Section 1: Initial Evaluation for Valvular Heart Disease
Table 1: Initial Evaluation of an Asymptomatic Patient

Indication	Level of Evidence (LEVEL) Review	Reference
1. Unexplained murmur or abnormal heart sounds	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease *(p. e64)*** **2.3.1. Diagnostic Testing–Initial Diagnosis:** **CLASS I** 1.TTE is recommended in the initial evaluation of patients with known or suspected VHD to confirm the diagnosis, establish etiology, determine severity, assess hemodynamic consequences, determine prognosis, and evaluate for timing of intervention. (Level of Evidence: B).
2. Reasonable suspicion of valvular heart disease	**LEVEL B** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease *(p. e64)*** **2.3.1. Diagnostic Testing–Initial Diagnosis:** **CLASS I** 1.TTE is recommended in the initial evaluation of patients with known or suspected VHD to confirm the diagnosis, establish etiology, determine severity, assess hemodynamic consequences, determine prognosis, and evaluate for timing of intervention. (Level of Evidence: B). **2.3.5. Diagnostic Testing - Exercise Testing: *(p. e65)*** **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. (Level of Evidence: B).
3.History of rheumatic heart disease	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e90)** 6.2. Rheumatic MS 6.2.1. Diagnosis and Follow-Up 6.2.1.1. DIAGNOSTIC TESTING INITIAL DIAGNOSIS: RECOMMENDATIONS 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) (Level of Evidence: B).
4.Known systemic or acquired disease associated with valvular heart disease	**LEVEL B**	**2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e186)** **6.4 Recommendations for Evaluation of the Unoperated Patient** **CLASS I** 1. Primary imaging and hemodynamic assessment of AS and aortic valve disease are recommended by echocardiography-Doppler to evaluate the presence and severity of AS or AR; LV size, function, and mass; and dimensions and anatomy of the ascending aorta and associated lesions. (Levelof Evidence: B).
5.First degree family history or a	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With**

personal history of a bicuspid aortic valve		**Valvular Heart Disease (p. e88)** **5.1. Bicuspid Aortic Valve** **5.1.1. Diagnosis and Follow-Up** **5.1.1.1. DIAGNOSTIC TESTING - INITIAL DIAGNOSIS: RECOMMENDATIONS** **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 (Level of Evidence: B).
6. Exposure to medications that could result in development of VHD	**LEVEL C**	None

Section 1: Initial Evaluation for Valvular Heart Disease
Table 2: Initial Evaluation of a Patient with Clinical Signs and/or Symptoms

Arrhythmias		
7. • Palpitations, and • No other symptoms or signs of cardiovascular disease	**LEVEL C**	None
Presyncope/Syncope		
8. • Presyncope, and • No other symptoms or signs of cardiovascular disease	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e74)** **3.2.1.5 Diagnostic Testing–Exercise Testing:** **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)(Level of Evidence: B).
9. • Syncope, and • No other symptoms or signs of cardiovascular disease	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e74)** **3.2.1.5 Diagnostic Testing–Exercise Testing:** **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 meanpressure gradient is 40 mm Hg or higher (stage D)(Level of Evidence: B).
Hypotension or Hemodynamic Instability		
10. • Hypotension or hemodynamic instability, and • Uncertain or suspected cardiac etiology	**LEVEL C**	None
11. Assessment of volume status in a critically ill patient	**LEVEL C**	None
12. Suspected acute mitral or aortic regurgitation	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e106-107)** **7.4 Chronic Secondary MR** **7.4.1 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 of wall motion abnormalities and to assess global LV function, severity of MR, and magnitude of

		pulmonary hypertension. 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 toassess myocardial viability, which in turn may influence management of functional MR. (Level of Evidence: C).
Respiratory Failure		
13. Respiratory failure or hypoxemia of uncertain etiology	**LEVEL C**	None
14. • Respiratory failure or hypoxemia, and • Non-cardiac etiology of respiratory failure has been established	**LEVEL C**	None
Heart Failure		
15. Initial evaluation in patients presented with HF to exclude the presence of primary or secondary valve disease	**LEVEL C**	**2013 ACCF/AHA Guideline for the Management of Heart Failure (p. e165)** **6.4. Noninvasive Cardiac Imaging:** **CLASS I** 2. A 2-dimensional echocardiogram with Doppler should be performed during initial evaluation of patients presenting with HF to assess ventricular function, size, wall thickness, wall motion, and valve function. (Level of Evidence: C).
Bacteremia/Endocarditis		
16. • Suspected infective endocarditis (native valve, prosthetic valve, endocardial lead), and • Positive blood cultures or a new murmur	**LEVEL B** **LEVEL B** **LEVEL B** **LEVEL B** **LEVEL B** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e131-e133)** **12.2. Infective Endocarditis** **Diagnosis and Follow-Up:** **CLASS I (p. e131)** 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. (Level of Evidence: B). **CLASS I (p. e132)** 7. Intraoperative TEE is recommended for patients undergoing valve surgery for IE. (Level of Evidence: B). **CLASS IIa (p. e133)** 1.TEE is reasonable to diagnose possible IE in patients with Staphylococcal aureus (S. aureus) bacteremia without a known source. (Level of Evidence: B). **CLASS IIa (p. e133)** 2. TEE is reasonable to diagnose IE of a prosthetic valve in the presence of persistent fever without bacteremia or a new murmur. (Level of Evidence: B). **CLASS IIb (p. e133)** 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. (Level of Evidence: B). **2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e159)** 1.6. Recommendations for Infective Endocarditis **CLASS I** 3. Transthoracic echocardiography (TTE) should be performed when

		the diagnosis of native-valve IE is suspected. (Level of Evidence: B).
17. • Transient fever, and • No evidence of bacteremia or a new murmur	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e133)** **12.2. Infective Endocarditis** **12.2.1 Diagnosis and Follow-Up:** **CLASS IIa** 2. TEE is reasonable to diagnose IE of a prosthetic valve in the presence of persistent fever without bacteremia or a new murmur. (Level of Evidence: B). **2003 ACC/AHA/ASE ECHO Guidelines (p. 956)** **Section II-F. Infective Endocarditis: Native Valves** **Recommendations for Echocardiography in Infective Endocarditis: Native Valves** **Class III** 1. Evaluation of transient fever without evidence of bacteremia or new murmur.
18. • Transient bacteremia, and • Pathogen not typically associated with infective endocarditis and/or a documented non-endovascular source or infection	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e133)** **12.2. Infective Endocarditis** **12.2.1 Diagnosis and Follow-Up:** **CLASS IIb (p. e133**) 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. (Level of Evidence: B). **2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e159)** **1.6. Recommendations for Infective Endocarditis** **CLASS I** 3. Transthoracic echocardiography (TTE) should be performed when the diagnosis of native-valve IE is suspected. (Level of Evidence: B).
Cardiac Mass/Cardiac Source of Emboli		
19. Suspected cardiac mass, suspected tumor or thrombus, or potential cardiac source of emboli	**LEVEL C**	**2003 ACC/AHA/ASE ECHO Guidelines (p. 957)** **Section IX. Pulmonary Disease Recommendations for Echocardiography in Pulmonary and Pulmonary Vascular Disease** Comment: One recommendation was moved from Class I to Class IIa. Class IIa recommendations have been renumbered for clarity. Evidence was added concerning the diagnosis of severe pulmonary embolism by echocardiography (122). **Class I** 2. Moved to Class IIa (see below). **Class IIa** 1. Pulmonary emboli and suspected clots in the right atrium or ventricle or main pulmonary artery branches.* *TEE is indicated when TTE studies are not diagnostic.

Section 2. Prior Testing

Table 3: Additional Testing to Clarify Diagnosis

Inadequate TTE Images		
20. Inadequate TTE images for the evaluation of possible valvular heart disease due to patient characteristics	**LEVEL C**	None
21. Characterization of native or prosthetic valves with clinical signs or symptoms suggesting valve dysfunction	**LEVEL C**	None

Suspected endocarditis with Negative TTE		
22. Suspected infective endocarditis with moderate to high pretest probability (e.g., staph bacteremia, fungemia, prosthetic heart valve, or intracardiac device)	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e131-e133)** **12.2. Infective Endocarditis** **Diagnosis and Follow-Up:** **CLASS I (p. e132)** 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. (Level of Evidence: B).
Aortic Stenosis (AS)		
23. • Symptomatic, severe aortic stenosis (AS) by calculated valve area (stage D2), and • Low flow, low gradient, and • Low LV ejection fraction (LVEF)	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e72)** **3.2. Aortic Stenosis** **3.2.1 Diagnosis and Follow-Up:** **3.2.1.1 Diagnostic Testing--Initial Diagnosis** **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 (95–97) (Level of Evidence: B): a. Calcified aortic valve with reduced systolic opening; b. LVEF less than 50%; c. Calculated valve area 1.0 cm2 or less; and d. Aortic velocity less than 4.0 m per second or mean pressure gradient less than 40 mm Hg.
24. • Severe AS, by calculated valve area and • Low-flow/low-gradient, and • Preserved LVEF for assessment of morphology, including calcification	**LEVEL C**	None
25. Moderate or asymptomatic severe AS (stages B and C), for measurement of changes in valve hemodynamics with exercise or pharmacologic stress	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e74)** **3.2.1.5. Diagnostic Testing - Changing Signs or Symptoms:** **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). (Level of Evidence: B).
26. Symptomatic severe AS (stage D), for measurement of changes in valve hemodynamics with exercise or pharmacological stress	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e74)** **3.2.1.5. Diagnostic Testing - Changing Signs or Symptoms:** **DIAGNOSTIC TESTING- EXERCISE TESTING:** **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). (Level of Evidence: B).
Mitral Stenosis		

27. Discrepancy between resting Doppler echocardiographic findings and clinical symptoms or signs in order to evaluate mean mitral gradient and pulmonary artery pressure	**LEVEL B** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e90-e91, e93)** **Diagnosis and Follow-Up** **6.2.1.1. DIAGNOSTIC TESTING- INITIAL DIAGNOSIS:** **CLASS I** 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 MR. (Level of Evidence: B). **6.2.1.5. DIAGNOSTIC TESTING- EXERCISE TESTING: (p e93)** **CLASS I** 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).
Mitral Regurgitation		
28. • Severe mitral regurgitation (MR) suspected clinically, and • Potentially underestimated on TTE despite optimal images, • Better imaging of MR jet needed	**LEVEL B** **LEVEL B** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e98-99)** **7.3 Chronic Primary MR** **7.3.1 Diagnosis and Follow -Up:** **7.3.1.1. Diagnostic Testing – Initial Diagnosis** **CLASS I** 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 (366,372,373).(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 (374,375). (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).
29. • Chronic symptomatic primary MR with discrepancy between exertional symptoms and the severity of MR at rest • Symptoms are out of proportion to the severity of MR determined at rest	**LEVEL B** **LEVEL B** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e98-e100, e102)** **7.3. Chronic Primary MR** **7.3.1. Diagnosis and Follow-Up** **7.3.1.1. DIAGNOSTIC TESTING- INITIAL DIAGNOSIS:** **CLASS I** 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. (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. (Level of Evidence: B) **7.3.1.5. DIAGNOSTIC TESTING- EXERCISE TESTING: (p. e102)** **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) . (Level of Evidence: B). ***7.3.1.5. DIAGNOSTIC TESTING- EXERCISE TESTING:*** ***CLASS IIa***

		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).
30. Chronic asymptomatic patient to distinguish between moderate or severe primary MR	**LEVEL B** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e98-e100)** **7.3. Chronic Primary MR** **7.3.1. Diagnosis and Follow-Up** **7.3.1.1. DIAGNOSTIC TESTING- INITIAL DIAGNOSIS:** **CLASS I** 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. (Level of Evidence: B). **CLASS I** 3.Intraoperative TEE is indicated to establish the anatomic basis for chronic primary MR (stages C and D) and to guide repair. (Level of Evidence: B).
31. Chronic secondary MR (stages B to D), to establish etiology including a possible ischemic etiology	**LEVEL C** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e99, e106-107)** **7.4. Chronic Secondary MR** **7.4.1. 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 B).
32. Chronic secondary MR (stages B to D), to assess myocardial viability	**LEVEL C** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e106)** **7.4 Chronic Secondary MR** **7.4.1 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).
Aortic Regurgitation		
33. Dilated aortic sinuses or ascending aorta or a bicuspid aortic valve (stages A and B) to evaluate the presence and severity of AR assuming optimal TTE images	**LEVEL C**	None
34. Discordance between clinical assessment and TTE about the severity of AR	**LEVEL C**	None
35. Assessment of symptoms and	**LEVEL C**	None

functional capacity in patients with moderate or severe AR		
Other Valvular Regurgitation		
36. Severe tricuspid regurgitation (TR) (stages C and D), and suboptimal TTE images for assessment of RV systolic function and systolic and diastolic volumes	**LEVEL C** **LEVEL C** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e108, e110-e111)** **8.2. Tricuspid Regurgitation** **8.2.1. Diagnosis and Follow-Up:** **1.CLASS IIa** 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). **1.CLASS IIb** CMR or real-time 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 2D echocardiograms. (Level of Evidence: C). **2.CLASS IIb** 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).
37. Assessment of pulmonary pressures during stress in patient with severe asymptomatic valve regurgitation prior to pregnancy	LEVEL C	None
Valvular Mass		
38. Further evaluation of valvular mass (including incidental finding noted on noncardiac imaging studies)	LEVEL C	None

Table 4: Sequential or Follow-up Testing Asymptomatic or Stable Symptoms

Stage A Valvular Disease		
39. Routine surveillance (every 3-5 years) for patients with stage A (bicuspid aortic valve or aortic sclerosis) for exclusion of progression to stage B.	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3. 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, ventricularsize, and ventricular function. (Level of Evidence: C).
Mild or Moderate Valvular Heart Disease		
40. Re-evaluation (3-5 years) of mild (stage B) valvular regurgitation	**LEVEL B** **LEVEL B** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e130-132)** **12.2. Infective Endocarditis** **12.2.1. Diagnosis and Follow-Up** **CLASS I** 2. The Modified Duke Criteria should be used in evaluating a patient with suspected IE (Tables 24 and 25) (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 (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

		(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) (679,682). (Level of Evidence: B).
41. Re-evaluation (1-2 y) of mild (stage B) VHD without a change in clinical status or cardiac exam	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
42. Re-evaluation (1-2 y) of moderate (stage B) VHD without a change in clinical status of cardiac exam	**LEVEL C** **LEVEL C** **LEVEL C**	**2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e186** **6.4. Recommendations for Evaluation of the Unoperated Patient** **CLASS IIa:** 3. In asymptomatic adolescents and young adults, echocardiography-Doppler is recommended yearly for AS with a mean Doppler gradient greater than 30 mm Hg or peak instantaneous gradient greater than 50 mm Hg and every 2 years for patients with lesser gradients (Level of Evidence: C). **2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3. Diagnosis and Follow-Up** **2.3.2 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). **2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
43. Re-evaluation in (<1y) in patients with moderate AS who will be subjected to increased hemodynamic demands (e.g., non-cardiac surgery, pregnancy)	**LEVEL C** **LEVEL C**	**2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e186)** **6.4. Recommendations for Evaluation of the Unoperated Patient** **CLASS IIa:** 3. In asymptomatic adolescents and young adults, echocardiography-Doppler is recommended yearly for AS with a mean Doppler gradient greater than 30 mm Hg or peak instantaneous gradient greater than 50 mm Hg and every 2 years for patients with lesser gradients (Level of Evidence: C). **2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3. Diagnosis and Follow-Up** **2.3.2 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). **2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
Severe Valvular Disease		
44. Re-evaluation (6-12 months) of asymptomatic severe (stage C1) AS without a change in clinical status or cardiac exam	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3. Diagnosis and Follow-Up** **2.3.2 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). **2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
45. Re-evaluation (every 1 year) for asymptomatic (stage C1) patients with AS	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
46. Re-evaluation (6-12 months) of stage C1 patients with asymptomatic severe AR with preserved ejection fraction and normal LV size	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
47. Re-evaluation (every 6-12 months) of stage C1 patients with asymptomatic severe MR	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
48. Re-evaluation in (<1 year) in patients with severe AS who will be subjected to increased hemodynamic demands (e.g., non-cardiac surgery, pregnancy)	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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).
49. Re-evaluation after control of hypertension patients with low-flow/low-gradient severe AS with preserved LVEF	**LEVEL C** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e65)** **2.3.3 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). **2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e186)** **6.4 Recommendations for Evaluation of the Unoperated Patient** **CLASS I** 2. Echocardiography is recommended for reevaluation of patients with AS who experience a change in signs or symptoms and for assessment of changes in AS hemodynamics during pregnancy. (Level of Evidence: B).
50. Re-evaluation (< I year) of the size and morphology of the aortic sinuses and ascending aorta in patients with a bicuspid aortic valve and an ascending aortic diameter greater than 4 cm with one of the following: •aortic diameter >4.5 cm •rapid rate of change in aortic diameter •family history (first degree relative) of aortic dissection	**LEVEL C** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e88-e89)** **5.1. Bicuspid Aortic Valve** **5.1.1. Diagnosis and Follow-Up** **5.1.1.1. DIAGNOSTIC TESTING- INITIAL DIAGNOSIS:** **CLASS I** 2. Aortic magnetic resonance angiography or CT angiography is indicated in patients with a bicuspid aortic valve when morphology of the aortic sinuses, sinotubular junction, or ascending aorta cannot be assessed accurately or fully by echocardiography. (Level of Evidence: C). **5.1.1.2. DIAGNOSTIC TESTING - ROUTINE FOLLOW-UP:** **CLASS I** 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)
Bicuspid AV with Dilated Aorta		
51. Re-evaluation (<1 year) of the size and morphology of the aortic sinuses and ascending aorta in patients with a bicuspid aortic valve and an aortic diameter between 4.0-4.5 cm without any of the risk factors listed in 50..	**LEVEL C**	None
52. Re-evaluation of prior TTE/TEE finding for interval change (e.g. resolution of vegetation after antibiotic therapy) when no change in therapy is anticipated	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e88-e89)** **5.1. Bicuspid Aortic Valve** **5.1.1. Diagnosis and Follow-Up** **5.1.1.1. DIAGNOSTIC TESTING- INITIAL DIAGNOSIS:** **CLASS I** 2. Aortic magnetic resonance angiography or CT angiography is indicated in patients with a bicuspid aortic valve when morphology of the aortic sinuses, sinotubular junction, or ascending aorta cannot be assessed accurately or fully by echocardiography. (Level of Evidence: C)

		5.1.1.2. DIAGNOSTIC TESTING - ROUTINE FOLLOW-UP: **CLASS I** 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)
Endocarditis		
53. Re-evaluation of prior TTE/TEE finding for interval change (e.g. resolution of vegetation after antibiotic therapy) when a change in therapy is anticipated	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e131-e133)** **12.2. Infective Endocarditis** **Diagnosis and Follow-Up:** **CLASS I (p. e132)** 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). (Level of Evidence: B). **2003 ACC/AHA/ASE ECHO Guidelines (p. 956)** **Section II-F. Infective Endocarditis: Native Valves** Recommendations for Echocardiography in Infective Endocarditis: Native Valves Comment: The Duke Criteria for the diagnosis of infective endocarditis have been added, as well as the value of TEE in the setting of a negative transthoracic echocardiogram when there is high clinical suspicion or when a prosthetic valve is involved (11,12. **Class IIa** 1. Evaluation of **persistent nonstaphylococcus** bacteremia without a known source
54. Re-evaluation of patient with IE at high risk of progression or complications (e.g., extensive infective tissue/large vegetation on initial echocardiogram or staphylococcal, enterococcal, or fungal infections) in the absence of clinical change	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e131-e133)** **12.2. Infective Endocarditis** **Diagnosis and Follow-Up:** **CLASS I (p. e132)** 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). (Level of Evidence: B). **2003 ACC/AHA/ASE ECHO Guidelines (p. 956)** **Section II-F. Infective Endocarditis: Native Valves** **Recommendations for Echocardiography in Infective Endocarditis: Native Valves** Comment: The Duke Criteria for the diagnosis of infective endocarditis have been added, as well as the value of TEE in the setting of a negative transthoracic echocardiogram when there is high clinical suspicion or when a prosthetic valve is involved (11,12. **Class IIa** 1. Evaluation of **persistent nonstaphylococcus** bacteremia without a

		known source

Table 5: Sequential or Follow-up Testing: New or Worsening Signs or Symptoms or to Guide Therapy

General		
55. Re-evaluation of known VHD with a change in clinical status or cardiac exam or to guide therapy	**LEVEL B** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e131-e133)** **12.2. Infective Endocarditis** **Diagnosis and Follow-Up:** **CLASS I (p. e132)** 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). (Level of Evidence: B). 2003 ACC/AHA/ASE ECHO Guidelines (p. 956) Section II-F. Infective Endocarditis: Native Valves Recommendations for Echocardiography in Infective Endocarditis: Native Valves Comment: The Duke Criteria for the diagnosis of infective endocarditis have been added, as well as the value of TEE in the setting of a negative transthoracic echocardiogram when there is high clinical suspicion or when a prosthetic valve is involved (11,12). **Class IIa** 1. Evaluation of persistent nonstaphylococcus bacteremia without a known source *. 2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e159) 1.6. Recommendations for Infective Endocarditis **CLASS I** 4. Transesophageal echocardiography (TEE) is indicated if TTE windows are inadequate or equivocal, in the presence of a prosthetic valve or material or surgically constructed shunt, in the presence of complex congenital cardiovascular anatomy, or to define possible complications of endocarditis (eg, sepsis, abscess, valvular destruction or dehiscence, embolism, or hemodynamic instability). (72) (Level of Evidence: B).
Endocarditis		
56. Re-evaluation of infective endocarditis (IE) in a patient with a change in clinical status or cardiac exam (e.g., new murmur, embolism, persistent fever, HF, abscess, or atrioventricular heart block)	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e131-e133)** **12.2. Infective Endocarditis** **Diagnosis and Follow-Up:** **CLASS I (p. e132)** 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). (Level of Evidence: B).

Table 6: Post-operative Imaging of Surgical Valve Replacement or Repair

Surgical Valve Replacement (no or stable symptoms)		
57.Initial postoperative evaluation of bioprosthetic or mechanical valve for establishment of baseline (6 weeks to 3 months post op)	**LEVEL C**	**2013 ACCF/AHA Guideline for the Management of Heart Failure (p. e165)** **6.4. Noninvasive Cardiac Imaging:** **CLASS I** 3. **Repeat measurement of EF** and measurement of the severity of structural remodeling are useful to provide information in patients with HF who have had a significant change in clinical status; who have experienced or recovered from a clinical event; or who have received treatment, including GDMT, that might have had a significant effect on cardiac function; or who may be candidates for device therapy (Level of Evidence: C).
58. Re-evaluation (<3 y after valve implantation) of bioprosthetic or mechanical valve if no known or suspected valve dysfunction	**LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **CLASS I** 1. An initial TTE study is recommended in patients after prosthetic valve implantation for evaluation of valve hemodynamics (522–525). (Level of Evidence: B).
59. Re-evaluation (≥3 y after valve implantation) of bioprosthetic or mechanical valve if no known or suspected valve dysfunction	**LEVEL C** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **CLASS I** 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).
60. re-evaluation in patients with a bioprosthetic valve after the first 10 years, even in the absence of a change in clinical status	**LEVEL C** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **CLASS I** 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).
61. Evaluation prior to pregnancy in patients with a prosthetic valve and no echo within the past year	**LEVEL C** **LEVEL C** **LEVEL C** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e145-e146)** **13.3 Prosthetic Valves in Pregnancy** **13.3.1. 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). 3.TTE should be performed in all pregnant patients with a prosthetic

		valve if not done before pregnancy. (Level of Evidence: C). **CLASS I** 4.Repeat TTE should be performed in all pregnant patients with a prosthetic valve who develop symptoms. (Level of Evidence: C). **CLASS I** 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).
62. Characterization of mechanical prosthetic valve if clinical sign or symptoms suggesting valve dysfunction	**LEVEL C** **LEVEL B**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **CLASS I** 3. TEE is recommended when clinical symptoms or signs suggest prosthetic valve dysfunction. (Level of Evidence: C). **2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e129-131)** **12.2 Infective Endocarditis** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **CLASS I** 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 (655–659). (Level of Evidence: B).
63. Characterization of bioprosthetic valve if clinical signs or symptoms suggesting valve dysfunction	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **CLASS I** 3. TEE is recommended when clinical symptoms or signs suggest prosthetic valve dysfunction. (Level of Evidence: C).
64. Characterization of bioprosthetic valve if suspected clinically significant valvular dysfunction and inadequate images from TTE or TEE	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **CLASS I** 3. TEE is recommended when clinical symptoms or signs suggest prosthetic valve dysfunction. (Level of Evidence: C).
65. Characterization of mechanical prosthetic valve if suspected clinically significant valvular dysfunction and inadequate images from TTE or TEE	**LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:** **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).
66. Re-evaluation of known prosthetic valve dysfunction when it would change management or guide therapy	**LEVEL C** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e116)** **11. Prosthetic Valves** **11.1. Evaluation and Selection of Prosthetic Valves** **11.1.1. Diagnosis and Follow-Up:**

		CLASS I 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).
67. Evaluation of documented prosthetic valve infective endocarditis when medical management is considered, in a patient who is at high risk for progression or complication or with a change in clinical status or cardiac exam	**LEVEL B**	**2008 ACC/AHA Guidelines for Adults With Congenital Heart Disease (p. e159)** **1.6. Recommendations for Infective Endocarditis** **CLASS I** 4. Transesophageal echocardiography (TEE) is indicated if TTE windows are inadequate or equivocal, in the presence of a prosthetic valve or material or surgically constructed shunt, in the presence of complex congenital cardiovascular anatomy, or to define possible complications of endocarditis (e.g., sepsis, abscess, valvular destruction or dehiscence, embolism, or hemodynamic instability). (72) (Level of Evidence: B).
68. Initial post-operative assessment of repaired valve (6 weeks to 3 months post-operatively)	**LEVEL C**	None
69. Re-evaluation (<3 years) in patients without suspected repaired valve dysfunction	**LEVEL C**	None
70. Re-evaluation (>= 3 years) in patients without suspected repaired valve	**LEVEL C**	None
71. Re-evaluation (<3 years) in patients without suspected repaired valve dysfunction	**LEVEL C**	None

Section 3: Transcatheter Intervention for Valvular Heart Disease

Table 7a: Pre-TAVR Evaluation

72. Assessment for concomitant CAD	**LEVEL A** **LEVEL C** **LEVEL B** **LEVEL B** **LEVEL C** **LEVEL B** **LEVEL C**	**2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e79-e81)** **3.2.4. Choice of Intervention:** **CLASS I** 1.Surgical AVR is recommended in patients who meet an indication for AVR (Section 3.2.3) with low or intermediate surgical risk (Section 2.5). (Level of Evidence: A) 2.For patients in whom 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) **CLASS I** 3.TAVR is recommended in patients who meet an indication for AVR (Section 3.2.3) who have a prohibitive risk for surgical AVR (Section 2.5) and a predicted post-TAVR survival greater than 12 months. (Level of Evidence: B) **CLASS IIa** 1.TAVR is a reasonable alternative to surgical AVR in patients who meet an indication for AVR (Section 3.2.3) and who have high surgical risk for surgical AVR (Section 2.5). (Level of Evidence: B) **CLASS IIb**

		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) **CLASS III: No Benefit** 1.TAVR is not recommended in patients in whom existing comorbidities would preclude the expected benefit from correction of AS. (Level of Evidence: B) **2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease (p. e151)** **14.2.1. Intervention for CAD: Recommendation** **Class IIa** 1. CABG or PCI is reasonable in patients undergoing valve repair or replacement with significant CAD (H70% reduction in luminal diameter in major coronary arteries or H50% reduction in luminal diameter in the left main coronary artery). (Level of Evidence: C).
73. Accurate assessment of annular size and shape*		**2012 TAVR Expert Consensus Document** **5.1.4.1.1. ANNULUS SIZE AND CUSP AND ROOT ANATOMY.** Annular dimensions can be measured with either TTE or TEE (162). With either modality, the annular anteroposterior diameter is measured from a long-axis view. Care must be taken to identify the true annulus, not overlying calcium. Measurements are made in systole at the hinge point of the leaflets into the LVOT with a trailing edge to leading edge convention. Because the annulus is often elliptical, optimal assessment should include measurement of the transverse (coronal)diameter, using the short-axis view, ideally with biplane TEE approach or CT, which allows simultaneous long- and short-axis interrogation of the annular plane. **Preprocedural Assessment** 1. Assessment of aortic annular size and shape (CT, CMR, 2D and 3D echocardiography).
74. Assessment of number of cusps and degree of calcification		**2012 TAVR Expert Consensus Document** Preprocedural Assessment 2. Assessment of aortic valve for number of cusps, degree of calcification and valve area by planimetry (CT, CMR, 2D and 3D echocardiography).
75. Measurement of the distance between annulus and the coronary ostia		**2012 TAVR Expert Consensus Document** In general, CT scanning provides a more comprehensive assessment of the relationship of the coronary arteries to the annulus and valve leaflets, demonstrating an average annular–left coronary artery distance of 13.4_3.2 mm and annular-right coronary artery distance of 13.6_2.8 mm (164). Nevertheless, echo, particularly TEE, can measure the distance from the aortic valve annulus to the right coronary ostium. Since the left coronary does not lie in a standard TEE or TTE imaging plane that intersects the annulus, measurement from 3D datasets may be a feasible approach for this. Preprocedural Assessment (p. 1223) 3. Measurement of the distance between annulus and coronary ostia (CT, CMR, 2D and 3D echocardiography).
76. Precise coaxial alignment of the implant within the centerline of the aortic valve		**2012 TAVR Expert Consensus Document** **Preprocedural Assessment (p. 1223)** 4. Planning for precise coaxial alignment of the stent-valve along the centerline of the aortic valve and aortic root (CT).

77. Assessment of aortic dimensions		**2012 TAVR Expert Consensus Document** **Preprocedural Assessment (p. 1223)** 5. Assessment of aortic dimensions (2D and 3D echocardiography, CT or CMR) and atherosclerosis (echocardiography, CT, or CMR)
78. Assessment of aortic atherosclerotic burden		**2012 TAVR Expert Consensus Document** **Preprocedural Assessment (p. 1223)** 6. Assessment of dimensions and atherosclerosis of iliofemoral vessels (CT, MR, angiography).
79. Assessment of iliofemoral vessels		**2012 TAVR Expert Consensus Document** **Preprocedural Assessment (p. 1223)** 6. Assessment of dimensions and atherosclerosis of iliofemoral vessels (CT, MR, angiography).

Table 7b: Intra-procedural Evaluation During TAVR

80. Guide-wire placement into the LV		2011 EAE/ASE Recommendations for the Use of Echocardiography in New Transcatheter Interventions in Valvular Heart Disease, (p. 937) 1. Guidewire placement: After confirming annular size for proper device selection, TEE can help with guidewire placement. This is particularly important in transapical TAVR, where manual dimpling of the apex can be visualized and guidewire passage through the AV can be confirmed, avoiding the submitral apparatus or the hypertrophied septum.
81. Valve placement		2011 EAE/ASE Recommendations for the Use of Echocardiography in New Transcatheter Interventions in Valvular Heart Disease, (p. 937) 1. Valve placement: TEE can be very helpful in the correct placement of the valve prosthesis, though fluoroscopy is commonly used for localization. It is critical to understand the landmarks of the valve when mounted on the guiding catheter. For the Sapien valve, roughly half of the device should be above and below the aortic annulus (Figure 6). For the CoreValve, TEE should confirm that the nitinol stent is well within the borders of the calcified native annulus. Visualizing the valve during the time of rapid pacing and balloon inflation (for the Sapien valve) or deployment of the CoreValve provides an immediate verification of correct valve placement. If the valve is placed using fluoroscopic guidance, the TEE probe must be partially retracted during that time to facilitate positioning or the luoroscopic view can be changed.
82. Post deployment assessment (position, function, regurgitation)		2011 EAE/ASE Recommendations for the Use of Echocardiography in New Transcatheter Interventions in Valvular Heart Disease, (p. 937) 2. Postdeployment assessment: A particular concern for periprocedural imaging relates to assessment of AR that is complicated by the common frequency of paravalvular leaks and shadowing from the prosthesis (Figures 7 and 8). This assessment must be made very rapidly in the procedure room (to allow possible reballooning or even deployment of a second valve if the AR is severe and cannot be controlled otherwise). It is critical to distinguish between valvular and paravalvular regurgitation and to determine whether it is severe enough to require immediate intervention. Small paravalvular leaks are often visualized due to the widespread irregular calcification in the native valves that leave gaps between the annulus and the prosthesis. If the leaks are punctate in cross section, with jets that do not extend beyond the LVOT and without visible proximal

		convergence zones above the prosthesis or flow reversal in the aortic arch, then no intervention is needed (Figure 7, jets A1 and A2). If not, and velocity aliasing is seen superior to the prosthesis with AR extending beyond the LVOT, then reballooningor a valve-in-valve approach may be appropriate (Figure 7, jet C).
83. Evaluate immediate complications _ Hypotension _ Coronary occlusion _ LV depression from rapid pacing _ LV outflow tract obstruction _ Severe MR _ Prosthesis dislodgment _ Tamponade _ Right ventricular perforation _ Air embolism _ Aortic dissection (paravalvular leak needs to be excluded)		2011 EAE/ASE Recommendations for the Use of Echocardiography in New Transcatheter Interventions in Valvular Heart Disease, (p. 937) Postdeployment echocardiography commonly discloses small areas of paravalvular or central valvular leak. Most commonly, these originate around areas of extreme leaflet calcification, particularly at the commissural areas. If significant, these may be treated with repeat ballooning of the prosthesis to further expand it to close paravalvular leaks or inadequate noncircular deployment. A small additional amount of fluid (1 mL) may be added to the system prior to reballooning to insure complete inflation (110,205–210). For CoreValve, indications are similar—significant paravalvular leak with AR and underexpanded prosthesis (assessed by TEE and/or fluoroscopy). There are a number of other complications that must be recognized immediately after TAVR if poor clinical outcome is to be averted. Persistent hypotension may result from occlusion of a coronary artery by the device or displaced calcium. This can be recognized by characteristic regional hypokinesis, best appreciated from the transgastric view and possibly by evaluating flow in the coronary arteries themselves. Global dysfunction with preserved coronary flow may reflect persistent depression from rapid pacing and balloon inflation, requiring inotropes and possibly intra-aortic counterpulsation or full bypass. Finally, hypotension may result from LVOT obstruction following the abrupt fall in afterload, requiring volume, negative inotropes, and vasopressors. Other etiologies such as severe MR, dislodgement of the AV prosthesis, pericardial tamponade, RV perforation from the pacemaker lead, air embolism, vascular access bleeding, and aortic dissection must be considered. Although TEE is very helpful for initial device placement and deployment, it is in the setting of hemodynamic instability that TEE is essential to rapidly diagnose these complications

Table 7c: Post-procedural Assessment After TAVR (Out of Lab and < 30 days)

84. Assessment of degree of aortic regurgitation (including valvular and paravalvular) with suspicion of valve dysfunction		**2012 TAVR Expert Consensus Document** 5.5.5.1. RECOMMENDATIONS FOR MANAGING SEVERE AR AFTER TAVR 1. When severe AR is present after TAVR, treatment is similar to native valve AR as detailed in the ACCF/AHA valvular heart disease guidelines (63). 2. With acute severe AR or chronic severe AR with symptoms of heart failure, surgical AVR may be considered if the patient is a surgical candidate and surgical risk is acceptable. Other options include placement of a second TAVR within the leaking prosthesis ("valve-in-valve").
85. Assessment of stroke with suspicion of valve dysfunction		**2012 TAVR Expert Consensus Document** **3.1.3.2.1. SPECIFIC SURGICAL RISKS** **3.1.3.2.1.1. Stroke.**Although ischemic stroke can result from many causes after AVR, a major concern is the role of thromboembolism. The risks of thromboembolism are usually greater in the first few days and months after bioprosthetic AVR implantation before the sewing ring of the prosthesis is endothelialized (66); risks

		after mechanical AVR continue. The risk of stroke within 30 days among 67,292 cases of AVR in the STS Registry was 1.5%; this data set was used to develop a model for predicting 30-day stroke risk (61).

Table 8a: Evaluation Prior to Percutaneous Mitral Valve Repair or Replacement

86. Determine patient eligibility*	**LEVEL C**	None
87. Exclude the presence of intracardiac mass, thrombus, or vegetation prior to (within 3 days of the procedure)	**LEVEL C**	None

Table 8b: Intra-procedural Evaluation During Percutaneous Mitral Valve Repair

88. Alignment of the device over the origin of the regurgitant jet and advance to the LV	**LEVEL C**	None
89. Guidance for grasping the mitral valve leaflets and device closure	**LEVEL C**	None
90. Assess for adequacy in the reduction of the MR	**LEVEL C**	None
91. Assess for presence of mitral stenosis	**LEVEL C**	None

Table 8c: Post-procedural Assessment After Percutaneous Mitral Valve Repair (Out of Lab)

92. Re-assessment for degree of MR and left ventricular function (pre-discharge at 1, 6, 12 months; and then annually to 5 years)	**LEVEL C**	None