# Management of Aortic Valve Disease: Review Questions

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## QUESTIONS

Choose the single best answer for each question.

**Questions 1 and 2 refer to the following case.**

A 72-year-old man with a past medical history noteworthy only for hypertension controlled on hydrochlorothiazide and a described "heart murmur with a tight valve" presents to the emergency department (ED) complaining of weeks of progressive exertional dyspnea and an episode of dyspnea awakening him from sleep. The patient reports no chest pain. Upon presentation, his blood pressure is 102/68 mm Hg, heart rate is 98 bpm and regular, respiratory rate is 18 breaths/min, and oxygen saturation is 90% on room air, which improves to 99% following oxygen supplementation at a rate of 4 L/min via nasal cannula. Physical examination reveals a diminished $A_2$, late-peaking systolic crescendo-decrescendo murmur, delayed and diminished carotid upstroke, an audible $S_3$, dilated jugular veins, and bibasilar rales. Chest radiograph shows pulmonary edema. An electrocardiogram (ECG) shows sinus tachycardia, left ventricular (LV) hypertrophy, left atrial enlargement, and 0.5-mm ST depressions in the anterior and lateral leads, with T-wave inversions in the lateral precordial leads.

1. **What is the next most appropriate step in the management of this patient?**
   (A) Immediate cardiothoracic surgery consultation for emergent aortic valve replacement surgery
   (B) Immediate measurement of brain natriuretic peptide (BNP) level and bedside echocardiogram to assess ejection fraction and valve function; initiate intravenous (IV) furosemide only if either of the tests is abnormal
   (C) Initiation of IV furosemide accompanied by IV nitroglycerine drip
   (D) Initiation of IV furosemide without nitroglycerine, with accurate monitoring of weight and urine output; readminister diuretic only if there are persistent findings of volume overload

2. **The following morning, the patient's clinical status is improved, with normal oxygen saturation on room air. Serial ECGs show sinus rhythm with normalization of the T-wave inversions noted previously. Troponin levels are undetectable. An echocardiogram shows normal LV size, moderate LV hypertrophy, a LV ejection fraction (LVEF) of 40%, and a calcified aortic valve with severe stenosis (aortic valve area = 0.8 $cm^2$). Which of the following is indicated in the workup and management of the patient at this time?**
   (A) Cardiology consultation for invasive coronary angiography prior to planned aortic valve replacement
   (B) Exercise stress test with nuclear myocardial perfusion imaging to assess for ischemia and exercise tolerance
   (C) High-dose statin therapy for reduction of aortic valve calcification
   (D) Initiation of a β-blocker, an angiotensin-converting enzyme (ACE) inhibitor, oral furosemide, and long-acting nitrates to reduce further hospitalizations and consideration of valve surgery if symptoms recur

3. **A 71-year-old woman with medication-controlled hypertension, hypercholesterolemia, and osteoarthritis presents in the outpatient setting for routine care. Physical examination reveals a harsh, midpeaking systolic murmur radiating to the neck, a slightly diminished carotid upstroke, no jugular venous distension, clear lungs, and no peripheral edema. She notes that her ambulation is at times limited by knee pain, but generally she is able to complete her**

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**activities of daily living, including walking through the supermarket, with no limiting dyspnea or chest discomfort. She denies any history of syncope. An echocardiogram performed 2 weeks prior demonstrates normal biventricular systolic function, moderate LV hypertrophy, normal LV dimensions, mild mitral regurgitation with mitral annular calcification, and a heavily calcified aortic valve with severe aortic stenosis. Which of the following interventions is indicated at this time?**

(A) Hospitalization for further workup and management of severe aortic valve disease
(B) Initiation of oral furosemide and a statin
(C) Repeat clinical assessment in 3 to 6 months and repeat echocardiographic assessment within 1 year or sooner if symptoms develop
(D) Treadmill exercise stress testing with nuclear myocardial perfusion imaging to assess for the presence of coronary artery disease

4. **A 64-year-old man with hypertension requiring 3 medications for control presents in the outpatient setting for routine care, having recently moved to the area. He denies any limiting dyspnea, orthopnea, or chest discomfort and notes that he can complete his activities of daily living effortlessly. He denies recent illness, hospitalization, or fevers. Physical examination reveals a symmetric blood pressure of 138/52 mm Hg, heart rate of 92 bpm, no jugular venous distension, markedly bounding pulses, and a decrescendo pandiastolic murmur at the left upper sternal border. The patient has a copy of an echocardiogram report from his prior assessment showing a moderately dilated left ventricle (internal dimension in diastole: 6.3 cm), an LVEF of 60%, a dilated aortic root (4.8 cm) with moderate to severe aortic insufficiency, and a bicuspid aortic valve. A repeat echocardiogram confirms the bicuspid aortic valves with the same left ventricle internal dimensions, but also shows an LVEF of 50%, an aortic root diameter of 4.9 cm, and severe aortic insufficiency. The patient is seen the following week, still without any limiting symptoms. Which of the following interventions is indicated at this time?**

(A) Cardiology consultation for coronary angiography and referral for aortic valve replacement with or without aortic graft
(B) Initiation of ACE inhibitor and furosemide and repeat echocardiogram in 6 months or sooner if symptoms develop
(C) Initiation of β-blocker and diuretic and reassessment in 6 months
(D) Transfer to emergency department for urgent contrast computed tomography (CT) of the aorta to assess for dissection

5. **A 73-year-old woman with known mild to moderate aortic insufficiency and normal LV systolic function returns for follow-up after a repeat echocardiogram, which is of good quality, demonstrating mildly dilated left ventricle with internal dimensions of 5.9 cm in diastole and 4.0 cm in systole, an LVEF of 65%, and moderate aortic insufficiency. Although she feels generally able to meet her activities of daily living, she notes having slightly less energy compared to 6 months prior. She denies any marked exertional or nocturnal dyspnea, orthopnea, or chest discomfort, and denies any recent fevers, illnesses, or hospitalizations. Her blood pressure and cholesterol are normal without the need of medications. According to recent ACC/AHA guidelines, which of the following is routinely recommended for further assessment and management of this patient?**

(A) Recommendation of antibiotic prophylaxis for all surgical and dental procedures
(B) Referral for cardiac catheterization and aortography to accurately quantify the grade of aortic regurgitation
(C) Referral for elective aortic valve replacement
(D) Repeat clinical assessment in 6 to 12 months with repeat transthoracic echocardiogram in 1 year, or sooner if symptoms develop

6. **A 51-year-old man who has been hospitalized for delayed presentation of a pneumococcal pneumonia complicated by bacteremia and hypotension has clinical improvement after initiation of antibiotics and aggressive hydration but has persistent low-grade fevers. Two days later, he develops increasing sinus tachycardia, dyspnea without chest or back pain, and diaphoresis. Physical examination reveals a blood pressure of 98/68 mm Hg, heart rate of 122 bpm, oxygen saturation of 90% on room air, a faint early diastolic murmur, bibasilar rales, and cool distal extremities. ECG reveals sinus tachycardia without other abnormality. Chest radiograph shows normal heart size, pulmonary vascular congestion, and mild pulmonary edema. Bedside transesophageal echocardiography reveals severe destruction of the aortic valve with severe aortic insufficiency. Which of the following interventions are indicated at this time?**

(A) Aggressive intravenous hydration, repeat blood cultures, addition of broad-spectrum antibiotics,

and repeat transesophageal echocardiogram after 3 days of therapy

(B) Aspirin, nitroglycerine, IV heparin, and evaluation of serial troponin levels every 8 hours

(C) Cautious administration of IV nitroprusside drip, intensive blood pressure monitoring, and referral for emergent valve replacement surgery

(D) IV β-blockers for improved heart rate control and urgent interventional cardiology consultation for intra-aortic balloon pump placement for his cardiogenic shock

## ANSWERS AND EXPLANATIONS

1. **(D) Initiation of IV furosemide without nitroglycerine, with accurate monitoring of weight and urine output; readminister diuretic only if there are persistent findings of volume overload.** The patient has acute decompensated heart failure related to severe aortic stenosis. This condition requires careful diuresis to relieve pulmonary edema and volume overload with close attention to the patient's volume status. Overaggressive reduction of preload (through aggressive diuresis and/or nitrates) can result in marked hemodynamic instability given the limited capacity of the heart to augment cardiac output due to the stenotic valve.[1] Given the clinical picture, neither a BNP level nor an urgent echocardiogram is likely to alter the clinical management of the patient at this point. Small ST-segment and T-wave changes are nonspecific in the setting of LV hypertrophy and tachycardia and must be interpreted in the larger clinical context.

2. **(A) Cardiology consultation for invasive coronary angiography prior to planned aortic valve replacement.** The development of symptoms attributable to aortic stenosis—angina, syncope, or heart failure—is a significant prognostic turning point in the disease course and warrants assessment for surgery. Medical therapy has not been demonstrated to alter the natural history of severe aortic stenosis. In the absence of surgical aortic valve replacement, the presence of angina, syncope, or heart failure is associated with a 50% mortality at 5, 3, and 2 years, respectively.[2] Exercise stress testing is contraindicated in patients with symptomatic severe aortic stenosis due to a high rate of complications and low diagnostic accuracy. Given the overlap of risk factors with coronary artery disease, invasive coronary angiography should be performed prior to aortic valve replacement to assess whether concomitant coronary artery bypass grafting is necessary. Statin therapy has demonstrated no benefit for prevention of progression of severe aortic valve calcification and should not be initiated for this purpose.[3]

3. **(C) Repeat clinical assessment in 3 to 6 months and repeat echocardiographic assessment within 1 year or sooner if symptoms develop.** Even with severe aortic stenosis, asymptomatic patients enjoy a natural history similar to normal patients until the development of symptoms.[3] These patients are best monitored by serial clinical assessment with a thorough evaluation for exertional symptoms, as well as annual echocardiogram for development of LV systolic dysfunction. The American College of Cardiology/American Heart Association (ACC/AHA) guidelines suggest serial echocardiography annually for severe aortic stenosis (or with change in clinical status, especially development of dyspnea, angina, or syncope) every 1 to 2 years for moderate stenosis and every 3 to 5 years for mild stenosis.[3] Given this patient's absence of symptoms and reassuring physical examination, there is no role for hospitalization at this time. Exercise testing in asymptomatic severe aortic stenosis is controversial and may be helpful in some patients with nonspecific symptoms to assess exercise capacity, development of exertional symptoms, or abnormal hemodynamic response to exercise. Stress testing in asymptomatic patients with severe aortic stenosis carries risk and is ideally performed with direct communication with the testing facility staff and cardiology consultation. Exercise stress testing is unlikely to be useful for the assessment of coronary artery disease in the setting of severe aortic stenosis. Exercise stress testing is contraindicated in patients with symptomatic aortic stenosis.

   Since volume overload or history of heart failure was not demonstrated, there is no role for diuresis in this patient. Statin therapy has not been demonstrated to alter the course of severe calcific aortic stenosis and should not be initiated for this purpose. Cardiology consultation in the future would be warranted when aortic valve replacement is contemplated and preoperative cardiac catheterization is needed, which is routinely performed prior to surgical valve replacement for evaluation of coronary artery disease.

4. **(A) Cardiology consultation for coronary angiography and referral for aortic valve replacement with or without aortic graft.** In contrast to stenotic aortic valve disease, surgery is indicated for chronic

regurgitant aortic valve disease prior to the development of symptoms. The indications for aortic valve replacement with asymptomatic chronic severe aortic insufficiency include new LV systolic dysfunction (defined by the ACC/AHA valve disease guidelines as LVEF ≤ 50%) or severe LV dilatation (LV end-diastolic dimension > 75 mm or LV end- systolic dimension > 55 mm).[3] This patient has demonstrated an interval decrease in LV systolic function into the abnormal range of 50% or less, which is a class 1 indication for aortic valve replacement, regardless of LV dimensions.[3] As with other valve lesions, patients at risk should be assessed for coronary disease prior to valve surgery. In this case, the patient is also at risk for both aortic dissection and rupture given the presence of a bicuspid aortic valve and a dilated aortic root; therefore, he should also be considered for aortic root replacement with a valved conduit for maximal likelihood of surgical success and recovery of LV systolic function.

An increase in pulse pressure (the difference between systolic and diastolic blood pressure) with an increased systolic blood pressure is a hallmark of chronic aortic insufficiency due to increased LV preload and may not be controlled on multiple medications. Therefore, medical therapy with a diuretic or β-blocker is not indicated, and in fact, rate-slowing with β-blockade poses theoretical harm because it would prolong diastole, exacerbating the time of insufficiency. Medical therapy with vasodilators such as an ACE inhibitors can be considered but should not delay or be considered a replacement for surgery in patients with chronic severe aortic insufficiency that has already met surgical criteria.

5. **(D) Repeat clinical assessment in 6 to 12 months with repeat transthoracic echocardiogram in 1 year, or sooner if symptoms develop.** This patient has asymptomatic moderate aortic insufficiency without evidence of LV dysfunction or dilatation; one could generally expect a long period without symptoms or development of LV dysfunction and an average mortality rate of less than 0.2% per year.[3,4] Therefore, the risks of aortic valve replacement and postoperative complications outweigh its benefits, and valve surgery is not yet indicated.[3] However, given the progressive nature of the disease, these patients should be followed closely, ideally with a multidisciplinary team including primary care physicians, cardiologists, and cardiothoracic surgeons. Although most patients with chronic aortic insufficiency develop symptoms prior to development of LV dysfunction, more than one quarter who die or develop systolic dysfunction do so before the onset of warning symptoms. Therefore, noninvasive assessment, generally with transthoracic echocardiography, is indicated, with particular attention to LV dimensions and LV systolic function.[3] Moreover, if the transthoracic echocardiography is of good quality, which is the case in this patient, there is no indication for invasive aortography.

The 2008 AHA focused update on infectious endocarditis suggests that antibiotic prophylaxis is only recommended for patients with a high risk of endocarditis defined as (1) patients with prosthetic heart valves, (2) patients with complex congenital heart disease, (3) patients with valvulopathy in a transplanted heart, and (4) patients with a prior history of endocarditis.[4] The presence of aortic insufficiency alone, as seen in this patient, is no longer a recommendation for antibiotic prophylaxis.[4]

6. **(C) Cautious administration of IV nitroprusside drip, intensive blood pressure monitoring, and referral for emergent valve replacement surgery.** This patient has acute severe aortic insufficiency from acute infective endocarditis. Acute severe aortic insufficiency is a clinical emergency that requires a high index of suspicion in the appropriate clinical setting (chest trauma, aortic dissection, or acute infective endocarditis), and generally requires emergent surgical valve replacement. Many of the classic physical examination manifestations of chronic aortic insufficiency are not evident in acute aortic insufficiency, including normal or only minimally increased pulse pressure. Emergent echocardiography is invaluable in quickly establishing the diagnosis, etiology, and severity. Cautious afterload reduction with nitroprusside and intensive blood pressure monitoring are useful to stabilize the patient's symptoms and serve as a bridge to emergent surgery in patients with acute severe aortic insufficiency, especially in the setting of heart failure.[3]

Given the hemodynamic instability of the patient and the fact that aortic insufficiency occurs during diastole, β-blockers are contraindicated as they can prolong diastole. Similarly, an intra-aortic balloon pump exerts its actions by inflating during cardiac diastole, exacerbating aortic insufficiency, and it is also contraindicated. There is no evidence to suggest that this patient has an acute coronary syndrome, and thus there is no role for aspirin, nitroglycerine, IV heparin, and evaluation of serial troponin levels every 8 hours.

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