, Thourani VH, Babaliaros VC, Webb JG, Herrmann HC, Bavaria JE, Kodali S, Brown DL, Bowers B, Dewey TM, Svensson LG, Tuzcu M, Moses JW, Williams MR, Siegel RJ, Akin JJ, Anderson WN, Pocock S, Smith CR, Leon MB, PARTNER Trial Investigators. Transcatheter aortic-valve replacement for inoperable severe aortic stenosis. N Engl J Med. 2012 May 3;366(18):1696-704. PubMed

Manghat NE, Morgan-Hughes GJ, Broadley AJ, Undy MB, Wright D, Marshall AJ, Roobottom CA. 16-detector row computed tomographic coronary angiography in patients undergoing evaluation for aortic valve replacement: comparison with catheter angiography. Clin Radiol. 2006 Sep;61(9):749-57. PubMed

Manne MB, Shrestha NK, Lytle BW, Nowicki ER, Blackstone E, Gordon SM, Pettersson G, Fraser TG. Outcomes after surgical treatment of native and prosthetic valve infective endocarditis. Ann Thorac Surg. 2012 Feb;93(2):489-93. PubMed

MarÃ©chaux S, Hachicha Z, Bellouin A, Dumesnil JG, Meimoun P, Pasquet A, Bergeron S, Arsenault M, Le Tourneau T, Ennezat PV, Pibarot P. Usefulness of exercise-stress echocardiography for risk stratification of true asymptomatic patients with aortic valve stenosis. Eur Heart J. 2010 Jun;31(11):1390-7. PubMed

Masuda J, Yutani C, Waki R, Ogata J, Kuriyama Y, Yamaguchi T. Histopathological analysis of the mechanisms of intracranial hemorrhage complicating infective endocarditis. Stroke. 1992 Jun;23(6):843-50. PubMed

McClure RS, Athanasopoulos LV, McGurk S, Davidson MJ, Couper GS, Cohn LH. One thousand minimally invasive mitral valve operations: early outcomes, late outcomes, and echocardiographic follow-up. J Thorac Cardiovasc Surg. 2013 May;145(5):1199-206. PubMed

McIvor RA. Percutaneous balloon aortic valvuloplasty during pregnancy. Int J Cardiol. 1991 Jul;32(1):1-3. PubMed

McLintock C, McCowan LM, North RA. Maternal complications and pregnancy outcome in women with mechanical prosthetic heart valves treated with enoxaparin. BJOG. 2009 Nov;116(12):1585-92. PubMed

Meijboom WB, Mollet NR, Van Mieghem CA, Kluin J, Weustink AC, Pugliese F, Vourvouri E, Cademartiri F, Bogers AJ, Krestin GP, de Feyter PJ. Pre-operative computed tomography coronary angiography to detect significant coronary artery disease in patients referred for cardiac valve surgery. J Am Coll Cardiol. 2006 Oct 17;48(8):1658-65. PubMed

Melgar GR, Nasser RM, Gordon SM, Lytle BW, Keys TF, Longworth DL. Fungal prosthetic valve endocarditis in 16 patients. An 11-year experience in a tertiary care hospital. Medicine. 1997 Mar;76(2):94-103. PubMed

MÃ©rie C, KÃ¸ber L, Skov Olsen P, Andersson C, Gislason G, Skov Jensen J, Torp-Pedersen C. Association of warfarin therapy duration after bioprosthetic aortic valve replacement with risk of mortality, thromboembolic complications, and bleeding. JAMA. 2012 Nov 28;308(20):2118-25. PubMed

Meschengieser SS, Fondevila CG, Frontroth J, Santarelli MT, Lazzari MA. Low-intensity oral anticoagulation plus low-dose aspirin versus high-intensity oral anticoagulation alone: a randomized trial in patients with mechanical prosthetic heart valves. J Thorac Cardiovasc Surg. 1997 May;113(5):910-6. PubMed

Meschengieser SS, Fondevila CG, Santarelli MT, Lazzari MA. Anticoagulation in pregnant women with mechanical heart valve prostheses. Heart. 1999 Jul;82(1):23-6. PubMed

Messika-Zeitoun D, Johnson BD, Nkomo V, Avierinos JF, Allison TG, Scott C, Tajik AJ, EnriquezSarano M. Cardiopulmonary exercise testing determination of functional capacity in mitral regurgitation: physiologic and outcome implications. J Am Coll Cardiol. 2006 Jun 20;47(12):2521-7. PubMed

Michelena HI, Khanna AD, Mahoney D, Margaryan E, Topilsky Y, Suri RM, Eidem B, Edwards WD, Sundt TM, EnriquezSarano M. Incidence of aortic complications in patients with bicuspid aortic valves. JAMA. 2011 Sep 14;306(10):1104-12. PubMed

Middlemost S, Wisenbaugh T, Meyerowitz C, Teeger S, Essop R, Skoularigis J, Cronje S, Sareli P. A case for early surgery in native left-sided endocarditis complicated by heart failure: results in 203 patients. J Am Coll Cardiol. 1991 Sep;18(3):663-7. PubMed

Mihaljevic T, Lam BK, Rajeswaran J, Takagaki M, Lauer MS, Gillinov AM, Blackstone EH, Lytle BW. Impact of mitral valve annuloplasty combined with revascularization in patients with functional ischemic mitral regurgitation. J Am Coll Cardiol. 2007 Jun 5;49(22):2191-201. PubMed

Miller DL, Morris JJ, Schaff HV, Mullany CJ, Nishimura RA, Orszulak TA. Reoperation for aortic valve periprosthetic leakage: identification of patients at risk and results of operation. J Heart Valve Dis. 1995 Mar;4(2):160-5. PubMed

Monin JL, Monchi M, Gest V, Duval-Moulin AM, Dubois-Rande JL, Gueret P. Aortic stenosis with severe left ventricular dysfunction and low transvalvular pressure gradients: risk stratification by low-dose dobutamine echocardiography. J Am Coll Cardiol. 2001 Jun 15;37(8):2101-7. PubMed

Monin JL, QuÃ©rÃ© JP, Monchi M, Petit H, Baleynaud S, Chauvel C, Pop C, Ohlmann P, Lelguen C, Dehant P, Tribouilloy C, GuÃ©ret P. Low-gradient aortic stenosis: operative risk stratification and predictors for long-term outcome: a multicenter study using dobutamine stress hemodynamics. Circulation. 2003 Jul 22;108(3):319-24. PubMed

Monmeneu Menadas JV, MarÃn OrtuÃ±o F, Reyes Gomis F, JordÃ¡n Torrent A, GarcÃa MartÃnez M, BodÃ Peris V, GarcÃa de Burgos de Rico E. Beta-blockade and exercise capacity in patients with mitral stenosis in sinus rhythm. J Heart Valve Dis. 2002 Mar;11(2):199-203. PubMed

MÃ¼gge A, Daniel WG, Frank G, Lichtlen PR. Echocardiography in infective endocarditis: reassessment of prognostic implications of vegetation size determined by the transthoracic and the transesophageal approach. J Am Coll Cardiol. 1989 Sep;14(3):631-8. PubMed

Mullin MJ, Engelman RM, Isom OW, Boyd AD, Glassman E, Spencer FC. Experience with open mitral commissurotomy in 100 consecutive patients. Surgery. 1974 Dec;76(6):974-82. PubMed

Myerson SG, Francis JM, Neubauer S. Direct and indirect quantification of mitral regurgitation with cardiovascular magnetic resonance, and the effect of heart rate variability. Magn Reson Mater Phys Biol Med. 2010 Sep;23(4):243-9. PubMed

Myerson SG, Mitchell AR, Ormerod OJ, Banning AP. What is the role of balloon dilatation for severe aortic stenosis during pregnancy?. J Heart Valve Dis. 2005 Mar;14(2):147-50. PubMed

MykÃ©n PS, Bech-Hansen O. A 20-year experience of 1712 patients with the Biocor porcine bioprosthesis. J Thorac Cardiovasc Surg. 2009 Jan;137(1):76-81. PubMed

Mylonakis E, Calderwood SB. Infective endocarditis in adults. N Engl J Med. 2001 Nov 1;345(18):1318-30. PubMed

Nadir MA, Wei L, Elder DH, Libianto R, Lim TK, Pauriah M, Pringle SD, Doney AD, Choy AM, Struthers AD, Lang CC. Impact of renin-angiotensin system blockade therapy on outcome in aortic stenosis. J Am Coll Cardiol. 2011 Aug 2;58(6):570-6. PubMed

Navia JL, Brozzi NA, Klein AL, Ling LF, Kittayarak C, Nowicki ER, Batizy LH, Zhong J, Blackstone EH. Moderate tricuspid regurgitation with left-sided degenerative heart valve disease: to repair or not to repair?. Ann Thorac Surg. 2012 Jan;93(1):59-67; discussion 68-9. PubMed

Nemoto S, Hamawaki M, De Freitas G, Carabello BA. Differential effects of the angiotensin-converting enzyme inhibitor lisinopril versus the beta-adrenergic receptor blocker atenolol on hemodynamics and left ventricular contractile function in experimental mitral regurgitation. J Am Coll Cardiol. 2002 Jul 3;40(1):149-54. PubMed

Ngaage DL, Schaff HV, Mullany CJ, Barnes S, Dearani JA, Daly RC, Orszulak TA, Sundt TM. Influence of preoperative atrial fibrillation on late results of mitral repair: is concomitant ablation justified?. Ann Thorac Surg. 2007 Aug;84(2):434-42; discussion 442-3. PubMed

Nishimura RA, Grantham JA, Connolly HM, Schaff HV, Higano ST, Holmes DR. Low-output, low-gradient aortic stenosis in patients with depressed left ventricular systolic function: the clinical utility of the dobutamine challenge in the catheterization laboratory. Circulation. 2002 Aug 13;106(7):809-13. PubMed

Nishimura RA, Rihal CS, Tajik AJ, Holmes DR. Accurate measurement of the transmitral gradient in patients with mitral stenosis: a simultaneous catheterization and Doppler echocardiographic study. J Am Coll Cardiol. 1994 Jul;24(1):152-8. PubMed

Nistri S, Sorbo MD, Marin M, Palisi M, Scognamiglio R, Thiene G. Aortic root dilatation in young men with normally functioning bicuspid aortic valves. Heart. 1999 Jul;82(1):19-22. PubMed

Novaro GM, Tiong IY, Pearce GL, Grimm RA, Smedira N, Griffin BP. Features and predictors of ascending aortic dilatation in association with a congenital bicuspid aortic valve. Am J Cardiol. 2003 Jul 1;92(1):99-101. PubMed

NuÃ±ez L, Gil Aguado M, Larrea JL, CelemÃn D, Oliver J. Prevention of thromboembolism using aspirin after mitral valve replacement with porcine bioprosthesis. Ann Thorac Surg. 1984 Jan;37(1):84-7. PubMed

O'Brien KD, Zhao XQ, Shavelle DM, Caulfield MT, Letterer RA, Kapadia SR, Probstfield JL, Otto CM. Hemodynamic effects of the angiotensin-converting enzyme inhibitor, ramipril, in patients with mild to moderate aortic stenosis and preserved left ventricular function. J Investig Med. 2004 Apr;52(3):185-91. PubMed

O'Brien SM, Shahian DM, Filardo G, Ferraris VA, Haan CK, Rich JB, Normand SL, DeLong ER, Shewan CM, Dokholyan RS, Peterson ED, Edwards FH, Anderson RP, Society of Thoracic Surgeons Quality Measurement Task Force. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: part 2--isolated valve surgery. Ann Thorac Surg. 2009 Jul;88(1 Suppl):S23-42. PubMed

Oh JK, Taliercio CP, Holmes DR, Reeder GS, Bailey KR, Seward JB, Tajik AJ. Prediction of the severity of aortic stenosis by Doppler aortic valve area determination: prospective Doppler-catheterization correlation in 100 patients. J Am Coll Cardiol. 1988 Jun;11(6):1227-34. PubMed

Olasinska-Wisniewska A, Mularek-Kubzdela T, Grajek S, Marszalek A, Sarnowski W, Jemielity M, Seniuk W, Lesiak M, Prech M, Podzerek T. Impact of atrial remodeling on heart rhythm after radiofrequency ablation and mitral valve operations. Ann Thorac Surg. 2012 May;93(5):1449-55. PubMed

Olesen KH. The natural history of 271 patients with mitral stenosis under medical treatment. Br Heart J. 1962 May;24:349-57. PubMed

Omran H, Rang B, Schmidt H, Illien S, Schimpf R, Maccarter D, Kubini R, Von Der Recke G, Tiemann K, Becher H, LÃ¼deritz B. Incidence of left atrial thrombi in patients in sinus rhythm and with a recent neurologic deficit. Am Heart J. 2000 Oct;140(4):658-62. PubMed

Oran B, Lee-Parritz A, Ansell J. Low molecular weight heparin for the prophylaxis of thromboembolism in women with prosthetic mechanical heart valves during pregnancy. Thromb Haemost. 2004 Oct;92(4):747-51. PubMed

Otto CM, Burwash IG, Legget ME, Munt BI, Fujioka M, Healy NL, Kraft CD, MiyakeHull CY, Schwaegler RG. Prospective study of asymptomatic valvular aortic stenosis. Clinical, echocardiographic, and exercise predictors of outcome. Circulation. 1997 May 6;95(9):2262-70. PubMed

Otto CM, Nishimura RA, Davis KB, Kisslo KB, Bashore TM. Doppler echocardiographic findings in adults with severe symptomatic valvular aortic stenosis. Balloon Valvuloplasty Registry Echocardiographers. Am J Cardiol. 1991 Dec 1;68(15):1477-84. PubMed

Otto CM, Pearlman AS, Comess KA, Reamer RP, Janko CL, Huntsman LL. Determination of the stenotic aortic valve area in adults using Doppler echocardiography. J Am Coll Cardiol. 1986 Mar;7(3):509-17. PubMed

Otto CM, Pearlman AS, Gardner CL. Hemodynamic progression of aortic stenosis in adults assessed by Doppler echocardiography. J Am Coll Cardiol. 1989 Mar 1;13(3):545-50. PubMed

Otto CM, Pearlman AS, Kraft CD, MiyakeHull CY, Burwash IG, Gardner CJ. Physiologic changes with maximal exercise in asymptomatic valvular aortic stenosis assessed by Doppler echocardiography. J Am Coll Cardiol. 1992 Nov 1;20(5):1160-7. PubMed

Otto CM, Pearlman AS. Doppler echocardiography in adults with symptomatic aortic stenosis. Diagnostic utility and cost-effectiveness. Arch Intern Med. 1988 Dec;148(12):2553-60. PubMed

Oxenham H, Bloomfield P, Wheatley DJ, Lee RJ, Cunningham J, Prescott RJ, Miller HC. Twenty year comparison of a Bjork-Shiley mechanical heart valve with porcine bioprostheses. Heart. 2003 Jul;89(7):715-21. PubMed

Ozdogan O, Yuksel A, Gurgun C, Kayikcioglu M, Yavuzgil O, Cinar CS. Evaluation of the severity of mitral regurgitation by the use of signal void in magnetic resonance imaging. Echocardiography. 2009 Nov;26(10):1127-35. PubMed

Pachulski RT, Weinberg AL, Chan KL. Aortic aneurysm in patients with functionally normal or minimally stenotic bicuspid aortic valve. Am J Cardiol. 1991 Apr 1;67(8):781-2. PubMed

Patel JJ, Shama D, Mitha AS, Blyth D, Hassen F, Le Roux BT, Chetty S. Balloon valvuloplasty versus closed commissurotomy for pliable mitral stenosis: a prospective hemodynamic study. J Am Coll Cardiol. 1991 Nov 1;18(5):1318-22. PubMed

Pedersen WR, Walker M, Olson JD, Gobel F, Lange HW, Daniel JA, Rogers J, Longe T, Kane M, Mooney MR. Value of transesophageal echocardiography as an adjunct to transthoracic echocardiography in evaluation of native and prosthetic valve endocarditis. Chest. 1991 Aug;100(2):351-6. PubMed

Pellikka PA, Sarano ME, Nishimura RA, Malouf JF, Bailey KR, Scott CG, Barnes ME, Tajik AJ. Outcome of 622 adults with asymptomatic, hemodynamically significant aortic stenosis during prolonged follow-up. Circulation. 2005 Jun 21;111(24):3290-5. PubMed

PÃ©rez-GÃ³mez F, AlegrÃa E, BerjÃ³n J, Iriarte JA, Zumalde J, Salvador A, Mataix L, NASPEAF Investigators. Comparative effects of antiplatelet, anticoagulant, or combined therapy in patients with valvular and nonvalvular atrial fibrillation: a randomized multicenter study. J Am Coll Cardiol. 2004 Oct 19;44(8):1557-66. PubMed

PÃ©rez-VÃ¡zquez A, FariÃ±as MC, GarcÃa-Palomo JD, Bernal JM, Revuelta JM, GonzÃ¡lez-MacÃas J. Evaluation of the Duke criteria in 93 episodes of prosthetic valve endocarditis: could sensitivity be improved?. Arch Intern Med. 2000 Apr 24;160(8):1185-91. PubMed

Pflugfelder PW, Sechtem UP, White RD, Cassidy MM, Schiller NB, Higgins CB. Noninvasive evaluation of mitral regurgitation by analysis of left atrial signal loss in cine magnetic resonance. Am Heart J. 1989 May;117(5):1113-9. PubMed

Pitt B, Zannad F, Remme WJ, Cody R, Castaigne A, Perez A, Palensky J, Wittes J. The effect of spironolactone on morbidity and mortality in patients with severe heart failure. Randomized Aldactone Evaluation Study Investigators. N Engl J Med. 1999 Sep 2;341(10):709-17. PubMed

Pizarro R, Bazzino OO, Oberti PF, Falconi ML, Arias AM, Krauss JG, Cagide AM. Prospective validation of the prognostic usefulness of B-type natriuretic peptide in asymptomatic patients with chronic severe aortic regurgitation. J Am Coll Cardiol. 2011 Oct 11;58(16):1705-14. PubMed

Pruefer D, Dahm M, Dohmen G. Intensity of oral anticoagulation after implantation of St. Jude Medical mitral or multiple valve replacement: lessons learned from GELIA (GELIA 5). Eur Heart J. 2001;3:Q43.

Pruitt AA, Rubin RH, Karchmer AW, Duncan GW. Neurologic complications of bacterial endocarditis. Medicine. 1978 Jul;57(4):329-43. PubMed

Pu M, Prior DL, Fan X, Asher CR, Vasquez C, Griffin BP, Thomas JD. Calculation of mitral regurgitant orifice area with use of a simplified proximal convergence method: initial clinical application. J Am Soc Echocardiogr. 2001 Mar;14(3):180-5. PubMed

Pu M, Vandervoort PM, Greenberg NL, Powell KA, Griffin BP, Thomas JD. Impact of wall constraint on velocity distribution in proximal flow convergence zone. Implications for color Doppler quantification of mitral regurgitation. J Am Coll Cardiol. 1996 Mar 1;27(3):706-13. PubMed

Quinn J, Von Klemperer K, Brooks R, Peebles D, Walker F, Cohen H. Use of high intensity adjusted dose low molecular weight heparin in women with mechanical heart valves during pregnancy: a single-center experience. Haematologica. 2009 Nov;94(11):1608-12. PubMed

Raine D, Dark J, Bourke JP. Effect of mitral valve repair/replacement surgery on atrial arrhythmia behavior. J Heart Valve Dis. 2004 Jul;13(4):615-21.

Rasmussen RV, HÃ¸st U, Arpi M, Hassager C, Johansen HK, Korup E, SchÃ¸nheyder HC, Berning J, Gill S, Rosenvinge FS, Fowler VG, MÃ¸ller JE, Skov RL, Larsen CT, Hansen TF, Mard S, Smit J, Andersen PS, Bruun NE. Prevalence of infective endocarditis in patients with Staphylococcus aureus bacteraemia: the value of screening with echocardiography. Eur J Echocardiogr. 2011 Jun;12(6):414-20. PubMed

Rasmussen RV, Snygg-Martin U, Olaison L, Buchholtz K, Larsen CT, Hassager C, Bruun NE. Major cerebral events in Staphylococcus aureus infective endocarditis: is anticoagulant therapy safe?. Cardiology. 2009;114(4):284-91. PubMed

Reant P, Brunot S, Lafitte S, Serri K, Leroux L, Corneloup O, Iriart X, Coste P, Dos Santos P, Roudaut R, Laurent F. Predictive value of noninvasive coronary angiography with multidetector computed tomography to detect significant coronary stenosis before valve surgery. Am J Cardiol. 2006 May 15;97(10):1506-10. PubMed

Recusani F, Bargiggia GS, Yoganathan AP, Raisaro A, Valdes-Cruz LM, Sung HW, Bertucci C, Gallati M, Moises VA, Simpson IA. A new method for quantification of regurgitant flow rate using color Doppler flow imaging of the flow convergence region proximal to a discrete orifice. An in vitro study. Circulation. 1991 Feb;83(2):594-604. PubMed

Remadi JP, Habib G, Nadji G, Brahim A, Thuny F, Casalta JP, Peltier M, Tribouilloy C. Predictors of death and impact of surgery in Staphylococcus aureus infective endocarditis. Ann Thorac Surg. 2007 Apr;83(4):1295-302. PubMed

Reyes VP, Raju BS, Wynne J, Stephenson LW, Raju R, Fromm BS, Rajagopal P, Mehta P, Singh S, Rao DP. Percutaneous balloon valvuloplasty compared with open surgical commissurotomy for mitral stenosis. N Engl J Med. 1994 Oct 13;331(15):961-7. PubMed

Rivera JM, Vandervoort PM, Thoreau DH, Levine RA, Weyman AE, Thomas JD. Quantification of mitral regurgitation with the proximal flow convergence method: a clinical study. Am Heart J. 1992 Nov;124(5):1289-96. PubMed

Roe MT, Abramson MA, Li J, Heinle SK, Kisslo J, Corey GR, Sexton DJ. Clinical information determines the impact of transesophageal echocardiography on the diagnosis of infective endocarditis by the duke criteria. Am Heart J. 2000 Jun;139(6):945-51. PubMed

Rohmann S, Erbel R, Darius H, GÃ¶rge G, Makowski T, Zotz R, Mohr-Kahaly S, Nixdorff U, Drexler M, Meyer J. Prediction of rapid versus prolonged healing of infective endocarditis by monitoring vegetation size. J Am Soc Echocardiogr. 1991 Sep-Oct;4(5):465-74. PubMed

Ronderos RE, Portis M, Stoermann W, Sarmiento C. Are all echocardiographic findings equally predictive for diagnosis in prosthetic endocarditis?. J Am Soc Echocardiogr. 2004 Jun;17(6):664-9. PubMed

Rosenhek R, Binder T, Porenta G, Lang I, Christ G, Schemper M, Maurer G, Baumgartner H. Predictors of outcome in severe, asymptomatic aortic stenosis. N Engl J Med. 2000 Aug 31;343(9):611-7. PubMed

Rosenhek R, Rader F, Klaar U, Gabriel H, Krejc M, Kalbeck D, Schemper M, Maurer G, Baumgartner H. Outcome of watchful waiting in asymptomatic severe mitral regurgitation. Circulation. 2006 May 9;113(18):2238-44. PubMed

Rosenhek R, Zilberszac R, Schemper M, Czerny M, Mundigler G, Graf S, BerglerKlein J, Grimm M, Gabriel H, Maurer G. Natural history of very severe aortic stenosis. Circulation. 2010 Jan 5;121(1):151-6. PubMed

RossebÃ¸ AB, Pedersen TR, Boman K, Brudi P, Chambers JB, Egstrup K, Gerdts E, Gohlke-BÃ¤rwolf C, Holme I, KesÃ¤niemi YA, Malbecq W, Nienaber CA, Ray S, Skjaerpe T, Wachtell K, Willenheimer R, SEAS Investigators. Intensive lipid lowering with simvastatin and ezetimibe in aortic stenosis. N Engl J Med. 2008 Sep 25;359(13):1343-56. PubMed

Rossi A, Dini FL, Faggiano P, Agricola E, Cicoira M, Frattini S, Simioniuc A, Gullace M, Ghio S, Enriquez-Sarano M, Temporelli PL. Independent prognostic value of functional mitral regurgitation in patients with heart failure. A quantitative analysis of 1256 patients with ischaemic and non-ischaemic dilated cardiomyopathy. Heart. 2011 Oct;97(20):1675-80. PubMed

Roudaut R, Lafitte S, Roudaut MF, Courtault C, Perron JM, JaÃ¯s C, Pillois X, Coste P, DeMaria A. Fibrinolysis of mechanical prosthetic valve thrombosis: a single-center study of 127 cases. J Am Coll Cardiol. 2003 Feb 19;41(4):653-8. PubMed

Roudaut R, Lafitte S, Roudaut MF, Reant P, Pillois X, Durrieu-JaÃ¯s C, Coste P, Deville C, Roques X. Management of prosthetic heart valve obstruction: fibrinolysis versus surgery. Early results and long-term follow-up in a single-centre study of 263 cases. Arch Cardiovasc Dis. 2009 Apr;102(4):269-77. PubMed

Roudaut R, Serri K, Lafitte S. Thrombosis of prosthetic heart valves: diagnosis and therapeutic considerations. Heart. 2007 Jan;93(1):137-42. PubMed

Rowan JA, McCowan LM, Raudkivi PJ, North RA. Enoxaparin treatment in women with mechanical heart valves during pregnancy. Am J Obstet Gynecol. 2001 Sep;185(3):633-7. PubMed

Rowe JC, Bland EF, Sprague HB, White PD. The course of mitral stenosis without surgery: ten- and twenty-year perspectives. Ann Intern Med. 1960 Apr;52:741-9. PubMed

Rozich JD, Carabello BA, Usher BW, Kratz JM, Bell AE, Zile MR. Mitral valve replacement with and without chordal preservation in patients with chronic mitral regurgitation. Mechanisms for differences in postoperative ejection performance. Circulation. 1992 Dec;86(6):1718-26. PubMed

Ruiz CE, Jelnin V, Kronzon I, Dudiy Y, Del Valle-Fernandez R, Einhorn BN, Chiam PT, Martinez C, Eiros R, Roubin G, Cohen HA. Clinical outcomes in patients undergoing percutaneous closure of periprosthetic paravalvular leaks. J Am Coll Cardiol. 2011 Nov 15;58(21):2210-7. PubMed

RundstrÃ¶m H, Kennergren C, Andersson R, Alestig K, Hogevik H. Pacemaker endocarditis during 18 years in GÃ¶teborg. Scand J Infect Dis. 2004;36(9):674-9. PubMed

Rushmer RF. Initial phase of ventricular systole: asynchronous contraction. Am J Physiol. 1956 Jan;184(1):188-94. PubMed

Russo A, Grigioni F, Avierinos JF, Freeman WK, Suri R, Michelena H, Brown R, Sundt TM, Enriquez-Sarano M. Thromboembolic complications after surgical correction of mitral regurgitation incidence, predictors, and clinical implications. J Am Coll Cardiol. 2008 Mar 25;51(12):1203-11. PubMed

Saiki Y, Kasegawa H, Kawase M, Osada H, Ootaki E. Intraoperative TEE during mitral valve repair: does it predict early and late postoperative mitral valve dysfunction?. Ann Thorac Surg. 1998 Oct;66(4):1277-81. PubMed

Salazar E, Izaguirre R, Verdejo J, Mutchinick O. Failure of adjusted doses of subcutaneous heparin to prevent thromboembolic phenomena in pregnant patients with mechanical cardiac valve prostheses. J Am Coll Cardiol. 1996 Jun;27(7):1698-703. PubMed

San Martin J, SarriÃ¡ C, de las Cuevas C, Duarte J, Gamallo C. Relevance of clinical presentation and period of diagnosis in prosthetic valve endocarditis. J Heart Valve Dis. 2010 Jan;19(1):131-8. PubMed

Sarris GE, Cahill PD, Hansen DE, Derby GC, Miller DC. Restoration of left ventricular systolic performance after reattachment of the mitral chordae tendineae. The importance of valvular-ventricular interaction. J Thorac Cardiovasc Surg. 1988 Jun;95(6):969-79. PubMed

Schaefer BM, Lewin MB, Stout KK, Gill E, Prueitt A, Byers PH, Otto CM. The bicuspid aortic valve: an integrated phenotypic classification of leaflet morphology and aortic root shape. Heart. 2008 Dec;94(12):1634-8. PubMed

Schaefer C. Angiotensin II-receptor-antagonists: further evidence of fetotoxicity but not teratogenicity. Birth Defects Res A Clin Mol Teratolx. 2003 Aug;67(8):591-4. PubMed

Scheffel H, Leschka S, Plass A, Vachenauer R, Gaemperli O, Garzoli E, Genoni M, Marincek B, Kaufmann P, Alkadhi H. Accuracy of 64-slice computed tomography for the preoperative detection of coronary artery disease in patients with chronic aortic regurgitation. Am J Cardiol. 2007 Aug 15;100(4):701-6.

Schlitt A, von Bardeleben RS, Ehrlich A, Eimermacher A, Peetz D, Dahm M, Rupprecht HJ. Clopidogrel and aspirin in the prevention of thromboembolic complications after mechanical aortic valve replacement (CAPTA). Thromb Res Suppl. 2003 Jan 25;109(2-3):131-5. PubMed

Schlosshan D, Aggarwal G, Mathur G, Allan R, Cranney G. Real-time 3D transesophageal echocardiography for the evaluation of rheumatic mitral stenosis. JACC Cardiovasc Imaging. 2011 Jun;4(6):580-8. PubMed

SchÃ¶n HR. Hemodynamic and morphologic changes after long-term angiotensin converting enzyme inhibition in patients with chronic valvular regurgitation. J Hypertens Suppl. 1994 Jul;12(4):S95-104. PubMed

Schuler G, Peterson KL, Johnson A, Francis G, Dennish G, Utley J, Daily PO, Ashburn W, Ross J. Temporal response of left ventricular performance to mitral valve surgery. Circulation. 1979 Jun;59(6):1218-31. PubMed

Scognamiglio R, Fasoli G, Dalla Volta S. Progression of myocardial dysfunction in asymptomatic patients with severe aortic insufficiency. Clin Cardiol. 1986 Apr;9(4):151-6. PubMed

Scognamiglio R, Rahimtoola SH, Fasoli G, Nistri S, Dalla Volta S. Nifedipine in asymptomatic patients with severe aortic regurgitation and normal left ventricular function. N Engl J Med. 1994 Sep 15;331(11):689-94. PubMed

Shapira Y, Weisenberg DE, Vaturi M, Sharoni E, Raanani E, Sahar G, Vidne BA, Battler A, Sagie A. The impact of intraoperative transesophageal echocardiography in infective endocarditis. Isr Med Assoc J. 2007 Apr;9(4):299-302. PubMed

Shively BK, Gurule FT, Roldan CA, Leggett JH, Schiller NB. Diagnostic value of transesophageal compared with transthoracic echocardiography in infective endocarditis. J Am Coll Cardiol. 1991 Aug;18(2):391-7. PubMed

Shotan A, Widerhorn J, Hurst A, Elkayam U. Risks of angiotensin-converting enzyme inhibition during pregnancy: experimental and clinical evidence, potential mechanisms, and recommendations for use. Am J Med. 1994 May;96(5):451-6. PubMed

Siemienczuk D, Greenberg B, Morris C, Massie B, Wilson RA, Topic N, Bristow JD, Cheitlin M. Chronic aortic insufficiency: factors associated with progression to aortic valve replacement. Ann Intern Med. 1989 Apr 15;110(8):587-92. PubMed

Sillesen M, Hjortdal V, Vejlstrup N, SÃ¸rensen K. Pregnancy with prosthetic heart valves - 30 years' nationwide experience in Denmark. Eur J Cardiothorac Surg. 2011 Aug;40(2):448-54. PubMed

Singer DE, Albers GW, Dalen JE, Fang MC, Go AS, Halperin JL, Lip GY, Manning WJ, American College of Chest Physicians.

Antithrombotic therapy in atrial fibrillation: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest. 2008 Jun;133(6 Suppl):546S-592S. PubMed

Smith CR, Leon MB, Mack MJ, Miller DC, Moses JW, Svensson LG, Tuzcu EM, Webb JG, Fontana GP, Makkar RR, Williams M, Dewey T, Kapadia S, Babaliaros V, Thourani VH, Corso P, Pichard AD, Bavaria JE, Herrmann HC, Akin JJ, Anderson WN, Wang D, Pocock SJ, PARTNER Trial Investigators. Transcatheter versus surgical aortic-valve replacement in high-risk patients. N Engl J Med. 2011 Jun 9;364(23):2187-98. PubMed

Smith WT, Ferguson TB, Ryan T, Landolfo CK, Peterson ED. Should coronary artery bypass graft surgery patients with mild or moderate aortic stenosis undergo concomitant aortic valve replacement? A decision analysis approach to the surgical dilemma. J Am Coll Cardiol. 2004 Sep 15;44(6):1241-7. PubMed

Sochowski RA, Chan KL. Implication of negative results on a monoplane transesophageal echocardiographic study in patients with suspected infective endocarditis. J Am Coll Cardiol. 1993 Jan;21(1):216-21. PubMed

Sohail MR, Uslan DZ, Khan AH, Friedman PA, Hayes DL, Wilson WR, Steckelberg JM, Jenkins SM, Baddour LM. Infective endocarditis complicating permanent pacemaker and implantable cardioverter-defibrillator infection. Mayo Clin Proc. 2008 Jan;83(1):46-53. PubMed

SÃ¸ndergaard L, Aldershvile J, Hildebrandt P, Kelbaek H, StÃ¥hlberg F, Thomsen C. Vasodilatation with felodipine in chronic asymptomatic aortic regurgitation. Am Heart J. 2000 Apr;139(4):667-74. PubMed

Sorajja P, Cabalka AK, Hagler DJ, Rihal CS. Long-term follow-up of percutaneous repair of paravalvular prosthetic regurgitation. J Am Coll Cardiol. 2011 Nov 15;58(21):2218-24. PubMed

Sorajja P, Cabalka AK, Hagler DJ, Rihal CS. Percutaneous repair of paravalvular prosthetic regurgitation: acute and 30-day outcomes in 115 patients. Circ Cardiovasc Interv. 2011 Aug;4(4):314-21. PubMed

St John Sutton MG, Plappert T, Abraham WT, Smith AL, DeLurgio DB, Leon AR, Loh E, Kocovic DZ, Fisher WG, Ellestad M, Messenger J, Kruger K, Hilpisch KE, Hill MR, Multicenter InSync Randomized Clinical Evaluation (MIRACLE) Study Group. Effect of cardiac resynchronization therapy on left ventricular size and function in chronic heart failure. Circulation. 2003 Apr 22;107(15):1985-90. PubMed

Starling MR. Effects of valve surgery on left ventricular contractile function in patients with long-term mitral regurgitation. Circulation. 1995 Aug 15;92(4):811-8. PubMed

Stassano P, Di Tommaso L, Monaco M, Iorio F, Pepino P, Spampinato N, Vosa C. Aortic valve replacement: a prospective randomized evaluation of mechanical versus biological valves in patients ages 55 to 70 years. J Am Coll Cardiol. 2009 Nov 10;54(20):1862-8. PubMed

Stein PD, Alpert JS, Bussey HI, Dalen JE, Turpie AG. Antithrombotic therapy in patients with mechanical and biological prosthetic heart valves. Chest. 2001 Jan;119(1 Suppl):220S-227S.

Stoll BC, Ashcom TL, Johns JP, Johnson JE, Rubal BJ. Effects of atenolol on rest and exercise hemodynamics in patients with mitral stenosis. Am J Cardiol. 1995 Mar 1;75(7):482-4. PubMed

Strom BL, Abrutyn E, Berlin JA, Kinman JL, Feldman RS, Stolley PD, Levison ME, Korzeniowski OM, Kaye D. Dental and cardiac risk factors for infective endocarditis. A population-based, case-control study. Ann Intern Med. 1998 Nov 15;129(10):761-9. PubMed

STS online risk calculator. [internet]. 2013 [accessed 2014 Feb 20].

Sugeng L, Weinert L, Lammertin G, Thomas P, Spencer KT, Decara JM, MorAvi V, Huo D, Feldman T, Lang RM. Accuracy of mitral valve area measurements using transthoracic rapid freehand 3-dimensional scanning: comparison with noninvasive and invasive methods. J Am Soc Echocardiogr. 2003 Dec;16(12):1292-300. PubMed

Sullenberger AL, Avedissian LS, Kent SM. Importance of transesophageal echocardiography in the evaluation of Staphylococcus aureus bacteremia. J Heart Valve Dis. 2005 Jan;14(1):23-8. PubMed

Suri RM, Schaff HV, Dearani JA, Sundt TM, Daly RC, Mullany CJ, Enriquez-Sarano M, Orszulak TA. Recovery of left ventricular function after surgical correction of mitral regurgitation caused by leaflet prolapse. J Thorac Cardiovasc Surg. 2009 May;137(5):1071-6. PubMed

Suri RM, Vanoverschelde JL, Grigioni F, Schaff HV, Tribouilloy C, Avierinos JF, Barbieri A, Pasquet A, Huebner M, Rusinaru D, Russo A, Michelena HI, Enriquez-Sarano M. Association between early surgical intervention vs watchful waiting and outcomes for mitral regurgitation due to flail mitral valve leaflets. JAMA. 2013 Aug 14;310(6):609-16. PubMed

Szekely P. Systemic embolism and anticoagulant prophylaxis in rheumatic heart disease. Br Med J. 1964 May 9;1(5392):1209-12. PubMed

Teague SM, Heinsimer JA, Anderson JL, Sublett K, Olson EG, Voyles WF, Thadani U. Quantification of aortic regurgitation utilizing continuous wave Doppler ultrasound. J Am Coll Cardiol. 1986 Sep;8(3):592-9. PubMed

Tessier P, Mercier LA, Burelle D, Bonan R. Results of percutaneous mitral commissurotomy in patients with a left atrial appendage thrombus detected by transesophageal echocardiography. J Am Soc Echocardiogr. 1994 Jul-Aug;7(4):394-9. PubMed

Thomas JD, Wilkins GT, Choong CY, Abascal VM, Palacios IF, Block PC, Weyman AE. Inaccuracy of mitral pressure half-time immediately after percutaneous mitral valvotomy. Dependence on transmitral gradient and left atrial and ventricular compliance. Circulation. 1988 Oct;78(4):980-93. PubMed

Thuny F, Di Salvo G, Disalvo G, Belliard O, Avierinos JF, Pergola V, Rosenberg V, Casalta JP, Gouvernet J, Derumeaux G, Iarussi D, Ambrosi P, CalabrÃ³ R, Calabro R, Riberi A, Collart F, Metras D, Lepidi H, Raoult D, Harle JR, Weiller PJ, Cohen A, Habib G. Risk of embolism and death in infective endocarditis: prognostic value of echocardiography: a prospective multicenter study. Circulation. 2005 Jul 5;112(1):69-75. PubMed

Tischler MD, Cooper KA, Rowen M, LeWinter MM. Mitral valve replacement versus mitral valve repair. A Doppler and quantitative stress echocardiographic study. Circulation. 1994 Jan;89(1):132-7. PubMed

Tischler MD, Rowan M, LeWinter MM. Effect of enalapril therapy on left ventricular mass and volumes in asymptomatic chronic, severe mitral regurgitation secondary to mitral valve prolapse. Am J Cardiol. 1998 Jul 15;82(2):242-5. PubMed

Tong AT, Roudaut R, Ozkan M, Sagie A, Shahid MS, Pontes JÃºnior SC, Carreras F, Girard SE, Arnaout S, Stainback RF, Thadhani R, Zoghbi WA, Prosthetic Valve Thrombolysis-Role of Transesophageal Echocardiography (PRO-TEE) Registry [trunc]. Transesophageal echocardiography improves risk assessment of thrombolysis of prosthetic valve thrombosis: results of the international PRO-TEE registry. J Am Coll Cardiol. 2004 Jan 7;43(1):77-84. PubMed

Torella M, Torella D, Chiodini P, Franciulli M, Romano G, De Santo L, De Feo M, Amarelli C, Sasso FC, Salvatore T, Ellison GM, Indolfi C, Cotrufo M, Nappi G. LOWERing the INtensity of oral anticoaGulant Therapy in patients with bileaflet mechanical aortic valve replacement: results from the "LOWERING-IT" Trial. Am Heart J. 2010 Jul;160(1):171-8. PubMed

Tornos MP, Olona M, PermanyerMiralda G, Herrejon MP, Camprecios M, Evangelista A, Garcia del Castillo H, Candell J, SolerSoler J. Clinical outcome of severe asymptomatic chronic aortic regurgitation: a long-term prospective follow-up study. Am Heart J. 1995 Aug;130(2):333-9. PubMed

Tornos P, Almirante B, Mirabet S, Permanyer G, Pahissa A, Soler-Soler J. Infective endocarditis due to Staphylococcus aureus: deleterious effect of anticoagulant therapy. Arch Intern Med. 1999 Mar 8;159(5):473-5. PubMed

Tornos P, Sanz E, Permanyer-Miralda G, Almirante B, Planes AM, Soler-Soler J. Late prosthetic valve endocarditis. Immediate and long-term prognosis. Chest. 1992 Jan;101(1):37-41. PubMed

Torsher LC, Shub C, Rettke SR, Brown DL. Risk of patients with severe aortic stenosis undergoing noncardiac surgery. Am J Cardiol. 1998 Feb 15;81(4):448-52. PubMed

Tribouilloy C, Grigioni F, Avierinos JF, Barbieri A, Rusinaru D, Szymanski C, Ferlito M, Tafanelli L, Bursi F, Trojette F, Branzi A, Habib G, Modena MG, Enriquez-Sarano M, MIDA Investigators. Survival implication of left ventricular end-systolic diameter in mitral regurgitation due to flail leaflets a long-term follow-up multicenter study. J Am Coll Cardiol. 2009 Nov 17;54(21):1961-8. PubMed

Tribouilloy C, LÃ©vy F, Rusinaru D, GuÃ©ret P, Petit-Eisenmann H, Baleynaud S, Jobic Y, Adams C, Lelong B, Pasquet A, Chauvel C, Metz D, QuÃ©rÃ© JP, Monin JL. Outcome after aortic valve replacement for low-flow/low-gradient aortic stenosis without contractile reserve on dobutamine stress echocardiography. J Am Coll Cardiol. 2009 May 19;53(20):1865-73. PubMed

Tribouilloy CM, Enriquez-Sarano M, Schaff HV, Orszulak TA, Bailey KR, Tajik AJ, Frye RL. Impact of preoperative symptoms on survival after surgical correction of organic mitral regurgitation: rationale for optimizing surgical indications. Circulation. 1999 Jan 26;99(3):400-5. PubMed

Trichon BH, Felker GM, Shaw LK, Cabell CH, OConnor CM. Relation of frequency and severity of mitral regurgitation to survival among patients with left ventricular systolic dysfunction and heart failure. Am J Cardiol. 2003 Mar 1;91(5):538-43. PubMed

Tsutsui H, Spinale FG, Nagatsu M, Schmid PG, Ishihara K, DeFreyte G, Cooper G, Carabello BA. Effects of chronic beta-adrenergic blockade on the left ventricular and cardiocyte abnormalities of chronic canine mitral regurgitation. J Clin Invest. 1994 Jun;93(6):2639-48. PubMed

Tumelero RT, Duda NT, Tognon AP, Sartori I, Giongo S. Percutaneous balloon aortic valvuloplasty in a pregnant adolescent. Arq Bras Cardiol. 2004 Jan;82(1):98-101, 94-7. PubMed

Turi ZG, Reyes VP, Raju BS, Raju AR, Kumar DN, Rajagopal P, Sathyanarayana PV, Rao DP, Srinath K, Peters P. Percutaneous balloon versus surgical closed commissurotomy for mitral stenosis. A prospective, randomized trial. Circulation. 1991 Apr;83(4):1179-85. PubMed

Turina J, Hess O, Sepulcri F, Krayenbuehl HP. Spontaneous course of aortic valve disease. Eur Heart J. 1987 May;8(5):471-83. PubMed

Turpie AG, Gent M, Laupacis A, Latour Y, Gunstensen J, Basile F, Klimek M, Hirsh J. A comparison of aspirin with placebo in patients treated with warfarin after heart-valve replacement. N Engl J Med. 1993 Aug 19;329(8):524-9. PubMed

Tzemos N, Silversides CK, Colman JM, Therrien J, Webb GD, Mason J, Cocoara E, Sermer M, Siu SC. Late cardiac outcomes after pregnancy in women with congenital aortic stenosis. Am Heart J. 2009 Mar;157(3):474-80. PubMed

Tzemos N, Therrien J, Yip J, Thanassoulis G, Tremblay S, Jamorski MT, Webb GD, Siu SC. Outcomes in adults with bicuspid aortic valves. JAMA. 2008 Sep 17;300(11):1317-25. PubMed

van Bommel RJ, Marsan NA, Delgado V, Borleffs CJ, van Rijnsoever EP, Schalij MJ, Bax JJ. Cardiac resynchronization therapy as a therapeutic option in patients with moderate-severe functional mitral regurgitation and high operative risk. Circulation. 2011 Aug 23;124(8):912-9. PubMed

Van de Veire NR, Braun J, Delgado V, Versteegh MI, Dion RA, Klautz RJ, Bax JJ. Tricuspid annuloplasty prevents right ventricular dilatation and progression of tricuspid regurgitation in patients with tricuspid annular dilatation undergoing mitral valve repair. J Thorac Cardiovasc Surg. 2011 Jun;141(6):1431-9. PubMed

Van de Werf F, Brueckmann M, Connolly SJ, Friedman J, Granger CB, HÃ¤rtter S, Harper R, Kappetein AP, Lehr T, Mack MJ, Noack H, Eikelboom JW. A comparison of dabigatran etexilate with warfarin in patients with mechanical heart valves: THE Randomized, phase II study to evaluate the safety and pharmacokinetics of oral dabigatran etexilate in patients after heart valve replacement (RE-ALIGN). Am Heart J. 2012 Jun;163(6):931-937.e1. PubMed

Van Rossum AC, Visser FC, Sprenger M, Van Eenige MJ, Valk J, Roos JP. Evaluation of magnetic resonance imaging for determination of left ventricular ejection fraction and comparison with angiography. Am J Cardiol. 1988 Sep 15;62(9):628-33. PubMed

Vandervoort PM, Greenberg NL, Powell KA, Cosgrove DM, Thomas JD. Pressure recovery in bileaflet heart valve prostheses. Localized high velocities and gradients in central and side orifices with implications for Doppler-catheter gradient relation in aortic and mitral position. Circulation. 1995 Dec 15;92(12):3464-72. PubMed

Varadarajan P, Joshi N, Appel D, Duvvuri L, Pai RG. Effect of Beta-blocker therapy on survival in patients with severe mitral regurgitation and normal left ventricular ejection fraction. Am J Cardiol. 2008 Sep 1;102(5):611-5. PubMed

Vassileva CM, Mishkel G, McNeely C, Boley T, Markwell S, Scaife S, Hazelrigg S. Long-term survival of patients undergoing mitral valve repair and replacement: a longitudinal analysis of Medicare fee-for-service beneficiaries. Circulation. 2013 May 7;127(18):1870-6. PubMed

Vincens JJ, Temizer D, Post JR, Edmunds LH, Herrmann HC. Long-term outcome of cardiac surgery in patients with mitral stenosis and severe pulmonary hypertension. Circulation. 1995 Nov 1;92(9 Suppl):II137-42. PubMed

Vitale N, De Feo M, Cotrufo M. Anticoagulation for prosthetic heart valves during pregnancy: the importance of warfarin daily dose. Eur J Cardiothorac Surg. 2002 Oct;22(4):656; author reply 657. PubMed

Wang A, Athan E, Pappas PA, Fowler VG, Olaison L, ParÃ© C, Almirante B, MuÃ±oz P, Rizzi M, Naber C, Logar M, Tattevin P, Iarussi DL, SeltonSuty C, Jones SB, CasabÃ© J, Morris A, Corey GR, Cabell CH, International Collaboration on Endocarditis-Prospective Cohort Study Investigators. Contemporary clinical profile and outcome of prosthetic valve endocarditis. JAMA. 2007 Mar 28;297(12):1354-61. PubMed

Wang K, Gobel F, Gleason DF, Edwards JE. Complete heart block complicating bacterial endocarditis. Circulation. 1972 Nov;46(5):939-47. PubMed

Watanakunakorn C. Staphylococcus aureus endocarditis at a community teaching hospital, 1980 to 1991. An analysis of 106 cases. Arch Intern Med. 1994 Oct 24;154(20):2330-5. PubMed

Weber A, Noureddine H, Englberger L, Dick F, Gahl B, Aymard T, Czerny M, Tevaearai H, Stalder M, Carrel TP. Ten-year comparison of pericardial tissue valves versus mechanical prostheses for aortic valve replacement in patients younger than 60 years of age. J Thorac Cardiovasc Surg. 2012 Nov;144(5):1075-83. PubMed

Weibert RT, Le DT, Kayser SR, Rapaport SI. Correction of excessive anticoagulation with low-dose oral vitamin K1. Ann Intern Med. 1997 Jun 15;126(12):959-62. PubMed

Wilkins GT, Weyman AE, Abascal VM, Block PC, Palacios IF. Percutaneous balloon dilatation of the mitral valve: an analysis of echocardiographic variables related to outcome and the mechanism of dilatation. Br Heart J. 1988 Oct;60(4):299-308. PubMed

Wilson JK, Greenwood WF. The natural history of mitral stenosis. Can Med Assoc J. 1954 Oct;71(4):323-31. PubMed

Wilson WR, Geraci JE, Danielson GK, Thompson RL, Spittell JA, Washington JR, Giuliani ER. Anticoagulant therapy and central nervous system complications in patients with prosthetic valve endocarditis. Circulation. 1978 May;57(5):1004-7. PubMed

Wisenbaugh T, Sinovich V, Dullabh A, Sareli P. Six month pilot study of captopril for mildly symptomatic, severe isolated mitral and isolated aortic regurgitation. J Heart Valve Dis. 1994 Mar;3(2):197-204. PubMed

Witkowski TG, Thomas JD, Debonnaire PJ, Delgado V, Hoke U, Ewe SH, Versteegh MI, Holman ER, Schalij MJ, Bax JJ, Klautz RJ, Marsan NA. Global longitudinal strain predicts left ventricular dysfunction after mitral valve repair. Eur Heart J Cardiovasc Imaging. 2013 Jan;14(1):69-76. PubMed

Wolff M, Witchitz S, Chastang C, RÃ©gnier B, Vachon F. Prosthetic valve endocarditis in the ICU. Prognostic factors of overall survival in a series of 122 cases and consequences for treatment decision. Chest. 1995 Sep;108(3):688-94. PubMed

Wu AH, Aaronson KD, Bolling SF, Pagani FD, Welch K, Koelling TM. Impact of mitral valve annuloplasty on mortality risk in patients with mitral regurgitation and left ventricular systolic dysfunction. J Am Coll Cardiol. 2005 Feb 1;45(3):381-7. PubMed

Yao F, Han L, Xu ZY, Zou LJ, Huang SD, Wang ZN, Lu FL, Yao YL. Surgical treatment of multivalvular endocarditis: twenty-one-year single center experience. J Thorac Cardiovasc Surg. 2009 Jun;137(6):1475-80. PubMed

Yilmaz O, Suri RM, Dearani JA, Sundt TM, Daly RC, Burkhart HM, Li Z, Enriquez-Sarano M, Schaff HV. Functional tricuspid regurgitation at the time of mitral valve repair for degenerative leaflet prolapse: the case for a selective approach. J Thorac Cardiovasc Surg. 2011 Sep;142(3):608-13. PubMed

Yinon Y, Siu SC, Warshafsky C, Maxwell C, McLeod A, Colman JM, Sermer M, Silversides CK. Use of low molecular weight heparin in pregnant women with mechanical heart valves. Am J Cardiol. 2009 Nov 1;104(9):1259-63. PubMed

Yiu KH, Siu CW, Jim MH, Tse HF, Fan K, Chau MC, Chow WH. Comparison of the efficacy and safety profiles of intravenous vitamin K and fresh frozen plasma as treatment of warfarin-related over-anticoagulation in patients with mechanical heart valves. Am J Cardiol. 2006 Feb 1;97(3):409-11. PubMed

Zahid M, Sonel AF, Saba S, Good CB. Perioperative risk of noncardiac surgery associated with aortic stenosis. Am J Cardiol. 2005 Aug 1;96(3):436-8. PubMed

Zile MR, Gaasch WH, Carroll JD, Levine HJ. Chronic mitral regurgitation: predictive value of preoperative echocardiographic indexes of left ventricular function and wall stress. J Am Coll Cardiol. 1984 Feb;3(2 Pt 1):235-42. PubMed

Zoghbi WA, Chambers JB, Dumesnil JG, Foster E, Gottdiener JS, Grayburn PA, Khandheria BK, Levine RA, Marx GR, Miller FA, Nakatani S, QuiÃ±ones MA, Rakowski H, Rodriguez LL, Swaminathan M, Waggoner AD, Weissman NJ, Zabalgoitia M, American Society of Echocardiography's Guidelines and Standards Committee, Task Force on Prosthetic Valves, American College of Cardiology Cardiovascular Imaging Committee, Cardiac Imaging Committee of the American Heart Association, European Association of Echocardiography, European Society of Cardiology, Japanese Society of Echocardiography, Canadian Society of Echocardiography, American College of Cardiology Foundation, American Heart Association, European Association of Echocardiography, European Society of Cardiology, Japanese Society of Echocardiography, Canadian Society of Echocardiography. Recommendations for evaluation of prosthetic valves with echocardiography and doppler ultrasound: a report From the American Society of Echocardiography's Guidelines and Standards Committee and the Task Force on Prosthetic Valves, developed in conjunction with the American College of Cardiology Cardiovascular Imaging Committee, Cardiac Imaging Committee of the American Heart Association, the European Association of Echocardiography [trunc]. J Am Soc Echocardiogr. 2009 Sep;22(9):975-1014; quiz 1082-4. PubMed

Zoghbi WA, Enriquez-Sarano M, Foster E, Grayburn PA, Kraft CD, Levine RA, Nihoyannopoulos P, Otto CM, Quinones MA, Rakowski

H, Stewart WJ, Waggoner A, Weissman NJ, American Society of Echocardiography. Recommendations for evaluation of the severity of native valvular regurgitation with two-dimensional and Doppler echocardiography. J Am Soc Echocardiogr. 2003 Jul;16(7):777-802. PubMed

### Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see the "Major Recommendations" field).

## Benefits/Harms of Implementing the Guideline Recommendations

### Potential Benefits

Appropriate management of patients with valvular heart disease (VHD)

### Potential Harms

- Peri-operative and post-operative morbidity and mortality, including side effects of anesthetic medications
- Short- and long-term complications of valve repair and replacement including thromboembolic risks
- Bleeding complications associated with anticoagulant therapy
- Side effects of cardiovascular drugs
- False-negative results of transesophageal echocardiography (TEE)
- Major complications can occur during pregnancy in patients with prosthetic valves. The increased hemodynamic burden of pregnancy can lead to heart failure if there is prosthetic valve thrombosis, stenosis, regurgitation, or patient-prosthesis mismatch. There is an increased risk for thrombosis of mechanical valves due to the hypercoagulable state of pregnancy.

## Contraindications

### Contraindications

- Intra-aortic balloon counterpulsation is contraindicated in patients with acute severe aortic regurgitation (AR).
- Cardiac magnetic resonance imaging is contraindicated in patients with implanted devices.
- The presence of either severe and uncorrectable pulmonary hypertension or significant right ventricular (RV) dysfunction constitutes a relative contraindication to reoperation for isolated tricuspid valve repair or replacement.
- Aspirin intolerance or history of bleeding is a contraindication to use of aspirin in combination with a vitamin K antagonist (VKA).
- The U.S. Food and Drug Administration (FDA) has issued a specific contraindication for use of dabigatran in patients with mechanical heart valves.
- Angiotensin-converting enzyme (ACE) inhibitors and angiotensin-receptor blockers (ARBs) are contraindicated during pregnancy due to fetal toxicity, including renal or tubular dysplasia, oligohydramnios, growth retardation, ossification disorders of the skull, lung hypoplasia, and intrauterine fetal death.
- Macrolide antibiotics should not be used in persons taking other medications that inhibit cytochrome P450 3A, such as azole antifungal agents, human immunodeficiency virus (HIV) protease inhibitors, and some selective serotonin reuptake inhibitors.

## Qualifying Statements

### Qualifying Statements

- Because the American College of Cardiology (ACC)/American Heart Association (AHA) practice guidelines address patient populations (and clinicians) residing in North America, drugs that are not currently available in North America are discussed in the text without a specific class of recommendation (COR). For studies performed in large numbers of subjects outside North America, each writing committee

reviews the potential impact of different practice patterns and patient populations on the treatment effect and relevance to the ACC/AHA target population to determine whether the findings should inform a specific recommendation.

- The ACC/AHA practice guidelines are intended to assist clinicians in clinical decision making by describing a range of generally acceptable approaches to the diagnosis, management, and prevention of specific diseases or conditions. The guidelines attempt to define practices that meet the needs of most patients in most circumstances. The ultimate judgment about care of a particular patient must be made by the clinician and patient in light of all the circumstances presented by that patient. As a result, situations may arise in which deviations from these guidelines may be appropriate. Clinical decision making should involve consideration of the quality and availability of expertise in the area where care is provided. When these guidelines are used as the basis for regulatory or payer decisions, the goal should be improvement in quality of care. The Task Force recognizes that situations arise in which additional data are needed to inform patient care more effectively; these areas are identified within each respective guideline when appropriate.
- Prescribed courses of treatment in accordance with these recommendations are effective only if followed. Because lack of patient understanding and adherence may adversely affect outcomes, clinicians should make every effort to engage the patient's active participation in prescribed medical regimens and lifestyles. In addition, patients should be informed of the risks, benefits, and alternatives to a particular treatment and should be involved in shared decision making whenever feasible, particularly for COR IIa and IIb, for which the benefit-to-risk ratio may be lower.

# Implementation of the Guideline

## Description of Implementation Strategy

An implementation strategy was not provided.

## Implementation Tools

Clinical Algorithm

Quick Reference Guides/Physician Guides

Resources

Slide Presentation

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

# Institute of Medicine (IOM) National Healthcare Quality Report Categories

## IOM Care Need

Getting Better

Living with Illness

Staying Healthy

## IOM Domain

Effectiveness

Patient-centeredness

# Identifying Information and Availability

## Bibliographic Source(s)

Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Guyton RA, O'Gara PT, Ruiz CE, Skubas NJ, Sorajja P, Sundt TM, Thomas JD, American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2014 Jun 10;63(22):e57-185. PubMed

## Adaptation

Not applicable: The guideline was not adapted from another source.

## Date Released

1998 Nov 1 (revised 2014 June 10)

## Guideline Developer(s)

American College of Cardiology Foundation - Medical Specialty Society

American Heart Association - Professional Association

## Source(s) of Funding

The American College of Cardiology and the American Heart Association

## Guideline Committee

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

## Composition of Group That Authored the Guideline

*Writing Committee Members*: Rick A. Nishimura, MD, MACC, FAHA (*Co-chair*), ACC/AHA representative; Catherine M. Otto, MD, FACC, FAHA (*Co-chair*), ACC/AHA representative; Robert O. Bonow, MD, MACC, FAHA, ACC/AHA representative; Blase A. Carabello, MD, FACC, ACC/AHA representative; John P. Erwin III, MD, FACC, FAHA, ACC/AHA Task Force on Performance Measures liaison; Robert A. Guyton, MD, FACC, ACC/AHA Task Force on Practice Guidelines liaison; Patrick T. O'Gara, MD, FACC, FAHA, ACC/AHA representative; Carlos E. Ruiz, MD, PhD, FACC, ACC/AHA representative; Nikolaos J. Skubas, MD, FASE, Society of Cardiovascular Anesthesiologists representative; Paul Sorajja, MD, FACC, FAHA, Society for Cardiovascular Angiography and Interventions representative; Thoralf M. Sundt III, MD, American Association for Thoracic Surgery representative, Society of Thoracic Surgeons representative; James D. Thomas, MD, FASE, FACC, FAHA, American Society of Echocardiography representative

*Task Force Members*: Jeffrey L. Anderson, MD, FACC, FAHA (*Chair*); Jonathan L. Halperin, MD, FACC, FAHA (*Chair-elect*); Nancy M. Albert, PhD, CCNS, CCRN, FAHA; Biykem Bozkurt, MD, PhD, FACC, FAHA; Ralph G. Brindis, MD, MPH, MACC; Mark A. Creager, MD, FACC, FAHA*; Lesley H. Curtis, PhD, FAHA; David DeMets, PhD; Robert A. Guyton, MD, FACC*; Judith S. Hochman, MD, FACC, FAHA; Richard J. Kovacs, MD, FACC, FAHA; E. Magnus Ohman, MD, FACC; Susan J. Pressler, PhD, RN, FAHA; Frank W. Sellke, MD, FACC, FAHA; Win-Kuang Shen, MD, FACC, FAHA; William G. Stevenson, MD, FACC, FAHA*; Clyde W. Yancy, MD, FACC, FAHA*

*Former Task Force member during the writing effort.

## Financial Disclosures/Conflicts of Interest

The Task Force makes every effort to avoid actual, potential, or perceived conflicts of interest that may arise as a result of relationships with industry and other entities (RWI) among the members of the writing committee. All writing committee members and peer reviewers of the guideline are required to disclose all current healthcare-related relationships, including those existing 12 months before initiation of the writing effort.

In December 2009, the American College of Cardiology (ACC) and the American Heart Association (AHA) implemented a new RWI policy that requires the writing committee chair plus a minimum of 50% of the writing committee to have no relevant RWI (Appendix 1 in the original guideline document includes the ACC/AHA definition of relevance). The Task Force and all writing committee members review their respective RWI disclosures during each conference call and/or meeting of the writing committee, and members provide updates to their RWI as changes occur. All guideline recommendations require a confidential vote by the writing committee and require approval by a consensus of the voting members. Authors' and peer reviewers' RWI pertinent to this guideline are disclosed in Appendixes 1 and 2 in the original guideline document. Members may not draft or vote on any recommendations pertaining to their RWI. Members who recused themselves from voting are indicated in the list of writing committee members with specific section recusals noted in Appendix 1 in the original guideline document. In addition, to ensure complete transparency, writing committee members' comprehensive disclosure information—including RWI not pertinent to this document—is available as an online supplement.

Comprehensive disclosure information for the Task Force is also available online at http://www.cardiosource.org/en/ACC/About-ACC/Who-We-Are/Leadership/Guidelines-and-Documents-Task-Forces.aspx. The ACC and AHA exclusively sponsor the work of the writing committee without commercial support. Writing committee members volunteered their time for this activity. Guidelines are official policy of both the ACC and AHA.

## Guideline Endorser(s)

American Association for Thoracic Surgery - Medical Specialty Society

American Society of Echocardiography - Professional Association

Society for Cardiovascular Angiography and Interventions - Medical Specialty Society

Society of Cardiovascular Anesthesiologists - Medical Specialty Society

Society of Thoracic Surgeons - Medical Specialty Society

## Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Bonow RO, Carabello BA, Chatterjee K, de Leon AC Jr, Faxon DP, Freed MD, Gaasch WH, Lytle BW, Nishimura RA, O'Gara PT, O'Rourke RA, Otto CM, Shah PM, Shanewise JS, American College of Cardiology/American Heart Association Task Force on Practice Guidelines. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines [trunc]. J Am Coll Cardiol. 2008 Sep 23;52(13):e1-142. [1067 references]

## Guideline Availability

Electronic copies: Available from the Journal of the American College of Cardiology (JACC) Web site and from the Circulation Web site.

Print copies: Available from the American College of Cardiology, 2400 N Street NW, Washington DC, 20037; (800) 253-4636 (US only).

## Availability of Companion Documents

The following are available:

- Hiratzka LF, Nishimura RA, Bonow RO, Creager MA, Guyton RA, Isselbacher EM, Sundt TM 3rd, Svensson LG. Surgery for aortic dilatation in patients with bicuspid aortic valves: a statement of clarification from the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol 2016;67:724–31. Available from the Journal of the American College of Cardiology (JACC) Web site .
- Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Guyton RA, O'Gara PT, Ruiz CE, Skubas NJ, Sorajja P, Sundt TM, Thomas JD. 2014 AHA/ACC guideline for the management of patients with valvular heart disease: executive summary. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol. 2014 Jun 10;63(22):2438-88. Electronic copies: Available from the JACC Web site .
- Nishimura RA, Otto CM, Bonow RO, Carabello BA, Erwin JP, Guyton RA, O'Gara PT, Ruiz CE, Skubas NJ, Sorajja P, Sundt TM, Thomas JD. 2014 AHA/ACC guideline for the management of patients with valvular heart disease. A report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Online data supplement. Available from the JACC Web site .
- 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Ten points to remember. Electronic copies: Available from the American College of Cardiology (ACC) Web site .
- 2014 AHA/ACC guideline for the management of patients with valvular heart disease: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. Slide set. Electronic copies: Available to subscribers from the ACC Web site .
- Methodology manual and policies from the ACCF/AHA Task Force on Practice Guidelines. 2010 Jun. 88 p. American College of Cardiology Foundation and American Heart Association, Inc. Electronic copies: Available from the ACC Web site .


Print copies: Available from the American College of Cardiology, 2400 N Street NW, Washington DC, 20037; (800) 253-4636 (US only).

## Patient Resources

None available

## NGC Status

This NGC summary was completed by ECRI on July 26, 1999. The information was verified by the guideline developer on October 15, 1999. This summary was updated by ECRI on August 3, 2006. The information was verified by the guideline developer on August 17, 2006. This summary was updated by ECRI on March 6, 2007 following the U.S. Food and Drug Administration (FDA) advisory on Coumadin (warfarin sodium). This summary was updated by ECRI Institute on June 22, 2007 following the U.S. Food and Drug Administration (FDA) advisory on heparin sodium injection. This summary was updated by ECRI Institute on September 7, 2007 following the revised U.S. Food and Drug Administration (FDA) advisory on Coumadin (warfarin). This summary was updated by ECRI Institute on March 14, 2008, April 22, 2009 following the updated FDA advisory on heparin sodium injection. This summary was updated by ECRI Institute on July 13, 2009. The updated information was verified by the guideline developer on July 23, 2009. This summary was updated by ECRI Institute on January 5, 2010 following the U.S. Food and Drug Administration advisory on Plavix (Clopidogrel). This summary was updated by ECRI Institute on May 17, 2010 following the U.S. Food and Drug Administration advisory on Plavix (clopidogrel). This summary was updated by ECRI Institute on July 27, 2010 following the FDA drug safety communication on Heparin. This summary was updated by ECRI Institute on August 7, 2014. The updated information was verified by the guideline developer on September 24, 2014. This summary was updated by ECRI Institute on February 15, 2017 following the U.S. Food and Drug Administration advisory on general anesthetic and sedation drugs.

## Copyright Statement


This NGC summary is based on the original guideline, which is subject to the guideline developer's copyright restrictions as follows:

Copyright to the original guideline is owned by the American College of Cardiology Foundation (ACCF) and the American Heart Association, Inc. (AHA). NGC users are free to download a single copy for personal use. Reproduction without permission of the ACC/AHA guidelines is prohibited. Permissions requests should be directed to copyright_permissions@acc.org.

# Disclaimer

## NGC Disclaimer

The National Guideline Clearinghouseâ„¢ (NGC) does not develop, produce, approve, or endorse the guidelines represented on this site.

All guidelines summarized by NGC and hosted on our site are produced under the auspices of medical specialty societies, relevant professional associations, public or private organizations, other government agencies, health care organizations or plans, and similar entities.

Guidelines represented on the NGC Web site are submitted by guideline developers, and are screened solely to determine that they meet the NGC Inclusion Criteria.

NGC, AHRQ, and its contractor ECRI Institute make no warranties concerning the content or clinical efficacy or effectiveness of the clinical practice guidelines and related materials represented on this site. Moreover, the views and opinions of developers or authors of guidelines represented on this site do not necessarily state or reflect those of NGC, AHRQ, or its contractor ECRI Institute, and inclusion or hosting of guidelines in NGC may not be used for advertising or commercial endorsement purposes.

Readers with questions regarding guideline content are directed to contact the guideline developer.