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SPECIAL ARTICLE

An Overview of the American College of Cardiology/American Heart Association 2014 Valve Heart Disease Practice Guidelines: What Is Its Relevance for the Anesthesiologist and Perioperative Medicine Physician?

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The American College of Cardiology and the American Heart Association have jointly engaged in the production of clinical guidelines for cardiovascular disease since 1980. The first version of the American College of Cardiology/American Heart Association guidelines for the management of patients with valvular heart disease (VHD) was published in 1998, revised in 2006, and updated in 2008.[1] The latest VHD guidelines were published in electronic format in the March 2014 issue of the *Journal of American College of Cardiology*[2] and in the June 2014 issue *Circulation*[3] and are accessible online (executive summary: http://content.onlinejacc.org/article.aspx?articleid=1838844 and full text: http://content.onlinejacc.org/article.aspx?articleid=1838843). The VHD practice guidelines are considered essential in guiding the clinician's decision for the diagnosis, management, and prevention of VHD. The entire publication is a hefty production, with the Executive Summary numbering 96 pages and the full document 234 pages, with 939 referenced articles, which are linked to abstracts in PubMed (http://content.onlinejacc.org/article.aspx?articleid=1838843). Links within the Executive Summary to the full-text document, along with summary tables, flowcharts, evidence tables, and a helpful data supplement section complete this comprehensive resource.

In this article, we summarize the most important information that is, in the authors' view, pertinent to practicing anesthesiologists and perioperative physicians regarding specific valve pathology, diagnosis, follow-up, medical therapy and surgical interventions, bacterial endocarditis prophylaxis, management of the pregnant patient with valve disease, as well as anticoagulation for prosthetic valves and perioperative bridging therapy. The significant changes to the previous VHD guidelines published in 2008 are identified. New to the 2014 edition is an important section on noncardiac surgery in patients with VHD.

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In the 2014 VHD practice guidelines, the recommended interventions, including procedures or treatments, are presented in classes of recommendation (COR) and supported by levels of evidence (LOE). Of note, changes in the definition of COR were made to differentiate between lack of proven benefit (class III: no benefit) and harm to the patient (class III: harm) (Table 1).

CLASSIFICATION OF DISEASE SEVERITY (SECTION 2.2 OF 2014 VHD PRACTICE GUIDELINES)

In the current practice guidelines, there is emphasis on the multimodal diagnostic approach. Auscultation, which occupied a whole section in the 2008 version, is not featured as a prominent diagnostic tool. The patient's history (presence or absence of symptoms), a detailed physical examination including evaluation of heart rhythm, and imaging studies should be used to diagnose the presence and the rate of VHD progression along with the response of the left ventricle (LV) or right ventricle, and the effect on the systemic or pulmonary circulation caused by volume or pressure overload. In the 2008 version, staging of severity was based on echocardiography, whereas in the 2014 guidelines there is a new 4-stage classification scheme to identify the stages of VHD, where symptoms have a central role (Table 2).

This classification should ideally become the primary reference terminology used to standardize communication among health care providers. Therefore, severe VHD may be symptomatic (stage D) or asymptomatic (stage C), and the latter may exist with compensated (C1) or decompensated (C2) ventricular function. In the case of aortic valve stenosis (AS), a maximum transaortic velocity of >4 m/s may be found in stages C1 to D, but a symptomatic patient with a calcified and stenosed aortic valve (AV) is classified as stage D disease, irrespective of the maximum transaortic velocity as described in stages D2 and D3 (see below).

EVALUATION OF SURGICAL AND INTERVENTIONAL RISK (SECTION 2.5 OF 2014 VHD PRACTICE GUIDELINES)

New to the 2014 guidelines, the risk assessment score is based on the Society of Thoracic Surgeons (STS) predicted risk of mortality, presence of frailty, comorbidity from compromised function of a major organ system, or procedure-related issues such as reoperation and chest radiation should be considered when estimating the surgical risk (Table 3). For example, a single index of frailty, such as inability for independent care or use of a walking aid, requiring assistance to

Table 1. Classes of Recommendation and Levels of Evidence

		The intervention…	Because it…
Class of recommendation	I	**Should** be performed	**Is** useful/beneficial/effective
	IIa	**Reasonable** to perform	**Can** be useful/beneficial/effective
	IIb	**May be considered**	Effectiveness **is not well** established/known
	III	**Not beneficial**	Not helpful or no proven benefit
	III	**Harmful**	Excess cost without benefit or harmful
		Populations evaluated:	Data derived from…
Level of evidence	A	**Multiple**	**Multiple** randomized clinical trials or meta-analyses
	B	**Limited**	**Single** randomized clinical trial or nonrandomized studies
	C	**Very limited**	Consensus opinion of experts, case studies, or standard of care

Table 2. Disease Severity

Stage	Definition	Symptoms	Severity
A	At risk	Asymptomatic	Risk factors only
B	Progressive	Asymptomatic	Mild to moderate
C	Severe	Asymptomatic	Severe
C1			*Compensated* right or left ventricular function, normal size
C2			*Decompensated* right or left ventricular function, dilated chamber
D	Severe	Symptomatic	Severe

walk, or walk 5 m in >6 seconds, will suffice to classify the risk as intermediate, irrespective of the STS risk score.[4,5]

THE HEART VALVE TEAM AND HEART VALVE CENTERS OF EXCELLENCE (SECTION 2.6 OF 2014 VHD PRACTICE GUIDELINES)

A very important addition in the 2014 VHD practice guidelines is the recognition and definition of the "Heart Valve Team" and "Heart Valve Center of Excellence." Patients with VHD stage C or D should be evaluated by a multidisciplinary Heart Valve Team comprising an experienced group of VHD specialists, including cardiologists, surgeons, interventionalists, cardiovascular imaging specialists, anesthesiologists, and nurses, which is capable of offering all available options for diagnosis and management, including complex valve repair, aortic surgery, and transcatheter interventions. Our peers recognize the critical role of the cardiovascular anesthesiologist whose participation in the collaborative preoperative management of the critically ill VHD patient is specifically recommended.[6,7] A Heart Valve Center of Excellence should participate in regional or national outcome registries, demonstrate adherence to national guidelines, participate in continued evaluation and quality improvement processes to enhance patient outcomes, and publicly report the physicians' available mortality and success rates. Decisions about intervention should be dependent on the Heart Valve Center of Excellence publicly available mortality rates and operative outcomes. It is recognized that some Heart Valve Centers of Excellence may have expertise in select valve problems. It is also important for our societies, including the American Society of Anesthesiologists and Society of Cardiovascular Anesthesiologists, to promote this recognized role of the anesthesiologists and for the private or academic institutions to foster this type of collaboration. Of note, the specific accreditation or certification required for an institution to claim to have a Heart Valve Center of Excellence is not addressed in the document, and it is acknowledged that its composition "will vary depending on the specific clinical situation and will also vary from institution to institution."[7]

AORTIC VALVE STENOSIS (SECTION 3 OF 2014 VHD PRACTICE GUIDELINES)

The diagnosis and staging of AS are based on the transaortic valve maximum velocity or mean pressure gradient, provided that the left ventricular ejection fraction (LVEF) and stroke volume are normal. Contrary to the 2008 guidelines, the AV area is not used as an independent criterion. For AS, stage C2 is reserved for asymptomatic severe AS with ventricular dysfunction (LVEF <50%); the stages of symptomatic severe AS (stage D) are subdivided into the following (Table 4):

- D1: the "typical" AS, with maximum transvalvular aortic velocity > 4m/s or a mean pressure gradient >40 mm Hg, and an expected AV area <1 cm^2 (all assuming LVEF >50%);
- D2 (low-flow/low-gradient AS): depressed LV systolic function (50%) results in a symptomatic patient with a maximum transvalvular aortic velocity <4 m/s or a mean pressure gradient <40 mm Hg; a dobutamine stress echocardiographic study should show an increase in the maximum transvalvular aortic velocity to >4 m/s and an AV area <1 cm^2; and
- D3 (low-gradient/normal ejection fraction AS): a paradoxically small LV stroke volume (LV stroke volume index <35 mL/m^2) is the reason for a maximum transvalvular aortic velocity <4 m/s, despite a normal LVEF in this classification.

This emphasis on transvalvular aortic maximum velocity along with evaluation of LV size and function should become the new paradigm in diagnosing severe AS in the operating room. The intraoperative echocardiographic examination should include an assessment of the stenosed/diseased AV with continuous-wave Doppler to measure the maximum transaortic velocity and derive the mean pressure gradient, along with the evaluation of the LVEF and stroke volume. The calculation of the AV area is not highly emphasized because it is a functional not an anatomic orifice and is dependent on additional measurements, including velocity and diameter of the LV outflow tract. An accurate assessment and diagnosis of AS severity is critical because the incidental finding of a stenosed AV (stage C or D) in an asymptomatic patient during another planned cardiac surgical procedure is an indication for AV replacement (AVR).

Also new to these guidelines is the choice between surgical AVR and transcatheter AVR (TAVR). The advent of TAVR

Table 3. Risk Assessment

	Low risk (all criteria)	Intermediate risk (any criterion)	High risk (any criterion)	Prohibitive risk (any criterion)
STS risk of mortality	<4%	4%–8%	>8%	>50% at 1 year
Frailty: compromise of…	None (patient is able to perform all activities)	1 (mild frailty)	≥2 (moderate to severe)	
Transferring				
Urinary continent				
Toileting				
Bathing				
Dressing				
Feeding				
Ability to walk 5 m in <6 s				
Major organ system compromise not expected to improve postoperatively[a]	None	1 organ system	≤2 organ systems	≥3 organ systems
Procedure-specific impediment[b]	None	Possible	Possible	Severe

STS = Society of Thoracic Surgeons.

[a]Major organ system compromise examples are severe systolic or diastolic left or right ventricular dysfunction, pulmonary hypertension, chronic kidney disease ≥3, pulmonary disease, central nervous system disease, liver disease, gastrointestinal disease, and cancer.

[b]Procedure-specific impediment examples are tracheostomy, calcified ascending aorta, coronary artery bypass graft adhering to sternum, and radiation damage.

Table 4. Severe Symptomatic Aortic Stenosis

	Valve anatomy	Valve hemodynamics	Hemodynamic consequences	Symptoms
D1; high gradient	Severe calcification, reduced cusp motion	Transaortic Vmax ≥4 m/s or mean ΔPG ≥40 mm Hg AVA ≤1 cm² (AVAi ≤0.6 cm²/m²)	LV diastolic dysfunction LVH ± pulmonary hypertension	Exertional dyspnea/angina/(pre)syncope or decreased exercise tolerance
D2; low-flow/low-gradient with decreased LVEF	Severe calcification, reduced cusp motion	Resting: AVA ≤1 cm² transaortic with Vmax <4 m/s or mean ΔPG <40 mm Hg Dobutamine stress echocardiography: AVA ≤1 cm² with transaortic Vmax ≥4 m/s	LV diastolic dysfunction LVH LVEF <50%	Heart failure Angina (Pre)syncope
D3; low-gradient with normal LVEF or paradoxical low-flow	Severe calcification, reduced cusp motion	AVA ≤1 cm² with transaortic Vmax <4 m/s or mean ΔPG <40 mm Hg AVAi ≤0.6 cm²/m² LV SVi <35 mL/m² (normotensive patient; systolic blood pressure <140 mm Hg)	LV restrictive filling Increased LV relative wall thickness LVEF >50% LV: small chamber with decreased stroke volume	Heart failure Angina (Pre)syncope

AVA = aortic valve area; AVAi = AVA (indexed); LV = left ventricle; LVH = LV hypertrophy; LVEF = left ventricular ejection fraction; LV SVi = LV stroke volume (indexed); PG = pressure gradient.

and the favorable results from many well-designed Food and Drug Administration–sponsored prospective studies[8] made the inclusion of this nonsurgical AVR approach necessary. Surgical AVR is recommended for patients in whom valve replacement is indicated if the surgical risk is low or intermediate. Alternatively, if the surgical risk is high or prohibitive, TAVR is indicated. However, TAVR is not recommended (COR III: no benefit; LOE: B) if the AS patient has comorbidities, such as advanced age, smoking, chronic obstructive pulmonary disease, anemia, pulmonary hypertension, liver disease, history of stroke, or STS score ≥15%, that may negate any benefit from AVR.[8] If the surgical risk is high, irrespective of the type of AVR (i.e., surgical or transcatheter), a Heart Valve Team whose members collaborate closely to provide optimal patient care should be consulted.

AORTIC VALVE REGURGITATION (SECTION 4 OF 2014 VHD PRACTICE GUIDELINES)

Severe asymptomatic AV regurgitation (AR) with decreased LVEF (<50%) and dilated LV (end-systolic diameter >50 mm or >25 mm/m²) is considered stage C2.

For patients with AR, the decision-making tree is much simpler in the 2014 practice guidelines: AVR is indicated in severe symptomatic (stage D) AR, in asymptomatic (stage C2) AR with progressive LV dilation, decreased LVEF, or in those undergoing another cardiac surgical procedure. AVR is also indicated in patients with progressive AR (stage B) concomitant to other cardiac surgery. For the anesthesiologist-echocardiographer, it is important to accurately diagnose the severity of AR based on the published American Society of Echocardiography criteria.[9]

BICUSPID AORTIC VALVE AND AORTOPATHY (SECTION 5 OF 2014 VHD PRACTICE GUIDELINES)

The section on bicuspid AV and aortopathy is much more extensive in the 2014 VHD practice guidelines, with slightly different aortic diameter cutoff criteria for surgical intervention. In patients with a bicuspid AV, repair of the aortic sinuses or replacement of the ascending aorta is indicated if their diameters are >5.5 cm (COR: I, LOE: B) or reasonable if the diameters are >5 cm in the presence of risk factors for dissection, such as family history of dissection or the rate of diameter increase is ≥0.5 cm per year (COR: IIa, LOE: C) The replacement of the dilated ascending aorta (diameter >4.5 cm) is considered reasonable in patients with a bicuspid AV who are undergoing AV surgery for severe AS or AR (COR: IIa, LOE: C).

MITRAL STENOSIS (SECTION 6 OF 2014 VHD PRACTICE GUIDELINES)

In patients with mitral stenosis (MS), the anatomic (by planimetry) and effective (by pressure half-time) mitral orifice area are recommended for use in disease staging. The 2014 VHD practice guidelines designate a mitral valve (MV) area <1.5 cm^2 that corresponds to a mean pressure gradient of 5 to 10 mm Hg, as severe MS (stages C and D), contrary to the 2008 document, where the criteria for severe MS were area <1.0 cm^2 and a mean pressure gradient >10 mm Hg. A MV area <1 cm^2 is considered "very severe" MS.

MV surgery including repair, commissurotomy, or replacement should be considered in patients with a MV area <1.5 cm^2, unless they are considered to be high perioperative risk. Percutaneous mitral balloon commissurotomy is an alternative, provided that there are no left atrial thrombi, the MV anatomy is favorable, and any mitral regurgitation (MR) is less than moderate. A patient with moderate MS (MV area 1.5–2 cm^2) should undergo conventional MV repair or replacement if cardiac surgery is required for other reasons.

MITRAL REGURGITATION (SECTION 7 OF 2014 VHD PRACTICE GUIDELINES)

The 2014 VHD practice guidelines differentiate between chronic primary (degenerative) and chronic secondary (functional) MR. In primary MR only, stage C (asymptomatic severe MR) is divided into stage C1, if ventricular function (LVEF >60%) and dimension (end-systolic diameter <4 cm) are preserved, and stage C2, if LVEF is decreased (≤60%) and ventricle is dilated (end-systolic diameter ≥4 cm). Two useful echocardiographic methods to diagnose severe MR include the effective regurgitant orifice area (EROA) and regurgitant volume (RegVol). However, the cutoff values for severe MR differ between primary (degenerative) MR (EROA ≥0.4 cm^2 and RegVol ≥60 mL) and secondary (functional) MR (EROA ≥0.2 cm^2 and RegVol ≥30 mL). These smaller cutoff EROA and RegVol values were associated with mortality in functional (ischemic) MR independently of the degree of LV dysfunction.[10] In the 2008 document, MV repair was recommended for asymptomatic MR patients with preserved LVEF if performed by experienced surgeons. However, the emphasis in the 2014 VHD practice guidelines is on surgical repair of the affected mitral leaflet(s) in both primary or secondary MR. In fact, surgical replacement for isolated severe primary MR that is limited to less than one-half of the posterior leaflet is contraindicated (COR: III-Harm, LOE: B), unless repair was attempted and failed. Similar to AS, transcatheter MV replacement may be considered in high-risk patients with primary MR (COR: IIb, LOE: B).

The only explicit recommendation for intraoperative transesophageal echocardiographic examination (TEE) during valve surgery pertains to the importance of diagnosing severe MR (COR: I, LOE: B) to establish the anatomic basis for chronic primary (degenerative) MR and to guide repair. This recommendation is unchanged from the 2008 edition. If continued growth in the use of 3D echocardiography is considered,[11] the accumulation of prospective data from well-designed studies will probably lead to even stronger recommendations that are supported by rigorous, higher level evidence on the use of intraoperative TEE for mitral and other types of valve surgery.

TRICUSPID REGURGITATION (SECTION 8.2 OF 2014 VHD PRACTICE GUIDELINES) AND STENOSIS (SECTION 8.4 OF 2014 VHD PRACTICE GUIDELINES)

Severe (stages C or D) tricuspid regurgitation (TR) is characterized by tethered leaflets and dilated tricuspid valve annulus (>4 cm or >2.1 mm/m^2). These cutoff echocardiographic measurements acquired from the midesophageal 4-chamber view with TEE are new to the 2014 VHD practice guidelines. The tricuspid valve should be repaired during left-sided valve surgery in severe TR or tricuspid valve stenosis (COR: I), as well as in less than severe TR if the tricuspid annulus is dilated (>40 mm) or there is history of right heart failure (COR: IIa) or pulmonary artery hypertension (COR: IIb).

CHOICE OF PROSTHETIC VALVE (SECTION 11.1 OF 2014 VHD PRACTICE GUIDELINES) AND ANTITHROMBOTIC THERAPY (SECTION 11.2 OF 2014 VHD PRACTICE GUIDELINES)

The 2014 VHD practice guidelines highlight the following recommendations:

1. Selection: the choice of valve intervention and type of prosthesis should be a shared decision between the informed patient and his physician after a full disclosure of the anticoagulation risk and potential risks of reoperation. If anticoagulation is contraindicated, a bioprosthesis is recommended (COR: I) in patients of any age. Otherwise, if there is no contraindication to anticoagulation, a mechanical prosthesis is reasonable for AVR or MV replacement in patients <60 years of age and a bioprosthesis in patients >70 years of age (COR: IIa). In the 2008 edition, the cutoff age for bioprosthesis versus mechanical prosthesis was 65 years.
2. Antithrombotic therapy: aspirin and warfarin are recommended for patients with a mechanical prosthesis to provide protection against valve thrombosis and thromboembolism.[12–14] The target international normalized ratio (INR) is simplified in the 2014 VHD practice guidelines; however, it varies depending on the valve site and thromboembolic risk (Table 5). Oral antithrombin inhibitors or anti-Xa agents should not be used in patients with mechanical prostheses (COR: III-harmful).
3. Excessive anticoagulation and bleeding and bridging: in case of emergent noncardiac surgery or invasive procedures or uncontrollable bleeding, anticoagulation should be reversed with administration of fresh frozen plasma or prothrombin complex concentrate. The anticoagulation with warfarin should not be interrupted before minor surgical procedures such as dental extractions or cataract removal.
4. Thrombotic events: TEE is indicated in left-sided prosthetic valve thrombosis to evaluate for thrombus size. Emergent surgery is indicated if the patient is symptomatic or a mobile or large (>0.8 cm^2) thrombus is found. Fibrinolytic therapy is indicated if the thrombus is small (<0.8 cm^2), of recent onset (<14 days) or symptoms are not severe (New York Heart Association class I–II), and in right-sided prosthetic valve thrombosis.

Table 5. Antithrombotic Therapy and Bridging Therapy

Antithrombotic therapy	Mechanical prosthesis			Bioprosthesis		
	MVR	AVR and risk factors	AVR, no risk factors	MVR	AVR	Transcatheter AVR
ASA 75–100 mg PO	Yes	Yes	Yes	Yes	Yes	Yes (6 months)
INR	3	3	2.5	2.5 (3 months)	2.5 (3 months)	n/a
Clopidogrel 75 mg PO	n/a	n/a	n/a	n/a	n/a	Yes (6 months)
Bridging therapy						
INR	Minimize time on subtherapeutic INR	Minimize time on subtherapeutic INR	Minimize time on subtherapeutic INR	n/a	n/a	n/a
Unfractionated heparin or low-molecular-weight heparin SQ	Yes	Yes	Not recommended	Not recommended	Not recommended	Not recommended

Risk factors include ball-in-cage mechanism, atrial fibrillation, previous thromboembolism, left ventricular dysfunction, or hypercoagulability.
ASA = aspirin; AVR = aortic valve replacement; INR = international normalized ratio; MVR = mitral valve replacement; PO = orally; SQ = subcutaneous.

INFECTIVE ENDOCARDITIS (SECTION 12 OF 2014 VHD PRACTICE GUIDELINES)

The section on infectious endocarditis provides up-to-date diagnostic criteria and the diagnostic role of echocardiography in both the initial workup and the subsequent medical/surgical decision making.

In the 2014 VHD practice guidelines, the diagnosis of infectious endocarditis is defined according to the proposed modified Duke Criteria (Tables 24 and 25 of 2014 VHD PRACTICE GUIDELINES).

Anesthesiologists who perform echocardiography should be aware of the importance of TEE in the diagnosis of patients with staphylococcal bacteremia without a known source and in the initial and serial evaluation with a known source.

PREGNANCY (SECTION 13 OF 2014 VHD PRACTICE GUIDELINES)

Patients with native valve disease or a prosthetic heart valve should be consulted before pregnancy. Pregnant patients with severe valve stenosis or regurgitation (stages C and D) and those with a mechanical valve prosthesis should be followed in a tertiary care center with a dedicated Heart Valve Team comprising cardiologists, surgeons, anesthesiologists, and obstetricians with expertise in the management of high-risk cardiac patients. A patient should discontinue or replace any angiotensin-converting enzyme inhibitors or angiotensin receptor blockers before pregnancy. β-Blockers or diuretics are not contraindicated, if required for the management of VHD.

Because of the high risk of mortality (fetal: 30%–40%; maternal: 9%), no valve intervention should be performed in the absence of New York Heart Association class III or IV symptoms of heart failure. The symptomatic pregnant patient with severe intractable heart failure and severe AS, AR, or MS should undergo a valve intervention. Percutaneous mitral balloon commissurotomy is recommended in severe MS if valve morphology is favorable. If the mother can carry the fetus to full maturity, cesarean delivery followed by open heart surgery should be attempted. Otherwise, an intervention between the 20th and 28th week of pregnancy is preferred, when the risks for premature delivery and fetal malformation are balanced out.

Medical therapy recommendations are gestational age-specific. Anticoagulation is indicated only for pregnant women with native MS and atrial fibrillation. Similar to the European Society of Cardiology guidelines,[15] all pregnant patients with mechanical prosthetic valves should receive dual antithrombotic therapy with warfarin and aspirin in the second and third trimester until the time of delivery when IV heparin should be initiated and targeted to an activated partial thromboplastin time >2× control. Pregnant patients with bioprosthetic valves should only receive aspirin. Because warfarin is associated with embryopathy during the first trimester, a warfarin dose <5 mg every day to achieve a therapeutic INR is reasonable after discussion of risks and benefits. If therapeutic INR levels require a larger dose of warfarin (>5 mg every day) or if warfarin is not desired, heparin (IV unfractionated or subcutaneous low molecular weight with monitoring of anti-Xa levels) are reasonable alternatives.

NONCARDIAC SURGERY (SECTION 15 OF 2014 VHD PRACTICE GUIDELINES)

The section on noncardiac surgery is new. There are no large prospective studies that provide data to support recommendations for patients with VHD undergoing noncardiac surgery.[16] The evidence is primarily limited to retrospective, nonrandomized case series (LOE: C). If the clinical history or symptoms suggest the presence of valve disease that meets the criteria for valve intervention, this should occur before elective noncardiac surgery. Otherwise, the guidelines recommend a comprehensive preoperative workup (transthoracic echocardiography, stress echocardiographic or nuclear imaging study, coronary angiography) to diagnose the severity of the underlying valve or coronary artery disease, to evaluate the LV systolic function, and to estimate the pulmonary artery pressure.

Particular attention should be devoted to patients with stenotic valve lesions in whom the perioperative risk for cardiac complications after noncardiac surgery is higher compared with those with regurgitant valve lesions, particularly if the anesthesiologist and surgeon are unaware of the presence or severity of valve disease. Appropriate monitoring with invasive arterial, central venous, or pulmonary artery

catheters or TEE should be implemented preoperatively and continued for 2 to 3 days or longer postoperatively to diagnose acute changes in volume, afterload, and heart rate and rhythm that can impair cardiac performance.[17] There are no specific recommendations for monitoring, but it is clear that invasive arterial pressure monitoring is suggested for all such patients, while the choice for central venous or pulmonary artery catheter or TEE is left to the discretion of the physician. Similar to the European Society of Cardiology 2012 guidelines,[18] the role of a cardiovascular anesthesiologist who is properly trained to use invasive hemodynamic monitors and TEE is pivotal, especially in patients with severe VHD who undergo emergent noncardiac surgery. In general, asymptomatic patients with severe AS can safely undergo moderate risk, noncardiac surgery without further preoperative intervention.[19–21] Nonetheless, hemodynamic volatility in the perioperative period often requires the use of vasoactive medications including phenylephrine or norepinephrine to restore normal arterial blood pressure.[22,23] Epidural anesthesia has been proven to be safe for orthopedic surgery.[24] Patients with asymptomatic severe MR[25] or severe AR with preserved LVEF[26] may undergo noncardiac surgery under proper hemodynamic intraoperative and postoperative hemodynamic monitoring. Alternatively, for a patient with asymptomatic severe MS, the guidelines suggest that percutaneous mitral balloon commissurotomy be performed initially if the anatomy is favorable, followed by the noncardiac surgical procedure. Otherwise, perioperative hemodynamic monitoring should be used for the noncardiac surgical procedure in a patient with MS, in a fashion similar to the other valvular lesions.

EVIDENCE GAPS AND FUTURE DIRECTIONS

The 2014 VHD practice guidelines recommendations for evaluation and management of VHD are largely based on clinical experience and observational studies, with very few prospective randomized controlled studies. The writing committee recommends that research on valve disease span the spectrum from basic science to prospective randomized trials and that studies focus on each stage of the disease process from the patient at risk to the patient with end-stage disease. Specific areas of future research include the prevention of valve disease, medical therapy to treat or prevent disease progression, and the optimal timing of intervention.

Anesthesiologists and perioperative care physicians are well suited to pursue these research opportunities especially in the areas of preventative medicine, hemodynamic monitoring, and outcome. It has been pointed out that the current recommendations only support the use of intraoperative TEE during valve surgery for severe MR (COR: I, LOE: B) to establish the anatomic basis for chronic primary/organic MR and to guide repair, while in the 2008 edition the use of intraoperative TEE was recommended for valve repair, during valve surgery for infective endocarditis and for valve replacement with stentless xenograft, homograft, or autograft valve. Further accumulation of prospective evidence supporting the utility of both 2D and 3D intraoperative TEE in facilitating clinical decision making will hopefully lead to more recommendations that are supported by rigorous (higher level of) evidence on the use of intraoperative TEE for other types of valve surgery as well.

The integration of guideline recommendations into routine clinical practice remains one of the greatest challenges that the health care system faces today. Although focused implementation of guidelines at single institutions are often successful, evidence-based best practice guidelines, including those focused on adult cardiac surgery, are being used in less than half of the world's clinical settings today.[27]

Anesthesiologists and perioperative physicians have an important role in implementing the 2014 VHD practice guidelines. The International Anesthesia Research Society and the Society of Cardiovascular Anesthesiologists are committed to disseminating this information and developing educational formats to aid the implementations of these guidelines. The authors of this article and the leaders of our professional societies look forward to working together to achieve this goal.

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