SECTION I
QUESTIONS
(CHAPTERS 1 TO 20)

Fundamentals of Cardiovascular Disease;
Genetics and Personalized Medicine;
Evaluation of the Patient
Sanjay Divakaran and Leonard S. Lilly

Directions:
For each question below, select the ONE BEST response.

QUESTION 1
A 54-year-old African-American man with a history of hypertension and hypercholesterolemia undergoes a treadmill exercise test using the standard Bruce protocol. He stops at 11 minutes 14 seconds because of fatigue, at a peak heart rate of 152 beats/min and peak systolic blood pressure of 200 mm Hg. The diastolic blood pressure declines by 5 mm Hg during exercise. During recovery, the systolic blood pressure decreases to 15 mm Hg below his preexercise pressure. There are no ischemic changes on the ECG during or after exercise. Which of the following is correct?
A. His peak systolic blood pressure during exercise exceeds that normally observed
B. The change in diastolic blood pressure during exercise is indicative of significant coronary artery disease
C. This test is nondiagnostic owing to an inadequate peak heart rate
D. These results are consistent with a low prognostic risk of a coronary event
E. The postexercise reduction in systolic blood pressure is suggestive of severe coronary artery disease

QUESTION 2
Which of the following statements regarding the second heart sound (S2) is TRUE?
A. Earlier closure of the pulmonic valve with inspiration results in physiologic splitting of S2
B. Right bundle branch block results in widened splitting of S2
C. Paradoxical splitting of S2 is the auscultatory hallmark of an ostium secundum atrial septal defect
D. Fixed splitting of S2 is expected in patients with a right ventricular electronically paced rhythm
E. Severe pulmonic valvular stenosis is associated with a loud P2

QUESTION 3
A state-of-the-art blood test has been developed for the rapid, noninvasive diagnosis of coronary artery disease. The assay has a sensitivity of 90% and a specificity of 90% for the detection of at least one coronary stenosis of >70%. In which of the following scenarios is the blood test likely to be of most value to the clinician?
A. A 29-year-old man with exertional chest pain who has no cardiac risk factors
B. A 41-year-old asymptomatic premenopausal woman
C. A 78-year-old diabetic woman with exertional chest pain who underwent two-vessel coronary stenting 6 weeks ago
D. A 62-year-old man with exertional chest pain who has hypertension, dyslipidemia, and a 2-pack-per-day smoking history
E. A 68-year-old man with chest discomfort at rest accompanied by 2 mm of ST-segment depression in the inferior leads on the ECG

QUESTION 4
A murmur is auscultated during routine examination of an 18-year-old asymptomatic college student, at the second left intercostal space, close to the sternum. The murmur is crescendo-decrescendo, is present throughout systole and diastole, and peaks simultaneously with S2. It does not change with position or rotation of the head. Which of the following best describes this murmur?
A. This is a continuous murmur, most likely a venous hum commonly heard in adolescents
B. This is a continuous murmur resulting from mixed aortic valve disease
C. This is a continuous murmur due to a congenital shunt, likely a patent ductus arteriosus
D. Continuous murmurs of this type can only be congenital; murmurs due to acquired arteriovenous connections are purely systolic
E. This murmur, the result of left subclavian artery stenosis, is not considered continuous, because a continuous murmur can result only from an arteriovenous communication
QUESTION 5
Unequal upper extremity arterial pulsations are often found in each of the following disorders EXCEPT
A. Aortic dissection
B. Takayasu disease
C. Supravalvular aortic stenosis
D. Subclavian artery atherosclerosis
E. Subvalvular aortic stenosis

QUESTION 6
A 58-year-old woman with metastatic breast cancer presents with exertional dyspnea and is found to have a large circumferential pericardial effusion, jugular venous distention, and hypotension. Which of the following echocardiographic signs is likely present?
A. Collapse of the right ventricle throughout systole
B. Exaggerated decrease in tricuspid inflow velocity during inspiration
C. Exaggerated decrease in mitral inflow velocity during inspiration
D. Exaggerated increase in left ventricular outflow tract velocity during inspiration
E. Markedly increased E/A ratio of the transmitral Doppler velocity profile

QUESTION 7
Which of the following statements about pulsus paradoxus is correct?
A. Inspiration in normal individuals results in a decline of systolic arterial pressure of up to 18 mm Hg
B. Accurate determination of pulsus paradoxus requires intra-arterial pressure measurement
C. Pulsus paradoxus in tamponade is typically accompanied by the Kussmaul sign
D. Pulsus paradoxus is unlikely to be present in patients with significant aortic regurgitation, even in the presence of tamponade
E. Pulsus paradoxus is common in patients with hypertrophic cardiomyopathy

QUESTION 8
A 57-year-old man with a history of hypertension and elevated LDL cholesterol presents to the emergency room with the acute onset of substernal chest pressure, dyspnea, and diaphoresis. His blood pressure is 158/96 mm Hg and the heart rate is 92 beats/min. Physical examination reveals clear lung fields and no cardiac gallop or murmurs. The ECG shows sinus rhythm with a prominent R wave in lead V2, 0.5 mm of ST elevation in lead III, and 2 mm of horizontal ST depression in leads V1–V3. Which of the following would return to baseline by 1 minute into recovery. Which of the following is NOT a possible cause of that sound?
A. Opening snap
B. Third heart sound
C. Ejection click
D. Tumor plop
E. Pericardial knock

QUESTION 9
Which of the following combinations does NOT have the potential for significant pharmacologic interaction?
A. Simvastatin and erythromycin
B. Sildenafil and nitroglycerin
C. Pravastatin and ketoconazole
D. Cyclosporine and St. John’s wort
E. Digoxin and verapamil

QUESTION 10
It would be reasonable and safe to order an exercise stress test for a patient with which of the following conditions?
A. Symptomatic hypertrophic obstructive cardiomyopathy
B. Advanced aortic stenosis
C. Acute myocarditis
D. Abdominal aortic aneurysm with transverse diameter of 5.5 cm
E. Unstable angina

QUESTION 11
A 42-year-old woman with hypertension and dyslipidemia underwent a 1-day rest-stress exercise myocardial perfusion single-photon emission computed tomography (SPECT) study with technetium-99m imaging to evaluate symptoms of “atypical” chest pain. Her resting ECG showed left ventricular hypertrophy. She exercised for 12 minutes 30 seconds on the standard Bruce protocol and attained a peak heart rate of 155 beats/min. She developed a brief sharp parasternal chest pain during the test that resolved quickly during recovery. Based on the images in Fig. 1.1, which of the following statements is correct?
A. The SPECT myocardial perfusion images are diagnostic of transmural myocardial scar in the distribution of the mid–left anterior descending coronary artery
B. The anterior wall defect on the SPECT images is likely an artifact due to breast tissue attenuation
C. Thallium-201 would have been a better choice of radiotracer to image this patient
D. Gated SPECT imaging cannot differentiate attenuation artifacts from a true perfusion defect
E. A transmural scar is associated with reduced wall motion but normal wall thickening on gated SPECT imaging

QUESTION 12
A 62-year-old man is noted to have an extra heart sound shortly after S2. Which of the following is NOT a possible cause of that sound?
A. Opening snap
B. Third heart sound
C. Ejection click
D. Tumor plop
E. Pericardial knock

QUESTION 13
A 56-year-old asymptomatic man with a history of hypertension and cigarette smoking is referred for an exercise treadmill test. After 7 minutes on the standard Bruce protocol, he is noted to have 1 mm of flat ST-segment depression in leads II, III, and aVF. He stops exercising at 9 minutes because of leg fatigue and breathlessness. The peak heart rate is 85% of the maximum predicted for his age. The ST segments return to baseline by 1 minute into recovery. Which of the following statements is correct?
A. This test is conclusive for severe stenosis of the proximal right coronary artery
B. His risk of death due to an acute myocardial infarction during the next year is >50%
C. He should proceed directly to coronary angiography
D. The test predicts a 25% risk of cardiac events over the next 5 years, most likely the development of angina
E. This is likely a false-positive test

QUESTION 14

In which of the following clinical scenarios do ST-segment depressions during standard exercise testing increase the diagnostic probability of significant coronary artery disease?
A. A 56-year-old man with left bundle branch block and a family history of premature coronary disease
B. A 45-year-old woman with diabetes and hypertension, with left ventricular hypertrophy on her baseline ECG
C. A 76-year-old woman with new exertional dyspnea, a history of cigarette smoking, and a normal baseline ECG
D. A 28-year-old woman with pleuritic left-sided chest pain after a gymnastics class
E. A 63-year-old man with exertional dyspnea on beta blocker, digoxin, and nitrate therapies

QUESTION 15

Which of the following statements regarding cardiac catheterization is TRUE?
A. The risk of a major complication from cardiac catheterization is 2.0% to 2.5%
B. The incidence of contrast-induced nephrotoxicity in patients with renal dysfunction is decreased with intravenous administration of mannitol before and after the procedure
C. High osmolar nonionic contrast agents demonstrate a reduced incidence of adverse hemodynamic reactions compared with low osmolar ionic contrast agents
D. One French unit (F), a measurement of catheter diameter, is equivalent to 0.33 mm
E. Retrograde left-sided heart catheterization is generally a safe procedure in patients with tilting-disc prosthetic aortic valves

QUESTION 16

A 75-year-old woman was brought urgently to the cardiac catheterization laboratory in the setting of an acute ST-elevation myocardial infarction. She had presented with chest pain, epigastric discomfort, and nausea. Physical examination was pertinent for diaphoresis, heart rate 52 beats/min, blood pressure 85/50 mm Hg, jugular venous distention, and slight bilateral pulmonary rales. Coronary angiography demonstrated ostial occlusion of a dominant right coronary artery, without significant left-sided coronary artery disease. Which of the following statements is correct?
A. Isolated infarction of the right ventricle, without left ventricular involvement, is likely
B. ST-segment elevation in leads V₁ and V₂ would be expected to accompany inferior ST elevation
C. The abnormal heart rate and blood pressure are likely a consequence of vagal stimulation
D. ST-segment depression is expected in lead V₄R

QUESTION 17

Using Doppler echocardiography, the following values are obtained in a patient with a restrictive ventricular septal defect (VSD) and mitral regurgitation: systolic transmural
flow velocity = 5.8 m/s and systolic flow velocity at the site of the VSD = 5.1 m/s. The patient’s blood pressure is 144/78 mm Hg. The estimated right ventricular systolic pressure is (choose the single best answer)
A. 20 mm Hg
B. 30 mm Hg
C. 40 mm Hg
D. 50 mm Hg
E. Not able to be determined from the provided information

QUESTION 18

A 68-year-old woman with a history of diabetes and cigarette smoking and previously normal cardiac examination is admitted to the hospital with the new onset of shortness of breath with exertion and orthopnea. She describes having experienced a “muscle ache” in her anterior chest 10 days earlier that lasted several hours and has not recurred. Her blood pressure is 109/88 mm Hg, the heart rate is 102 beats/min, and she is afebrile. Her examination reveals an elevated jugular venous pressure (JVP), bibasilar crackles, and 1+ pitting edema of both ankles. On auscultation, there is a II/VI early systolic murmur between the left sternal border and apex. The ECG reveals sinus tachycardia with inferior Q waves that were not present on a tracing 6 months earlier. The chest x-ray is consistent with pulmonary edema. She is admitted to the hospital and a transthoracic echocardiogram is obtained that is technically limited due to her body habitus. It reveals a left ventricular ejection fraction of 60% with inferior wall hypokinesis. The mitral valve is not well visualized but appears thickened and there is an anteriorly directed jet of mitral regurgitation that is difficult to quantitate. A diuretic is administered.

Which of the following is the next most reasonable approach in her management?
A. Urgent coronary angiography with planned percutaneous coronary intervention
B. Nuclear stress testing to evaluate for ongoing ischemia
C. Transesophageal echocardiography and surgical consultation
D. Initiate long-term management with aspirin, angiotensin-converting enzyme (ACE) inhibitor, and beta blocker therapies
E. Urgent right heart catheterization to evaluate for a left-to-right shunt

QUESTION 19

Which of the following statements regarding altered electrolytes and electrocardiographic abnormalities is TRUE?
A. Hypokalemia causes peaked T waves
B. Hyperkalemia causes QRS narrowing and increased P wave amplitude
C. Hypomagnesemia is associated with monomorphic ventricular tachycardia
D. Hypocalcemia causes prolongation of the QT interval
E. Severe hypocalcemia has been associated with the presence of a J wave (Osborn wave)

QUESTION 20

A 46-year-old woman with progressive exertional dyspnea was recently found to have bilateral hilar adenopathy on chest x-ray and first-degree atrioventricular (AV) block on her ECG. A transbronchial biopsy demonstrated noncaseating granulomas consistent with sarcoidosis and she is referred to you for assessment of cardiac involvement. Which of the following statements is TRUE regarding the diagnostic evaluation of cardiac sarcoidosis?
A. Left ventricular regional wall motion abnormalities in sarcoidosis are typically present in coronary distributions
B. An elevated serum angiotensin-converting enzyme level has low sensitivity, but high specificity, for the diagnosis of sarcoidosis
C. Sarcoid-associated late gadolinium enhancement (LGE) on cardiac magnetic resonance (CMR) imaging is usually localized to the endocardial border
D. CMR is not useful in the assessment of clinically silent cardiac sarcoidosis
E. 18F-fluorodeoxyglucose (FDG) uptake on cardiac positron emission tomography (PET) differentiates active cardiac sarcoidosis from inactive scar tissue

QUESTION 21

Which of the following statements about the ECG depicted in Fig. 1.2 is correct?
A. The basic rhythm is wandering atrial pacemaker
B. The fifth QRS complex on the tracing is likely a premature ventricular beat
C. The Ashman phenomenon is present and it occurs because the refractory period is directly related to the length of the preceding RR interval
D. The bundle of His is the likely anatomic location of conduction delay in the fifth beat because it has the longest refractory period of conduction tissue

QUESTION 22

The timing of an “innocent” murmur is usually
A. Early systolic
B. Presystolic
C. Midsystolic
D. Holosystolic
E. Early diastolic
QUESTION 23

Which of the following statements about the jugular venous wave form is correct?
A. The Kussmaul sign is pathognomonic for constrictive pericarditis
B. The c wave is a reflection of ventricular diastole and becomes visible in patients with diastolic dysfunction
C. The x descent is less prominent than the y descent in cardiac tamponade
D. Phasic declines in venous pressure (the x and y descents) are typically more prominent to the eye than the positive pressure waves (the a, c, and v waves)
E. Cannon a waves indicate intraventricular conduction delay

QUESTION 24

Which of the following statements regarding the measurement of cardiac output is correct?
A. In the thermodilution method, cardiac output is directly related to the area under the thermodilution curve
B. The thermodilution method tends to underestimate cardiac output in low-output states
C. In the presence of tricuspid regurgitation, the thermodilution method is preferred over the Fick technique for measuring cardiac output
D. A limitation of the Fick method is the necessity of measuring oxygen consumption in a steady state
E. Cardiac output is directly proportional to systemic vascular resistance

QUESTION 25

Which of the following conditions is associated with the Doppler transmitral inflow pattern shown in Fig. 1.3?
A. Gastrointestinal hemorrhage
B. Constrictive pericarditis
C. Normal aging
D. Restrictive cardiomyopathy
E. Hyperthyroidism

QUESTION 26

A 32-year-old woman, a native of India, is referred by her primary care physician for further evaluation of dyspnea on exertion. On examination, both an opening snap and mid-diastolic rumble are appreciated at the apex. An echocardiogram is obtained. Which of the following CANNOT be assessed from the transmitral Doppler tracing shown in Fig. 1.4?
A. The presence and severity of mitral stenosis
B. The presence of mitral regurgitation
C. The transmitral diastolic pressure gradient
D. The etiology of the valvular lesion
E. The mitral valve area

QUESTION 27

A 37-year-old woman with no significant past medical history presents to the emergency department with acute shortness of breath and pleuritic chest pain. Her only medication is an oral contraceptive. Her examination is notable for sinus tachycardia. A chest computed tomography (CT) shows subsegmental pulmonary emboli, and she is started on anticoagulation therapy. An echocardiogram is performed, which demonstrates the McConnell sign as well as mild tricuspid regurgitation with the following values:
- Peak systolic velocity across the tricuspid valve = 3 m/s
- Inferior vena cava (IVC) diameter = 1.9 cm with <50% collapse with inspiration

Which of the following statements is correct?
A. The McConnell sign refers to localized dyskinesis of the right ventricular apex in patients with acute pulmonary embolism
B. The Kussmaul sign may result from acute pulmonary embolism
C. This patient’s estimated pulmonary artery systolic pressure is 64 mm Hg
D. This patient’s right atrial pressure should be estimated as ~15 mm Hg

FIG. 1.3
**QUESTION 28**

Which of the following statements is TRUE regarding the response of healthy older adults to aerobic exercise?

A. Ventricular stroke volume decreases with age such that there is an age-related fall in cardiac output during exercise

B. Systolic and diastolic blood pressures each rise significantly during aerobic exercise

C. A decline in beta-adrenergic responsiveness contributes to a fall in the maximum heart rate in older individuals

D. A normal adult's cardiac output doubles during maximum aerobic exercise

E. Maximum aerobic capacity does not change significantly with age in sedentary individuals

**QUESTION 29**

Physiologic states and dynamic maneuvers alter the characteristics of heart murmurs. Which of the following statements is correct?

A. In acute mitral regurgitation, the left atrial pressure rises dramatically so that the murmur is heard only during late systole

B. Rising from a squatting to a standing position causes the murmur of mitral valve prolapse to begin later in systole

C. The diastolic rumble of mitral stenosis becomes more prominent during the strain phase of a Valsalva maneuver

D. The murmur of aortic stenosis, but not mitral regurgitation, becomes louder during the beat after a premature ventricular contraction

E. The murmur of acute aortic regurgitation can usually be heard throughout diastole

**QUESTION 30**

Which of the following statements regarding the computed tomograms of the chest shown in Fig. 1.5 is TRUE?

A. The patient's disorder should be managed medically, with surgical intervention considered only if there is evidence of secondary organ involvement

B. The left common carotid artery is spared by this process

C. The sensitivity of computed tomography for the diagnosis of this condition is >95%

D. Fewer than 50% of patients with this condition will report chest pain

E. Transesophageal echocardiography is necessary to confirm the diagnosis
QUESTION 31
Which of the following statements regarding ST-segment changes during exercise testing is TRUE?
A. The electrocardiographic localization of ST-segment depression predicts the anatomic territory of coronary obstructive disease
B. The J point is the proper isoelectric reference point on the ECG
C. J point depression during exercise is diagnostic for significant cardiac ischemia
D. Persistence of ST-segment depression for 60 to 80 milliseconds after the J point is necessary to interpret the electrocardiographic response as abnormal
E. ST-segment depression must be present both during exercise and in recovery to be interpreted as abnormal

QUESTION 32
An ECG is obtained as part of the routine preoperative evaluation of an asymptomatic 45-year-old man scheduled to undergo wrist surgery. The tracing is shown in Fig. 1.6 and is consistent with
A. Right ventricular hypertrophy
B. Left posterior fascicular block
C. Reversal of limb lead placement
D. Left anterior fascicular block and counterclockwise rotation
E. Dextrocardia with situs inversus

QUESTION 33
Which of the following statements is correct regarding exercise test protocols?
A. Regardless of the exercise protocol, the heart rate and systolic and diastolic blood pressures all must increase substantially to achieve a valid test
B. Bicycle, treadmill, and arm ergometry protocols all produce approximately equal heart rate and blood pressure responses
C. The standard Bruce protocol is characterized by only small increases in oxygen consumption between stages
D. A fall in systolic blood pressure during exercise is associated with severe coronary artery disease
E. An optimal graded treadmill exercise test rarely requires more than 5 minutes of exercise on the Bruce protocol

QUESTION 34
Which of the following patients is LEAST likely to have a cardiac cause of his/her recent onset of dyspnea?
A. An active 54-year-old man with a congenitally bicuspid aortic valve who has recently noticed shortness of breath walking his usual 18 holes of golf
B. A 70-year-old woman who sustained an anterior myocardial infarction 1 year ago with a left ventricular ejection fraction of 50% at that time. She has not had recurrent angina but has noted dyspnea during her usual housework over the past 2 months
C. A 46-year-old woman with a history of asymptomatic rheumatic mitral stenosis who recently noticed irregular palpitations and shortness of breath while climbing stairs
D. A 38-year-old woman with a previously asymptomatic ostium secundum atrial septal defect, now 8 months pregnant, who has noted shortness of breath during her usual weekly low-impact aerobics class
E. A 22-year-old man with trisomy 21 and a heart murmur who has described shortness of breath carrying grocery bundles over the past 3 months

QUESTION 35
A 68-year-old man with a history of diabetes, hypertension, and hyperlipidemia is transported to the hospital via ambulance, complaining of crushing substernal chest pain. Emergency medical services personnel report that ST segments are >2 mm elevated in multiple anterior leads. Which of the following electrocardiographic findings is LEAST likely in this patient?
A. Hyperacute T waves in the precordial leads
B. ST-segment depression in leads III and aVF
C. Shortened QT interval
D. New right bundle branch block

FIG. 1.6
**QUESTION 36**

Which of the following statements regarding nuclear imaging and acute myocardial infarction (MI) is TRUE?

A. The size of the resting myocardial perfusion defect after acute MI does not correlate with the patient’s prognosis
B. Increased lung uptake of radioisotope at rest correlates with a favorable prognosis
C. Submaximal exercise imaging soon after MI is a better predictor of late complications than adenosine myocardial perfusion imaging
D. Technetium-99m sestamibi imaging is inaccurate in assessing the effectiveness of reperfusion therapy
E. Measuring infarct size by technetium-99m sestamibi imaging before discharge from the hospital is a reliable way to predict subsequent ventricular remodeling

**QUESTION 37**

A 61-year-old man presents for a treadmill exercise test because of intermittent chest pain. He believes he had a “small heart attack” in the past. He has a history of prior tobacco use and his father died of a myocardial infarction at age 68. His baseline ECG shows normal sinus rhythm with Q waves in the inferior leads. At 6 minutes into the Bruce protocol he develops mild anterior chest heaviness and the ECG demonstrates ST elevation in leads I, aVL, V5, and V6. Which of the following statements regarding ST-segment elevation during exercise testing is correct?

A. ST-segment elevation during exercise testing is a common finding in patients with coronary artery disease
B. ST-segment elevation in a lead that contains a pathologic Q wave at baseline indicates severe myocardial ischemia
C. The electrocardiographic leads that manifest ST-segment elevation during exercise localize the anatomic regions of ischemia
D. ST-segment elevation that develops during exercise is usually a manifestation of benign early repolarization
E. ST-segment elevation during exercise is commonly associated with the development of complete heart block

**QUESTION 38**

Which of the following statements regarding coronary calcium assessment by electron beam tomography (EBT) is TRUE?

A. The amount of calcium on EBT strongly correlates with the severity of coronary disease detected by angiography
B. Patients who benefit most from screening with EBT are those at a high risk for coronary events based on traditional risk factors
C. The absence of coronary calcium completely excludes the presence of severe obstructive coronary artery stenosis
D. Interpretation of the calcium score is independent of the patient’s age and gender
E. A coronary calcium score higher than the median confers an increased risk of myocardial infarction and death

**QUESTION 39**

Which of the following statements is TRUE regarding prognosis as determined by myocardial perfusion imaging?

A. Patients with normal perfusion in the presence of angiographically documented coronary artery disease have very low rates of cardiac events (<1% per year)
B. Thallium imaging results in less breast attenuation artifact compared with technetium-99m sestamibi
C. Transient ischemic dilatation of the left ventricle and lung uptake of the nuclear tracer are common findings in normal individuals
D. The combination of clinical and cardiac catheterization data is more predictive of subsequent cardiac events than the combination of clinical and myocardial perfusion data
E. The risk of future cardiac events is unrelated to the number or extent of myocardial perfusion defects

**QUESTION 40**

A previously healthy 28-year-old man presented to the hospital because of 1 month of progressive exertional dyspnea, weakness, and weight loss. One day before hospitalization he was unable to climb one flight of stairs because of shortness of breath. On examination, he appeared fatigued with mild respiratory distress. His blood pressure was 110/70 mm Hg without pulsus paradoxus. His heart rate was 110 beats/min and regular. The jugular veins were distended without the Kussmaul sign. Pulmonary auscultation revealed scant bibasilar rales. The heart sounds were distant. There was mild bilateral ankle edema. As part of the evaluation during hospitalization, he underwent cardiac magnetic resonance imaging. A short-axis view at the midventricular level is shown in Fig. 1.7. Which of the following is the most likely diagnosis?

A. Pericardial malignancy
B. Chronic organized pericardial hematoma
C. Constrictive pericarditis
D. Extracardiac tumor compression of the heart
E. Congenital partial absence of the pericardium with cardiac herniation
QUESTION 41
Which of the following statements regarding intracardiac shunts is correct?
A. A left-to-right shunt should be suspected if the difference in oxygen saturation between the superior vena cava (SVC) and the pulmonary artery is 3% or more
B. Oxygen saturation in the SVC is normally higher than that in the inferior vena cava (IVC)
C. In a suspected atrial septal defect with left-to-right flow, mixed venous O₂ content should be measured at the level of the pulmonary artery
D. A pulmonic-to-systemic blood flow ratio \( \frac{Q_p}{Q_s} > 1 \) indicates a net right-to-left shunt
E. Pulmonary artery oxygen saturation exceeding 80% should raise the suspicion of a left-to-right shunt

QUESTION 42
A 46-year-old man with dyspnea on exertion is noted to have a systolic ejection murmur along the left sternal border. An echocardiogram is obtained. Fig. 1.8 shows Doppler pulsed-wave interrogation of the left ventricular outflow tract, recorded from the apex. Which of the following recommendations would be most appropriate?
A. Strict fluid restriction
B. Avoid volume depletion
C. Aortic valve replacement
D. Bed rest

QUESTION 43
Which of the following statements regarding echocardiography in pericardial disease is correct?
A. Small pericardial effusions tend to accumulate anterior to the heart
B. Up to 100 mL of pericardial fluid is present in normal individuals
C. In cardiac tamponade, right ventricular diastolic collapse occurs less frequently if pulmonary hypertension is present
D. In the presence of a pericardial effusion, right atrial diastolic indentation is a more specific sign of cardiac tamponade than early diastolic collapse of the right ventricle
E. Transthoracic echocardiography is superior to chest computed tomography as a means to accurately measure pericardial thickness

QUESTION 44
Which of the following statements regarding nuclear imaging in cardiac disease is TRUE?
A. The use of single-photon emission computed tomography (SPECT) with electrocardiographic gating has no impact on the specificity of nuclear testing in women with attenuation artifacts
B. Exercise nuclear stress imaging, rather than pharmacologic stress testing, is the preferred diagnostic modality for patients with left bundle branch block
C. The presence of reversible defects on pharmacologic stress perfusion imaging before noncardiac surgery predicts an increased risk of perioperative cardiac events, but the magnitude of risk is not related to the extent of ischemia
D. Cardiovascular event rates are similar in diabetics compared with nondiabetics for any given myocardial perfusion abnormality
E. Viability of noncontracting myocardium can be accurately evaluated by thallium-201 imaging

QUESTION 45
A 45-year-old woman was referred for exercise echocardiography because of a history of intermittent chest pain. She has a strong family history of premature coronary artery disease but no other atherosclerotic risk factors. The exercise echocardiogram achieved the desired heart rate goal and demonstrated a focal wall motion abnormality of the left ventricular anterior wall at rest, which was unchanged at maximum exercise. A subsequent cardiac magnetic resonance study was performed to characterize the myocardial tissue in that region. A delayed image taken after intravenous administration of gadolinium is shown in Fig. 1.9. What is the most likely cause of the anterior wall motion abnormality?
A. Transient myocardial ischemia due to a significant coronary artery stenosis
B. Prior myocardial infarction
C. Myocarditis
D. Infiltrative cardiomyopathy
E. Breast attenuation artifact

FIG. 1.8

FIG. 1.9
QUESTION 46
Which of the following statements concerning the echocardiographic evaluation of aortic stenosis is TRUE?
A. The peak-to-peak gradient measured at cardiac catheterization routinely exceeds the peak instantaneous aortic valve pressure gradient assessed by Doppler echocardiography
B. Patients with impaired left ventricular function may have severe aortic stenosis, as determined by the continuity equation, despite a peak outflow velocity of only 2 to 3 m/s
C. Among Doppler techniques, the most accurate transaortic valve flow velocity in aortic stenosis is measured by pulsed-wave Doppler imaging
D. The greatest degree of error in the calculation of aortic valve area using the continuity equation resides in inaccurate measurement of the transaortic valve flow velocity
E. The mean aortic valve gradient measured by Doppler echocardiography is typically higher than the mean gradient measured by cardiac catheterization

QUESTION 47
Which of the following statements regarding the assessment for intracardiac shunts during cardiac catheterization is correct?
A. In normal subjects, there should be no difference in O₂ content in different portions of the right atrium
B. Atrial septal defect, anomalous pulmonary venous drainage, and ruptured sinus of Valsalva aneurysm all are associated with a significant step-up in O₂ saturation between the right atrium and the right ventricle
C. Because of the normal variability in O₂ saturation, shunts with pulmonary-to-systemic flow ratios (Qₚ/Qₛ) ≤1.3 at the level of the pulmonary artery or right ventricle may escape detection by oximetry run analyses
D. When a shunt is bidirectional, its magnitude can be calculated as the difference between the pulmonary and systemic blood flows (Qₚ − Qₛ) as determined using the Fick equation
E. In patients with a pure right-to-left shunt, the Qₚ/Qₛ ratio should be >1.0

QUESTION 48
Which of the following findings during an exercise test is NOT associated with multivessel (or left main) coronary artery disease?
A. Early onset of ST-segment depression
B. Persistence of ST-segment changes late into the recovery phase
C. ST-segment elevation in lead aVR
D. Sustained ventricular tachycardia
E. Failure to increase systolic blood pressure by at least 10 mm Hg

QUESTION 49
Which of the following statements regarding the auscultatory findings in aortic stenosis is TRUE?
A. Initial squatting decreases the intensity of the murmur
B. The murmur is increased in intensity during the strain phase of the Valsava maneuver
C. In patients with premature ventricular contractions, aortic stenosis can be differentiated from mitral regurgitation because there is beat-to-beat variation in the intensity of the aortic stenosis murmur while the intensity of the mitral regurgitation remains constant
D. Respiration typically has a prominent effect on the intensity of the murmur

QUESTION 50
A 59-year-old business executive presents because of episodes of retrosternal chest discomfort that does not radiate. It is an aching, burning sensation, occurring most frequently at night, occasionally awakening the patient shortly after he has fallen asleep. It does not occur while walking or climbing stairs. His internist prescribed nitroglycerin, which he has taken infrequently. However, it does relieve his pain, usually within 10 to 20 minutes. The previous day during a luncheon meeting he had a severe episode while presenting a new financial plan; the discomfort seemed to lessen when he sat down and finished lunch. The most likely explanation for his chest discomfort is
A. Prinzmetal angina
B. Esophageal reflux and spasm
C. Pericarditis
D. Unstable angina pectoris
E. Biliary colic

QUESTION 51
A 44-year-old man with diabetes and a strong family history of premature coronary artery disease underwent cardiac evaluation because of episodes of exertional substernal chest pressure. His resting ECG demonstrated normal sinus rhythm and borderline left ventricular hypertrophy. During exercise myocardial perfusion imaging, he developed his typical chest discomfort and stopped at 03:20 minutes of the standard Bruce protocol, at a peak heart rate of 105 beats/min (60% of his age-predicted maximal heart rate). The systolic blood pressure decreased by 20 mm Hg at peak exercise. Based on the myocardial perfusion images in Fig. 1.10, which of the following statements is TRUE?
A. There is no evidence of reversible ischemia
B. Transient dilatation of the left ventricle after exercise stress is absent
C. The increased lung uptake of the radiotracer evident on stress imaging is a normal physiologic response
D. There is increased right ventricular tracer uptake on the post-stress images, which is a specific marker of multivessel or left main coronary disease
E. The test results are inconclusive owing to failure to achieve the target heart rate

QUESTION 52
Which of the following statements about the transaortic valve Doppler flow tracing shown in Fig. 1.11 is TRUE?
A. The probability of critical aortic stenosis in this patient is low
B. The estimated peak transaortic valvular gradient is 90 to 100 mm Hg
C. Aortic insufficiency is severe
D. Based on the Doppler findings, premature closure of the mitral valve is likely
E. The echocardiogram likely reveals normal left ventricular wall thickness
FIG. 1.10

TID Ratio: 1.37

Defect Blackout Map

HLA (Post -> Ant)

VLA (Sep -> Lat)

GATED STRESS [Rec]  GATED STRESS [Recon]  Reversibility

GATED STRESS  GATED REST

FIG. 1.11

5.0 m/s
QUESTION 53
Which of the following statements regarding abnormalities of the extremities in cardiac conditions is FALSE?
A. Arachnodactyly is associated with Marfan syndrome
B. A thumb with an extra phalanx commonly occurs in Turner syndrome
C. Quincke sign is typical of chronic aortic regurgitation
D. Osler nodes are tender, erythematous lesions of the fingers and toes in patients with infective endocarditis
E. Differential cyanosis is typical of patent ductus arteriosus with a reversed shunt

QUESTION 54
Which of the following is NOT commonly associated with the disorder illustrated in Fig. 1.12?
A. Tricuspid regurgitation
B. Patent foramen ovale
C. Wolff-Parkinson-White syndrome
D. Systemic hypertension
E. Atrial fibrillation

QUESTION 55
Which of the following statements is TRUE regarding the echocardiographic evaluation of suspected infective endocarditis?
A. Vegetations of the mitral valve typically appear on the ventricular aspect of the leaflets
B. The sensitivity of transthoracic echocardiography (TTE) for detection of vegetations is <70%
C. After successful antibiotic therapy, previously detected vegetations should not be visible by echocardiography
D. Functional and structural consequences of valvular infection are rarely observed by transthoracic echocardiographic evaluation, such that a transesophageal study (TEE) is always mandatory
E. TTE and TEE have similar sensitivities for detection of myocardial abscess formation

QUESTION 56
Which of the following statements is TRUE regarding examination of the arterial pulse?
A. A reduced-volume brachial pulse with a late systolic peak is the most characteristic arterial finding on physical examination in patients with severe aortic stenosis
B. A bisferious pulse is characterized by a systolic and then a diastolic peak and is typical of mixed mitral valve disease
C. The carotid artery is the blood vessel used to best appreciate the contour, volume, and consistency of the peripheral vessels
D. In coarctation of the aorta, the femoral pulse demonstrates a later peak than the brachial pulse
E. The normal abdominal aorta is palpable both above and below the umbilicus

QUESTION 57
Which of the following statements regarding cardiac catheterization is TRUE?
A. When catheterization is performed from the groin, the risk of retroperitoneal hemorrhage is decreased when the femoral artery puncture is made above the inguinal ligament
B. An international normalized ratio (INR) <2.2 is acceptable for radial artery catheterization
C. Patients with shellfish allergy are at greater risk of intravenous contrast reactions than patients with other food allergies
D. Pseudoaneurysm formation is more likely to occur if the femoral artery puncture is made above the bifurcation of the common femoral artery
E. Results of exercise testing are rarely useful when making clinical decisions about heart failure patients, such as timing of cardiac transplantation

QUESTION 58
Which of the following statements regarding the use of cardiopulmonary exercise testing in patients with congestive heart failure is TRUE?
A. A peak oxygen consumption <14 mL/kg/min identifies patients who would benefit from cardiac transplantation
B. Patients with ejection fractions <20% consistently have peak oxygen consumptions <10 mL/kg/min, and exercise testing is of little utility in this population
C. The exercise limitation in severe heart failure is due primarily to an inability to raise the heart rate
D. Exercise training in congestive heart failure patients improves functional capacity but has no effect on abnormalities of autonomic and ventilatory responsiveness or increased lactate production
E. Results of exercise testing are rarely useful when making clinical decisions about heart failure patients, such as timing of cardiac transplantation

QUESTION 59
In which of the following clinical scenarios is magnetic resonance imaging NOT a superior imaging modality for assessment?
A. Diagnosis of iron overload cardiomyopathy in a pediatric patient with beta-thalassemia major and congestive heart failure
B. Diagnosis of arrhythmogenic right ventricular cardiomyopathy in a 24-year-old man who recently survived a cardiac arrest
C. Diagnosis of aortic coarctation in a 17-year-old girl with hypertension and radial-femoral artery delay on physical examination
QUESTION 60

Fig. 1.13 shows the post-test probability of coronary artery disease (CAD) as a function of the pretest probability of CAD and results of exercise electrocardiography—either a positive \((+ ST, \text{ red bars})\) or negative \((- ST, \text{ blue bars})\) response. Four different patient examples are plotted. Which of the following statements is correct?

A. Stress testing should be pursued in the 45-year-old man with atypical chest pain because, if positive, the test will have the best positive predictive value of the cases shown

B. Stress testing should be pursued in the 55-year-old man with typical chest pain because, if negative, the test will have the best negative predictive value of the cases shown

C. The positive and negative predictive values cannot be determined for these patients from the given information

D. A 45-year-old asymptomatic man with a positive stress test is less likely to have CAD than is a man of the same age with atypical chest pain and a negative stress test

E. The pretest probability of coronary artery disease in a 45-year-old man depends solely on the presence of symptoms

QUESTION 61

Which of the following statements concerning imaging findings in hypertrophic cardiomyopathy (HCM) is TRUE?

A. The presence of systolic anterior motion of the mitral valve is consistent with dynamic outflow tract obstruction

B. Diastolic notching of the aortic valve on M-mode examination is typical in patients with outflow tract obstruction

C. Septal thickness is always abnormal in patients with HCM

D. Myocardial relaxation velocities measured by tissue Doppler imaging are typically normal

QUESTION 62

Each of the following statements regarding cardiac hemodynamics is true EXCEPT:

A. The \(x\) descent of the right atrial pressure wave form represents relaxation of the atrium and downward tugging of the tricuspid annulus by right ventricular contraction

B. In the left atrium, in contrast to the right atrium, the \(v\) wave is more prominent than the \(a\) wave

C. The \(y\) descent is blunted in cardiac tamponade

D. Tricuspid stenosis results in prominence of the \(y\) descent

QUESTION 63

Which of the following statements regarding the effects of maneuvers on the auscultation of cardiac murmurs is TRUE?

A. In patent ductus arteriosus, the diastolic phase of the murmur is softened by isometric handgrip

B. The murmur of hypertrophic obstructive cardiomyopathy becomes softer with standing or during a Valsalva strain maneuver

C. The murmur of a ventricular septal defect decreases with isometric handgrip

D. Isometric handgrip decreases the diastolic murmur of aortic regurgitation

E. The diastolic murmur of mitral stenosis becomes louder with exercise

QUESTION 64

A 62-year-old previously healthy man is brought to the emergency department because of severe headache and dizziness. He has no chest pain or dyspnea. He takes no medications. His blood pressure is 186/98 mm Hg; his heart rate is 56 beats/min and regular. The presenting ECG is shown in Fig. 1.14. Which of the following actions is appropriate?

A. Initiate antiplatelet therapy with aspirin and clopidogrel

B. Initiate antithrombotic therapy with heparin

C. Initiate anti-ischemic therapy with intravenous nitroglycerin and a beta blocker

D. Obtain a head computed tomographic scan

E. Proceed directly to cardiac catheterization if ST-segment/T wave abnormalities fail to quickly normalize with anti-ischemic therapy

QUESTION 65

Which of the following statements about diastolic murmurs is FALSE?

D. Serial evaluation of left ventricular function in a 54-year-old woman with metastatic breast cancer receiving doxorubicin chemotherapy

E. Diagnosis of renal artery stenosis in a 78-year-old man with refractory hypertension

QUESTION 60

Fig. 1.13 shows the post-test probability of coronary artery disease (CAD) as a function of the pretest probability of CAD and results of exercise electrocardiography—either a positive \([+ ST, \text{ red bars}]\) or negative \([- ST, \text{ blue bars}]\) response. Four different patient examples are plotted. Which of the following statements is correct?

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QUESTIONS: CHAPTERS 1 TO 20

C. The left circumflex artery is the dominant vessel in 45% of people.
D. The most densely vascularized area of the heart is the interventricular septum.
E. The abnormality shown in Fig. 1.15 is the most common type of coronary congenital abnormality that is hemodynamically significant.

QUESTION 66

Which of the following statements regarding coronary artery anatomy is NOT correct?
A. At cardiac catheterization, the left main coronary artery is best visualized in the anteroposterior projection with slight caudal angulation.
B. A ramus intermedius branch is present in more than 25% of people.
C. Diastolic murmurs are classified according to their time of onset as early diastolic, mid-diastolic, or late diastolic.
D. In aortic regurgitation due to aortic root dilatation, the murmur typically radiates to the right sternal border.
E. It is possible to differentiate the murmur of acute severe aortic regurgitation from that of chronic aortic regurgitation at the bedside.
F. Late diastolic (presystolic) accentuation of the murmur indicates that the patient is in atrial fibrillation.
G. The Graham Steell murmur begins in early diastole after a loud P₂.

A 25-year-old asymptomatic man presents for routine physical examination with his new primary care physician. The physician notes that the patient is tall with unusually long limbs and pectus excavatum. There is no family history of Marfan syndrome. Which of the following is among the “major criteria” for the diagnosis of Marfan syndrome?
A. Mitral valve prolapse.
B. Mild pectus excavatum.
C. Joint hypermobility.
D. Descending aortic aneurysm.
E. Ectopia lentis.

QUESTION 67

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F. Late diastolic (presystolic) accentuation of the murmur indicates that the patient is in atrial fibrillation.
G. The Graham Steell murmur begins in early diastole after a loud P₂.
QUESTION 68
Which one of the following echocardiographic findings suggests that aortic regurgitation is severe?
A. Diastolic flow reversal in the descending thoracic aorta
B. Premature closure of the aortic valve
C. Pressure half-time of the aortic regurgitation Doppler spectrum of 500 milliseconds
D. A color Doppler regurgitant jet that extends to the tips of the papillary muscles
E. A left ventricular outflow tract systolic gradient of 64 mm Hg

QUESTION 69
Which of the following statements regarding pharmacologic agents used in myocardial perfusion stress testing is FALSE?
A. Patients who cannot perform exercise can be adequately evaluated for coronary artery disease (CAD) using vaso-dilating medications and nuclear scintigraphy
B. Dipyridamole blocks the cellular uptake of adenosine, an endogenous vasodilator
C. During perfusion stress testing, administration of adenosine or dipyridamole commonly provokes myocardial ischemia in patients with CAD
D. Radiopharmaceutical agents should be injected 1 to 2 minutes before the end of exercise
E. Dobutamine pharmacologic scintigraphy increases coronary blood flow less than adenosine

QUESTION 70
Which of the following statements regarding the auscultatory findings of mitral stenosis is correct?
A. The opening snap (OS) is a late diastolic sound
B. A long A2-OS interval implies severe mitral stenosis
C. In atrial fibrillation, the A2-OS interval does not vary with cycle length
D. The “snap” is generated by rapid reversal of the position of the posterior mitral leaflet
E. The presence of an opening snap implies a mobile body of the anterior mitral leaflet

QUESTION 71
Which of the following statements about digitalis-induced arrhythmias is FALSE?
A. Ventricular bigeminy with varying morphology and regular coupling is a sign of digitalis toxicity
B. Nonparoxysmal junctional tachycardia is a common digitalis-induced arrhythmia
C. Atrial tachycardia with block is diagnostic of digitalis toxicity
D. The development of atrioventricular dissociation in a patient taking digitalis is a likely indication of digitalis toxicity
E. Ventricular premature beats are common but are not highly specific for the presence of digitalis toxicity

QUESTION 72
An 82-year-old man presents after a recent non-ST-elevation myocardial infarction. Coronary angiography revealed severe three-vessel disease with 100% occlusion of the proximal left anterior descending (LAD) coronary artery, 100% mid-right coronary artery occlusion, and a 70% stenosis of the proximal left circumflex coronary artery. Echocardiography demonstrated akinesia of the entire anterior wall, septum, and mid- and apical anterolateral wall, with an estimated left ventricular ejection fraction of 20%. Myocardial viability was evaluated using cardiac positron emission tomography (PET) with rest rubidium-82 ($^{82}$Rb flow tracer) and $^{18}$F-labeled fluorodeoxyglucose ($^{18}$F-FDG metabolism tracer) as shown in Fig. 1.16. The images show a large region of PET perfusion metabolism mismatch in the mid-LAD distribution. Which of the following statements about myocardial viability is FALSE?
A. This finding is consistent with the presence of hibernating (viable) myocardium
B. Radionuclide techniques are more sensitive than measurement of inotropic contractile reserve by dobutamine echocardiography for the detection of viable myocardium
C. Inotropic contractile reserve measured by dobutamine echocardiography is more specific than radionuclide techniques for predicting functional recovery after revascularization
D. Survival benefit associated with revascularization of hibernating myocardium has been demonstrated in randomized clinical trials
E. The transmural extent of myocardial scar can be assessed accurately using gadolinium-enhanced cardiac magnetic resonance imaging

QUESTION 73
Which of the following statements regarding physical findings that distinguish the murmur of aortic stenosis (AS) from the murmur of hypertrophic cardiomyopathy (HCM) is TRUE?
A. The strain phase of the Valsalva maneuver decreases the intensity of the murmurs of both AS and HCM
B. The carotid upstroke in HCM is more brisk than in AS
C. The murmurs of AS and HCM both radiate to the carotid arteries
D. If a systolic thrill is present, it is most often located in the second right intercostal space in HCM and at the apex in AS
E. Squatting increases the intensity of the murmur of HCM

QUESTION 74
Which of the following statements is correct regarding the oral anticoagulants dabigatran, rivaroxaban, and apixaban in the treatment of patients with atrial fibrillation?
A. These agents are as effective as warfarin for prevention of thromboemboli in patients with atrial fibrillation and mechanical heart valves
B. Each of these drugs can be used safely in patients with advanced renal disease
C. Intravenous idarucizumab rapidly reverses the anticoagulant effect of dabigatran
D. For patients whose INR levels on warfarin have varied due to noncompliance, rivaroxaban is an excellent alternative given its once-daily dosing
FIG. 1.16
QUESTION 75
A 73-year-old woman with exertional angina is referred for a standard Bruce protocol exercise tolerance test with thallium-201 single-photon emission computed tomography. Her nuclear images are shown in Fig. 1.17. What is the likely diagnosis?
A. Dilated cardiomyopathy
B. Single-vessel coronary artery disease involving the left circumflex artery
C. Prior inferior myocardial infarction with high-grade stenosis of the right coronary artery
D. Left main or severe multivessel coronary artery disease
E. Normal coronary arteries; the images demonstrate breast attenuation artifact

QUESTION 76
Which of the following statements regarding pulsus alternans in patients with marked LV dysfunction is true?
A. It is usually associated with electrical alternans of the QRS complex
B. It is less readily detected in the femoral as compared with radial arteries
C. It cannot be detected by noninvasive sphygmomanometry
D. It can be enhanced by the assumption of erect posture
E. It is uncommon for patients with pulsus alternans also to have an S3 gallop

QUESTION 77
Which of the following statements regarding exercise testing is TRUE?
A. Frequent ventricular ectopy in the early postexercise phase predicts a worse long-term prognosis than ectopy that occurs only during exercise
B. Patients who develop QT interval prolongation during exercise testing are good candidates for class IA antiarrhythmic drugs
C. The appearance of sustained supraventricular tachycardia during exercise testing is diagnostic of underlying myocardial ischemia
D. Exercise-induced left bundle branch block is not predictive of subsequent cardiac morbidity and mortality
E. Tachyarrhythmias are commonly precipitated during exercise testing in patients with Wolff-Parkinson-White syndrome

**QUESTION 78**
Which of the following statements regarding extra systolic sounds is FALSE?
A. Ejection sounds are high-frequency “clicks” that occur early in systole
B. Ejection sounds due to a dilated aortic root have a similar timing as those associated with aortic valvular disease
C. The ejection sound associated with pulmonic stenosis decreases in intensity during inspiration
D. Aortic ejection sounds vary with respiration, occurring later in systole during inspiration
E. The bedside maneuver of standing from a squatting position causes the click of mitral valve prolapse to occur earlier in systole

**QUESTION 79**
Which of the following statements regarding the ECG in chronic obstructive lung disease with secondary right ventricular hypertrophy is correct?
A. The mean QRS axis is typically <15 degrees
B. The amplitude of the QRS complex is abnormally high in the precordial leads
C. Even mild right ventricular hypertrophy produces diagnostic electrocardiographic abnormalities
D. A deep S wave in V6 is typical
E. Precordial lead transition is typically rotated in a counterclockwise fashion (early transition)

**QUESTION 80**
Which of the following statements regarding shunt detection is TRUE?
A. When an “anatomic” shunt is present, arterial oxygen saturation normalizes with administration of 100% oxygen
B. Methods of shunt detection include oximetry, echocardiography, and magnetic resonance imaging, but not radionuclide imaging
C. Among the sources of right atrial venous blood, the inferior vena cava (IVC) has the lowest oxygen saturation
D. Due to the low sensitivity of oximetry for shunt detection, most clinically relevant left-to-right shunts cannot be detected using this method
E. The Flamm formula is used to estimate mixed venous oxygen content proximal to a left-to-right shunt at the right atrial level

**QUESTION 81**
Which of the following conditions is NOT often associated with a prominent R wave in electrocardiographic lead V1?
A. Right ventricular hypertrophy
B. Wolff-Parkinson-White syndrome
C. Duchenne muscular dystrophy
D. Left anterior fascicular block
E. Misplacement of the chest leads

**QUESTION 82**
The hemodynamic tracing illustrated in Fig. 1.18 is associated with which of the following features?
A. Advanced valvular aortic stenosis
B. Abid aortic pulse contour
C. Normal left ventricular end-diastolic pressure
D. A delayed rise in the carotid artery pulsation
E. Expected clinical improvement with transcatheter aortic valve replacement

**QUESTION 83**
Which of the following statements regarding axis positions of the heart and findings on the ECG is FALSE?
A. A "horizontal" heart results in a tall R wave in lead aVL
B. "Clockwise rotation" refers to a delayed transition zone in the precordial leads
C. In patients with a “vertical” heart, the QRS complex is isoelectric in lead I
D. “Counterclockwise rotation” mimics left ventricular hypertrophy
E. When all six limb leads show isoelectric complexes, it is not possible to calculate the axis in the frontal plane

**QUESTION 84**
Which of the following statements concerning the cardiac catheterization evaluation of valve orifice areas is TRUE?
A. Valve area as calculated by the Gorlin formula is inversely proportional to the flow across the valve
B. Accompanying valvular regurgitation will result in a falsely high calculated valve area because actual flow across the valve is less than the flow calculated from the systemic cardiac output

**FIG. 1.18**
C. Calculation of mitral valve area typically relies on substitution of a confirmed pulmonary capillary wedge pressure for left atrial pressure.
D. Valve area calculation is more strongly influenced by errors in the pressure gradient measurement than by errors in cardiac output measurement.

**QUESTION 85**

A 56-year-old man who underwent coronary artery bypass graft surgery 6 years ago has experienced exertional chest discomfort in recent months. He is not able to perform an exercise test because of chronic hip pain. He undergoes an adenosine positron emission tomography (PET) vasodilator stress test, images from which are shown in Fig. 1.19. What is the correct interpretation of this study?

A. No perfusion defects
B. A partially reversible defect of the entire inferior wall
C. A severe predominantly reversible defect of the anterior wall
D. A fixed defect of the anterior wall without reversibility
E. Fixed defects of the apex and lateral walls
QUESTION 86

A 40-year-old man presents to his physician with shortness of breath on exertion, peripheral edema, and arthritis of his hands. On examination, his vital signs are normal. His sclerae are icteric and his skin has a bronzed hue. Lung examination demonstrates rales at the bases; the carotids are of normal upstroke. The cardiac impulse is displaced laterally and there is an audible S3. His abdomen is distended, with evidence of hepatosplenomegaly and ascites. There is peripheral pitting edema. Laboratory studies reveal a serum glucose level of 225 mg/dL and a transferrin saturation of 70%. Which of the following statements about this condition is TRUE?

A. It is inherited as an autosomal dominant condition
B. Cardiac involvement results in a mixed dilated and restrictive cardiomyopathy
C. Early cardiac death is common, due primarily to accelerated atherosclerosis
D. Ventricular hypertrophy with increased QRS voltages is the most common electrocardiographic finding
E. Echocardiography often shows a thickened ventricle with a "granular sparkling" appearance

QUESTION 87

A 56-year-old woman presents for routine evaluation. On examination, a systolic murmur is noted. Which of the following responses to maneuvers would be suggestive of mitral valve prolapse as the cause of the murmur?

A. With isometric handgrip, the murmur starts earlier in systole and becomes louder
B. With standing from a supine position, the murmur begins later in systole
C. Carotid sinus massage increases the intensity of the murmur
D. Valsalva maneuver causes the murmur to arise earlier in systole
E. Squatting from a standing position moves the onset of the murmur earlier in systole

QUESTION 88

Which of the following statements regarding the effect of the potassium concentration on the ECG is TRUE?

A. The earliest electrocardiographic sign of hyperkalemia is a reduction in P wave amplitude
B. Deep symmetric T wave inversions are characteristic of early hyperkalemia
C. Hyperkalemia predisposes to digitalis-induced tachyarrhythmias
D. Prominent U waves are a characteristic feature of hyperkalemia
E. QRS complex widening is common in severe hyperkalemia

QUESTION 89

Which of the following conditions does NOT result in significant electrocardiographic Q waves in the absence of infarction?

A. Left bundle branch block
B. Left ventricular dilatation with posterior rotation of the heart
C. Electrocardiographic lead misplacement
D. Acidosis
E. Wolff-Parkinson-White syndrome

QUESTION 90

Which of the following statements regarding the interpretation of exercise electrocardiography is TRUE?

A. The presence of right bundle branch block does not alter the sensitivity of exercise electrocardiography for the diagnosis of myocardial ischemia
B. ST-segment depressions in the inferior leads during exercise testing are specific for significant right coronary artery disease
C. The location of ST-segment elevations during exercise testing predicts the anatomic site of clinically advanced coronary stenosis
D. Digoxin therapy is not associated with false-positive findings on exercise electrocardiography if the baseline ST segments are normal

QUESTION 91

A patient underwent echocardiography as part of the evaluation of exertional dyspnea. Fig. 1.20 displays an image from the continuous-wave Doppler interrogation across the mitral valve, obtained from the apical long-axis view. Each of the statements below is true EXCEPT

A. The early diastolic peak velocity of 2.7 m/s is within the normal range
B. There is an abnormally delayed decline of the transmitral velocity signal during diastole
C. Significant mitral stenosis is present
D. Abnormal transmitral systolic blood flow is demonstrated
E. With color Doppler imaging, the extent of mitral regurgitation can be underestimated if the regurgitant jet is directed along the left atrial wall

QUESTION 92

Which of the following statements regarding commonly used quality improvement strategies is correct?

A. Iterative PDSA (Plan-Do-Study-Act) cycles are most successful when goals are subjective, allowing the quality improvement team to think creatively without being constrained by a discrete goal
B. The Lean approach focuses on high level concepts, avoiding getting bogged down in the details of a process  
C. The Lean approach focuses on reducing unnecessary variation in a process  
D. Six Sigma is an iterative process of Define, Measure, Analyze, Improve, and Control

**QUESTION 93**  
A 25-year-old man died suddenly while jogging, and a postmortem examination was performed. A histologic section of left ventricular myocardium is shown in Fig. 1.21. Which of the following statements is TRUE?  
A. The histologic findings are of normal myocardium subjected to chronic vigorous exercise  
B. This condition is inherited as an autosomal dominant trait  
C. This is a disease of plasma membrane protein synthesis  
D. The greatest risk to affected patients is the development of complete heart block  
E. One specific mutation has been identified that accurately predicts sudden cardiac death in the majority of patients with this disorder

**QUESTION 94**  
A 28-year-old woman presents for evaluation after a syncopal episode. Her family history is notable for sudden death in an older sibling. Physical examination reveals woolly hair and palmar keratosis. Electrocardiography demonstrates T wave inversions in leads V₁–V₃. An ambulatory (Holter) electrocardiographic monitor captures runs of ventricular tachycardia with a left bundle morphology and superior axis. A signal-averaged ECG demonstrates late potentials. Echocardiography demonstrates a mildly dilated right ventricle with reduced systolic function; the left ventricle appears structurally normal. Which of the following statements is TRUE about this condition?  
A. The majority of patients with this disorder have an abnormality of the ryanodine receptor  
B. Endomyocardial biopsy establishes the diagnosis with high sensitivity  
C. This patient likely has a mutation in the plakoglobin gene  
D. This condition is transmitted in an autosomal dominant fashion  
E. Noncaseating granulomas are likely present in the right ventricular myocardium

**QUESTION 95**  
A 72-year-old man with multiple myeloma presents with progressive exertional dyspnea, orthopnea, and peripheral edema. On examination the blood pressure is 118/62 mm Hg without pulsus paradoxus, but there is a 25 mm Hg systolic pressure postural decline. The jugular venous pressure is 12 cm, and there is periorbital purpura, macroglossia, hepatomegaly, and prominent symmetric pitting edema to the level of the mid-thighs. His electrocardiogram is remarkable for very low limb lead voltage. Which of the following echocardiographic findings is expected?  
A. Increased right ventricular wall thickness with normal left ventricular thickness  
B. Abnormal regional longitudinal strain on speckle tracking that spares the apex  
C. Reversal of normal tissue Doppler mitral annular E’ velocity ratio (medial > lateral)  
D. Very large pericardial effusion

**Directions:**  
Each group of questions below consists of lettered headings followed by a set of numbered questions. For each question, select the ONE lettered heading with which it is most closely associated. Each lettered heading may be used once, more than once, or not at all.

**QUESTIONS 96 TO 100**  
Match each of the following clinical scenarios to the most likely cause of syncope:  
A. Ventricular tachycardia  
B. High-degree atrioventricular block  
C. Epilepsy  
D. Neurocardiogenic syncope  
E. Hysterical fainting

96. A 73-year-old man with a remote history of myocardial infarction feels the onset of palpitations while driving, then awakens having driven his car into a ditch, unaware of what has transpired  
97. A 25-year-old woman on chronic antiseizure medication becomes warm, diaphoretic, and very pale after donating blood, then suffers frank syncope while seated upright in a chair. After being helped to the floor, she awakens embarrassed and alert
98. A 73-year-old woman with recent episodes of dizziness begins to feel lightheaded while seated at church, then within seconds turns pale and slumps to the floor with a few clonic jerks. She regains consciousness 1 minute later, completely aware of where she is and asks what has happened. When an ambulance arrives, her blood pressure is 108/70 mm Hg and the heart rate is 60 beats/min.

99. A 32-year-old man with a history of prior syncope notices an odd odor, after which he falls to the ground. He awakens 3 minutes later, confused and disoriented, and is found to be incontinent of urine.

100. An 18-year-old Army recruit falls to the ground while standing at attention for 20 minutes during his first week of basic training. He immediately awakens, feels a bit groggy, but quickly is able to rejoin his squad.

QUESTIONS 101 TO 104

For each clinical scenario, select the most likely ECG from the four tracings shown in Fig. 1.22:

101. A 19-year-old male college student with exertional lightheadedness and a harsh systolic murmur that intensifies after standing from a squatting position.

102. A 56-year-old woman with sudden onset of pleuritic chest discomfort and dyspnea.

103. A 36-year-old man with sharp inspiratory precordial chest discomfort that radiates to the left shoulder.

104. A 71-year-old alcoholic man with epigastric discomfort after 18 hours of intermittent vomiting.
FIG. 1.22
QUESTIONS 105 TO 109

Match the most appropriate descriptive phrase to each angiogram shown in Fig. 1.23:

105. Right anterior oblique (RAO) projection: left anterior descending (LAD) artery, demonstrating myocardial bridging with narrowing in systole and near-normal caliber in diastole

106. Left anterior oblique (LAO) projection: right coronary arteriogram demonstrating anomalous origin of the left circumflex artery from the right coronary sinus

107. Collateral vessels arising from the distal right coronary artery (RCA) and supplying an occluded LAD artery

108. Right coronary arteriogram demonstrating diffuse coronary spasm and restoration of normal caliber with introduction of nitroglycerin

109. A dilated left circumflex artery and subsequent coronary sinus opacification due to a congenital coronary fistula

FIG. 1.23
FIG. 1.23, cont’d
QUESTIONS 110 TO 113

For each clinical scenario, match the most likely computed tomogram in Fig. 1.24:

110. A 53-year-old woman with exertional dyspnea, recurrent transient ischemic attacks, lightheadedness with sudden changes in position, and a 15-pound weight loss over the past 6 months
111. A 21-year-old man with recurrent syncope
112. A 69-year-old woman with recent myocardial infarction and subsequent stroke
113. A 71-year-old man with jugular venous distention, ascites, and marked peripheral edema

A. E wave > A wave, LV deceleration time >190 milliseconds
B. E wave > A wave, LV deceleration time <190 milliseconds
C. E wave < A wave, LV deceleration time >200 milliseconds
D. E wave >> A wave, LV deceleration time <150 milliseconds

114. Restrictive cardiomyopathy
115. Normal pattern
116. Pseudonormalized pattern
117. Impaired LV diastolic relaxation

QUESTIONS 118 TO 121

For each of the chest radiographs shown in Fig. 1.25, match the most appropriate cardiac diagnosis:

118. Mitral stenosis
119. Aortic regurgitation
120. Atrial septal defect
121. Pericardial effusion

QUESTIONS 122 TO 125

Match each description below to the most appropriate cardiac rhythm:

A. E wave > A wave, LV deceleration time >190 milliseconds
B. E wave > A wave, LV deceleration time <190 milliseconds
C. E wave < A wave, LV deceleration time >200 milliseconds
D. E wave >> A wave, LV deceleration time <150 milliseconds

FIG. 1.24

A. Atrial tachycardia
B. Atrial flutter
C. Sinus rhythm
D. Atrioventricular nodal reentrant tachycardia
E. Atrial fibrillation

122. P waves are negative in lead aVR and upright in leads I, II, and aVF
123. Rhythm can be due to automaticity, reentry, or triggered mechanisms
124. Macroreentrant mechanism in the right atrium
125. The initial P wave of the tachycardia is usually different from the subsequent P waves

Questions 126 to 129

For the receiver-operating curve (ROC) for two diagnostic tests shown in Fig. 1.26, match the following:

![Receiver-Operating Curve](image)
QUESTIONS: CHAPTERS 1 TO 20

A. 11%
B. 40%
C. 59%
D. 47%
E. Test A
F. Test B

126. The false-positive rate of Test A at a sensitivity of 98%
127. The sensitivity of Test A at a specificity of 98%
128. The positive predictive value of Test A with a sensitivity of 98%, for a population with disease prevalence of 50/1000
129. The superior screening test

QUESTIONS 130 TO 133

For each clinical scenario, select the appropriate ECG from those provided in Fig. 1.27:

130. A 49-year-old man with chronic renal failure and progressive fatigue
131. A 37-year-old man with a recent viral syndrome and sharp anterior chest pain that worsens when he changes position
132. A 59-year-old man with severe lightheadedness
133. A 38-year-old woman with perioral and peripheral cyanosis, digital clubbing, and a history of cardiac surgery as a child
FIG. 1.27, cont'd
Echocardiograms (Questions 134–142)

Directions:
Each of the still-frame echocardiographic images below is introduced by a brief clinical scenario. For each image, comment on the major abnormal findings:

134. A 62-year-old man who sustained a myocardial infarction 1 month ago (Fig. 1.28)

135. A 33-year-old woman with an early systolic click (Fig. 1.29)

136. A 26-year-old man with a loud asymptomatic systolic murmur (Fig. 1.30)

137. A tall, thin 31-year-old woman with a diastolic murmur (Fig. 1.31)
138. A 59-year-old woman with a systolic murmur (Fig. 1.32)

139. Doppler tissue imaging in a 54-year-old man with multiple myeloma, exertional dyspnea, and peripheral edema (Fig. 1.33)
140. A 44-year-old woman with an acute stroke (Fig. 1.34)

141. A 78-year-old woman with atrial fibrillation (Fig. 1.35)

142. A 66-year-old man with dyspnea (Fig. 1.36)
ELECTROCARDIOGRAMS

Electrocardiogram Response Form (For Use With Questions 143–167)

General Features
- 1. Normal ECG
- 2. Normal variant
- 3. Incorrect electrode placement
- 4. Artifact

P Wave Abnormalities
- 5. Right atrial abnormality/enlargement
- 6. Left atrial abnormality/enlargement

Atrial Rhythms
- 7. Sinus rhythm
- 8. Sinus arrhythmia
- 9. Sinus bradycardia (<60)
- 10. Sinus tachycardia (>100)
- 11. Sinus pause or arrest
- 12. Sinoatrial exit block
- 13. Atrial premature complexes
- 14. Atrial parasystole
- 15. Atrial tachycardia
- 16. Atrial tachycardia, multifocal
- 17. Supraventricular tachycardia
- 18. Atrial flutter
- 19. Atrial fibrillation

AV Junctional Rhythms
- 20. AV junctional escape complexes
- 21. AV junctional rhythm/tachycardia

Ventricular Rhythms
- 22. Ventricular premature complex(es)
- 23. Ventricular parasystole
- 24. Ventricular tachycardia (3 or more consecutive complexes)
- 25. Accelerated idioventricular rhythm
- 26. Ventricular escape complexes or rhythm
- 27. Ventricular fibrillation

AV Conduction
- 29. AV block, 1°
- 30. AV block, 2°—Mobitz type I (Wenckebach)
- 31. AV block, 2°—Mobitz type II
- 32. AV block, 2:1
- 33. AV block, 3°
- 34. Wolff-Parkinson-White pattern
- 35. AV dissociation

Abnormalities of QRS Voltage or Axis
- 36. Low voltage
- 37. Left axis deviation (>−30 degrees)
- 38. Right axis deviation (>+100 degrees)
- 39. Electrical alternans

Ventricular Hypertrophy
- 40. Left ventricular hypertrophy
- 41. Right ventricular hypertrophy
- 42. Combined ventricular hypertrophy

Intraventricular Conduction
- 43. Right bundle branch block (RBBB), complete
- 44. RBBB, incomplete
- 45. Left anterior fascicular block
- 46. Left posterior fascicular block
- 47. Left bundle branch block (LBBB), complete
- 48. LBBB, incomplete
- 49. Intraventricular conduction disturbance, nonspecific type
- 50. Functional (rate-related) aberrancy

ST, T, U Wave Abnormalities
- 61. Normal variant, early repolarization
- 62. Normal variant, juvenile T waves
- 63. Nonspecific ST and/or T wave abnormalities
- 64. ST and/or T wave abnormalities suggesting myocardial ischemia
- 65. ST and/or T wave abnormalities suggesting myocardial injury
- 66. ST and/or T wave abnormalities suggesting electrolyte disturbances
- 67. ST and/or T wave abnormalities secondary to hypothyroidism
- 68. Prolonged QT interval
- 69. Prominent U waves

Clinical Disorders
- 70. Brugada syndrome
- 71. Digitalis toxicity
- 72. Torsades de pointes
- 73. Hyperkalemia
- 74. Hypokalemia
- 75. Hypercalcemia
- 76. Hypocalcemia
- 77. Dextrocardia, mirror image
- 78. Chronic lung disease
- 79. Acute cor pulmonale including pulmonary embolus
- 80. Pericardial effusion
- 81. Acute pericarditis
- 82. Hypertrophic cardiomyopathy
- 83. Central nervous system disorder
- 84. Hypothermia

Pacemaker Function
- 85. Atrial or coronary sinus pacing
- 86. Ventricular demand pacemaker (VVI), normally functioning
- 87. Dual-chamber pacemaker (DDD), normally functioning
- 88. Pacemaker malfunction, not constantly capturing (atrium or ventricle)
- 89. Pacemaker malfunction, not constantly sensing (atrium or ventricle)
- 90. Biventricular pacing or cardiac resynchronization therapy

Q Wave Myocardial Infarction

<table>
<thead>
<tr>
<th>AGE RECENT, OR PROBABLY ACUTE</th>
<th>AGE INDETERMINATE, OR PROBABLY OLD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterolateral</td>
<td>51</td>
</tr>
<tr>
<td>Anterior or anteroseptal</td>
<td>53</td>
</tr>
<tr>
<td>Lateral</td>
<td>55</td>
</tr>
<tr>
<td>Inferior</td>
<td>57</td>
</tr>
<tr>
<td>Posterior</td>
<td>59</td>
</tr>
</tbody>
</table>
Directions:
Each of the 12-lead ECGs below is introduced by a brief clinical description of the patient. For each ECG, perform a systematic reading. Consider the rhythm, rate, axis, and intervals and whether atrioventricular conduction disturbances are present. Then determine if criteria are met for atrial or ventricular hypertrophy, intraventricular conduction disturbances, or prior myocardial infarction. Continue by noting abnormalities of the ST segment and T waves. Conclude by suggesting a clinical diagnosis compatible with each tracing. You may use the electrocardiographic response form (p. 33) and its numerical codes, representative of that used by the American Board of Internal Medicine Cardiovascular Disease Certification Examination, as a framework.

143. A 70-year-old woman presents to the emergency department with severe chest pain and dyspnea (Fig. 1.37)

144. A 66-year-old man with a history of cigarette smoking, who has not received medical care for many years, presents to his new primary care physician for a routine examination (Fig. 1.38)
145. A 28-year-old man with a lifelong heart murmur (Fig. 1.39)

146. An 85-year-old woman who comes for a routine appointment with her cardiologist (Fig. 1.40)
147. A 47-year-old man with episodes of syncope (Fig. 1.41)

148. A 63-year-old man with a rapid heart rate (Fig. 1.42)

149. A 78-year-old woman with a history of a heart murmur presents with intermittent dyspnea and lightheadedness (Fig. 1.43)
150. A 21-year-old woman with palpitations and presyncope (Fig. 1.44)

151. A 48-year-old woman with nausea (Fig. 1.45)
152. A 61-year-old man admitted with frequent dizziness (Fig. 1.46)

153. A 65-year-old man who underwent coronary artery bypass graft surgery 24 hours ago (Fig. 1.47)

154. A 74-year-old man with an irregular pulse (Fig. 1.48)
155. A 28-year-old man presents for a pre-employment physical examination (Fig. 1.49)

156. A 66-year-old woman with renal failure, palpitations, and lightheadedness (Fig. 1.50)

157. A 63-year-old man admitted for elective orthopedic surgery (Fig. 1.51)
158. A 54-year-old man with sudden lightheadedness (Fig. 1.52)

159. A 64-year-old woman with profound nausea and diaphoresis (Fig. 1.53)
160. A 55-year-old man with long-standing hypertension (Fig. 1.54)

161. An asymptomatic 36-year-old man presents for an insurance physical examination (Fig. 1.55)
162. A 23-year-old woman referred to the cardiology clinic because of a murmur and abnormal ECG (Fig. 1.56)

163. A 51-year-old woman with discrete episodes of presyncope (Fig. 1.57)
164. A 72-year-old man with palpitations after coronary artery bypass surgery *(Fig. 1.58)*

![ECG Image](image1)

**FIG. 1.58**

165. A 78-year-old man with a long history of cigarette smoking and paroxysmal atrial fibrillation *(Fig. 1.59)*

![ECG Image](image2)

**FIG. 1.59**
166. A 69-year-old man with a history of dilated cardiomyopathy (Fig. 1.60)

![ECG tracing for a 69-year-old man with dilated cardiomyopathy](image1.png)

167. An elderly nursing home resident with fatigue (Fig. 1.61)

![ECG tracing for an elderly nursing home resident with fatigue](image2.png)