

Chapter 2

Practice Test #1: Difficulty Level—Easy

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Questions

1. The first-pass myocardial extraction fraction of Tl-201 is in the range of:
 - A. 95 %
 - B. 85 %
 - C. 75 %
 - D. 65 %
2. Tl-201 myocardial imaging, when compared with Tc-99 m-based tracers:
 - A. Creates less soft tissue attenuation
 - B. Produces improved image quality
 - C. Produces improved image contrast
 - D. Creates less liver and gut activity
3. On the SPECT 17-segment model, myocardial perfusion is graded within each segment on a scale of:
 - A. 0–4
 - B. 0–8
 - C. 1–4
 - D. 1–8

Answers to Test #1 begin on page 44

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4. The physical half-life of O-15 is:
 - A. 63 s
 - B. 124 s
 - C. 248 s
 - D. 496 s

5. An immune inflammatory process, which over decades, results in the heart's arterial narrowing, is called:
 - A. Arrhythmia
 - B. Coronary artery disease
 - C. Myocardial infarction
 - D. Unstable angina

6. Substantial tracer uptake observed throughout the lung fields after stress, that is not present at rest, indicates a diagnosis of:
 - A. Bronchial asthma
 - B. Cardiac arrhythmia
 - C. Lung carcinoma
 - D. Severe ischemia

7. An indirect coronary vasodilator that works by increasing intravascular adenosine levels is called:
 - A. Adenosine
 - B. Dipyridamole
 - C. Dobutamine
 - D. Regadenoson

8. A photoelectric method allowing the monitoring of the degree of oxygen saturation of the blood hemoglobin is called:
 - A. Absorptiometry
 - B. Oximetry
 - C. Spectrophotometry
 - D. Sphygmomanometry

9. Which of the following tracers has ~50 % myocardial clearance at 6 h?
 - A. Tc-99m sestamibi
 - B. Tc-99m teboroxime
 - C. Tc-99m tetrofosmin
 - D. Thallium-201

10. The maximum heart rate (HR) can be estimated utilizing the following formula:
 - A. $HR = 220 + \text{age (in years)}$
 - B. $HR = 220 - \text{age (in years)}$
 - C. $HR = (220 + \text{age in years}) \times 0.85$
 - D. $HR = (220 - \text{age in years}) \times 0.85$

11. The sum of segmental scores from the rest images (the summed rest score, SRS) represents the extent of:
 - A. Hibernation
 - B. Ischemia
 - C. Infarction
 - D. Viability

12. The nuclear cardiology procedure during which a dynamic bolus of radioactivity is imaged as it quickly transits through different chambers of the heart and lungs is called:
 - A. Equilibrium gated radionuclide angiography
 - B. First-pass radionuclide angiography
 - C. Gated single photon emission computed tomography
 - D. Infarct avid imaging study

13. Which of the following approaches has NOT been effective in reducing the impact of breast tissue attenuation on the specificity of myocardial perfusion?
 - A. Reviewing of the cine display
 - B. Performing delay imaging
 - C. The use of Tc-99 m-based agents with SPECT imaging
 - D. The use of electrocardiography (ECG) gating

14. During PET acquisition the emitted positron travels in the tissues until it collides with a/an:
 - A. Electron
 - B. Neutron
 - C. Positron
 - D. Proton

15. The Coronary flow reserve (CFR) is defined as the ratio of:
 - A. Stress-to-rest perfusion
 - B. Rest-to-delay rest perfusion
 - C. Stress-to-delay stress perfusion
 - D. Rest-to-stress perfusion

16. In healthy patients, the following hemodynamic changes are observed during exercise EXCEPT:
 - A. Total calculated peripheral resistance decreases
 - B. Oxygen extraction increases
 - C. Diastolic blood pressure decreases
 - D. Skeletal muscle blood flow is increased

17. Which of the following SPECT filters has NO selectable parameters?
 - A. The Butterworth filter
 - B. The ramp filter
 - C. The Parzen filter
 - D. The Hanning filter

18. The ECG silver chloride electrodes are covered with a fluid column in order to:
 - A. Avoid direct metal to skin contact
 - B. Prevent skin infection
 - C. Reduce skin resistance
 - D. Remove skin oil

19. The MPI artifacts described as falsely “hotter” or falsely “cold” cardiac regions are caused by:
 - A. Patient motion
 - B. Gating error
 - C. Extracardiac activity
 - D. Breast attenuation

20. The metabolic equivalent task (MET)—a unit of oxygen uptake in a sitting, resting person is corresponding to:
 - A. 3.5 ml O₂/kg/h of body weight
 - B. 3.5 ml O₂/kg/min of body weight
 - C. 7.0 ml O₂/kg/h of body weight
 - D. 7.0 ml O₂/kg/min of body weight

21. Thallium clearance from normal myocardium with high thallium activity, when compared with clearance from ischemic myocardium, is:
 - A. Dose dependent
 - B. Faster
 - C. Slower
 - D. The same

22. In patients undergoing pharmacologic stress test with adenosine, adjunctive low-level exercise is effective in:
 - A. Lowering patient radiation exposure
 - B. Improving imaging characteristics
 - C. Reducing personnel radiation exposure
 - D. Lessening motion artifacts

23. The extent and severity of stress-induced ischemia is represented by:
- A. The summed rest score (SRS)
 - B. The summed stress score (SSS)
 - C. The summed difference score (SDS)
 - D. All of the above
24. Which of the following PET techniques are employed to assess myocardial viability?
- A. N-13 ammonia as a metabolic marker of glucose use and FDG as a perfusion tracer
 - B. N-13 ammonia and FDG as perfusion tracers
 - C. N-13 ammonia and FDG as metabolic marker of glucose use
 - D. N-13 ammonia as a perfusion tracer and FDG as a metabolic marker of glucose use
25. The substance deposited in the walls of the coronary arteries that is made up of a complex mixture of fats, including cholesterol and cell debris is called:
- A. Atheroma
 - B. Calcium
 - C. Cholesterol
 - D. Lipoma
26. In a typical gated SPECT acquisition, the frame in the middle of the cardiac cycle represents the event called:
- A. End-diastolic
 - B. End-systolic
 - C. Mid-diastolic
 - D. Mid-systolic
27. A 58-year-old woman presents to her primary care physician with complaints of atypical chest pain over last few days. She currently is asymptomatic and has no significant past medical, family, or social history. The electrocardiogram (Fig. 2.1) shows:
- A. Atrial fibrillation
 - B. Electronic ventricular pacemaker
 - C. Normal sinus rhythm
 - D. Ventricular bigeminy

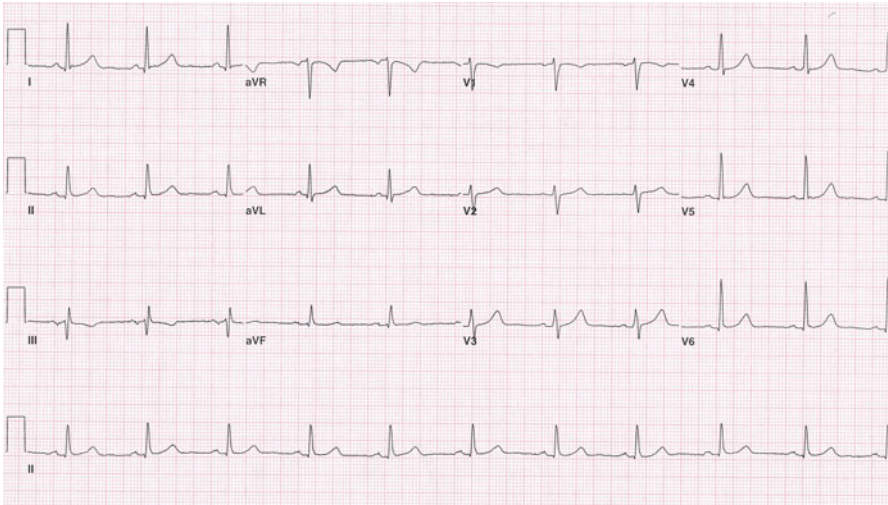


Fig. 2.1 Electrocardiogram

28. Optimizing selection of patients with heart failure whose symptoms and natural history may improve after revascularization is the goal of performing:
- Coronary angiography
 - Stress echocardiography
 - Stress MPI study
 - Viability study
29. All of the following statements correctly describe findings from a direct comparison of SPECT MPI with PET MPI EXCEPT:
- PET has shown significantly improved normalcy rate
 - PET has shown significantly improved sensitivity
 - SPECT has shown a superior diagnostic performance when subanalyzed for gender
 - SPECT ability to identify multivessel ischemia was significantly lower
30. The exercise stress test should be stopped if:
- There are technical difficulties in monitoring systolic blood pressure
 - 1 mm of ST depression is present
 - Arterial blood pressure is 200/110
 - Systolic blood pressure drops by 15 mmHg

31. The counts distribution of all short-axis slices displayed in concentric rings is called:
- A. A bull's eye
 - B. A counts profile
 - C. A planogram
 - D. A sinogram
32. During equilibrium gated radionuclide angiography (ERNA), images are acquired after the administered radioactivity has equilibrated in the:
- A. Endocardium
 - B. Lymphatic space
 - C. Myocardium
 - D. Vascular space
33. The term incremental value of SPECT MPI implies that perfusion imaging data provide information on the natural history, risk, and outcomes that are:
- A. Additive to information from more available or less expensive tests
 - B. More valuable than information from more available or less expensive tests
 - C. Contradictive to information from more available or less expensive tests
 - D. Less valuable than information from more available or less expensive tests
34. A strontium Sr-82 generator can be used for up to:
- A. 1 week
 - B. 1 month
 - C. 6 months
 - D. 1 year
35. Peak exercise in normal individuals produces an increase in myocardial oxygen demand and increase in myocardial blood flow:
- A. A twofold
 - B. A twofold to threefold
 - C. A threefold to fourfold
 - D. A fourfold to fivefold
36. Which of the following exercise protocols is most frequently used to assess cardiovascular reserve?
- A. Dynamic exercise
 - B. Isometric exercise
 - C. Resistive exercise
 - D. Static exercise

37. Patients scheduled for a pharmacological stress test with Lexiscan should be instructed to avoid consumption of any products containing methylxanthines for at least:
- A. 3 h
 - B. 6 h
 - C. 12 h
 - D. 24 h
38. The proportion of tracer removed from the blood as it passes through the myocardium is called:
- A. First-pass extraction fraction
 - B. Ejection fraction
 - C. Coronary flow reserve
 - D. Myocardial blood flow
39. Gated single photon emission computed tomography (GSPECT) is not suitable for accurate right ventricular function measurement because the RV:
- A. Is not visualized
 - B. Is not adequately visualized
 - C. Is attenuated by the liver
 - D. Is attenuated by the spleen
40. The room temperature of the treadmill stress testing area should be between:
- A. 55° and 63° F
 - B. 64° and 72° F
 - C. 73° and 80° F
 - D. 80° and 85° F
41. Thallium washes out of the myocardium at a rate dependent on:
- A. Injected dose
 - B. Local myocardial perfusion
 - C. Local ejection fraction
 - D. Blood pressure
42. During a typical stress Tc-99m tetrofosmin study, imaging begins:
- A. 5 min after the exercise stress injection and 10–15 min after the pharmacological stress injection
 - B. 5 min after the exercise stress injection and 20–30 min after the pharmacological stress injection
 - C. 10 min after the exercise stress injection and 20–30 min after the pharmacological stress injection
 - D. 10 min after the exercise stress injection and 30–45 min after the pharmacological stress injection

43. All of the following approaches have been used in high-speed SPECT technology EXCEPT:
- A. Novel image reconstruction algorithm
 - B. Slip ring technology
 - C. Solid-state detector columns with cadmium zinc telluride
 - D. Wide-angle tungsten collimators
44. Which of the following protocols stimulating maximal F-18 FDG uptake is based on the simultaneous infusion of insulin and glucose?
- A. Euglycemic hypoinsulinemic clamp protocol
 - B. Euglycemic hyperinsulinemic clamp protocol
 - C. Hypoglycemic hyperinsulinemic clamp protocol
 - D. Hypoglycemic hypoinsulinemic clamp protocol
45. Viable myocardial tissue is NOT present in:
- A. Infarcted myocardium
 - B. Ischemic myocardium
 - C. Stunned myocardium
 - D. Hibernating myocardium
46. Visual comparison of MPI stress and rest displays revealing a perfusion defect that is seen on stress but not on rest images describes:
- A. Normal myocardium
 - B. Ischemic myocardium
 - C. Scarred myocardium
 - D. Stunned myocardium
47. Lexiscan (regadenoson) is contraindicated in patients with:
- A. Asthma
 - B. Hypovolemia
 - C. Pericarditis
 - D. Sinus node dysfunction
48. The areas of ECG electrode application are rubbed with an alcohol-saturated pad to remove from the skin:
- A. Bacteria
 - B. Hair
 - C. Oil
 - D. Sweat
49. Tl-201 emits 80 keV of photon energy and has a physical half-life of:
- A. 53 h
 - B. 63 h
 - C. 73 h
 - D. 83 h

50. The Bruce protocol begins with:
- A treadmill speed of 1.7 mph and a grade of 0°
 - A treadmill speed of 1.7 mph and a grade of 10°
 - A treadmill speed of 3.4 mph and a grade of 0°
 - A treadmill speed of 3.4 mph and a grade of 10°
51. TI-201 compared with the ^{99m}Tc -based agents:
- Offers improved performance in patients with large breasts
 - Offers improved performance in obese patients
 - Delivers a higher radiation dose
 - Allows the option of higher quality gated images
52. During a GSPECT acquisition, one cardiac cycle is represented by the:
- P–Q interval
 - P–R interval
 - R–R interval
 - R–T interval
53. All of the following are examples of MPI automated quantitative analysis systems incorporated into SPECT camera-computer equipment EXCEPT:
- Cedars QPS
 - 4D-MSPECT
 - McKesson Practice Choice Software
 - Emory Toolbox
54. Which of the following are the physical characteristics of the positron emitted by Rb-82?
- Energy of 511 keV and average range of 2.8 mm
 - Energy of 3.15 MeV and average range of 2.8 mm
 - Energy of 3.15 MeV and average range of 0.22 mm
 - Energy of 511 keV and average range of 0.22 mm
55. The typical ejection fraction (EF) of the left ventricle is approximately:
- 100 %
 - 87 %
 - 58 %
 - 29 %
56. During the exercise stress test, the heart rate, blood pressure, and ECG should be recorded (select three):
- At the beginning of each stage of exercise
 - At the onset of an ischemic response
 - Immediately after stopping exercise
 - Every minute in the stage 3
 - In the middle of each stage of exercise
 - The end of each stage of exercise

57. An adenosine injection is contraindicated in individuals with:
- A. Atrial fibrillation
 - B. Bigeminy
 - C. Pacemaker
 - D. Third-degree AV block
58. All of the following diagnostic procedures are available on PET-CT scanners equipped with multislice CT EXCEPT:
- A. Coronary calcium measurement
 - B. Coronary angiography
 - C. Doppler echocardiography
 - D. PET viability study
59. Gated single photon emission computed tomography (GSPECT) acquisition starts with the R wave on the ECG which corresponds to the:
- A. End-diastole
 - B. End-systole
 - C. Mid-diastole
 - D. Mid-systole
60. The number of correct findings on a MPI test, regardless of whether the patient has CAD, describes the diagnostic test:
- A. Accuracy
 - B. Reproducibility
 - C. Sensitivity
 - D. Specificity
61. Which of the following patients are the best candidates for gated SPECT studies?
- A. Patients with atrial fibrillation
 - B. Patients with premature atrial contractions
 - C. Patients with premature ventricular contractions
 - D. Patients with sinus rhythm
62. Which of the following statements correctly describe properties of Tc-99m versus Tl-201 as radionuclide tracers for myocardial imaging?
- A. Tc-99m has a higher emission energy and a longer half-life than Tl-201
 - B. Tc-99m has a higher emission energy and a shorter half-life than Tl-201
 - C. Tc-99m has a lower emission energy and a longer half-life than Tl-201
 - D. Tc-99m has a lower emission energy and a shorter half-life than Tl-201
63. Which of the following factors/conditions can be a reason of a false positive MPI study?
- A. Balanced ischemia
 - B. Suboptimal level of exercise
 - C. Left bundle branch block
 - D. Patient on nitrates

64. The most frequently used clinical myocardial perfusion PET agent is:
- A. F-18 FDG
 - B. Rb-82
 - C. Tc 99 m-sestamibi
 - D. Tl-201
65. Myocardial oxygen consumption (MVO₂) is measured in the units of:
- A. ml O₂/min per kg
 - B. ml O₂/min per 100 g
 - C. ml O₂/h per 100 g
 - D. lO₂/min per 100 g
66. Tl-201, when compared with technetium 99 m-based myocardial imaging:
- A. Creates less soft tissue attenuation
 - B. Produces improved image quality
 - C. Produces improved image contrast
 - D. Creates less liver and gut activity
67. The most common adverse reaction associated with adenosine administration is/are:
- A. Arrhythmias
 - B. Flushing
 - C. Hypotension
 - D. Paresthesias
68. Heparin and warfarin are:
- A. Antibiotics
 - B. Anticoagulants
 - C. Antiemetics
 - D. Antipyretics
69. The major vasodilators used for pharmacologic radionuclide myocardial perfusion imaging (rMPI) are (select three):
- A. Adenosine
 - B. Aggrenox
 - C. Atropine
 - D. Dipyridamole
 - E. Regadenoson
70. Which of the following is absolute contraindication for exercise stress testing?
- A. Acute pulmonary embolism
 - B. Left main coronary artery stenosis
 - C. Physical impairment
 - D. Significant tachyarrhythmias

71. MPI has the greatest diagnostic value for detection of CAD when it is used in patients with:
- A. A very low pretest likelihood of disease
 - B. A low pretest likelihood of disease
 - C. A moderate pretest likelihood of disease
 - D. A high pretest likelihood of disease
72. Tomographic reconstruction theory can be described as:
- A. A 3-dimensional image volume reconstituted from a series of 2-dimensional images
 - B. A 3-dimensional image volume reconstituted from a series of 3-dimensional images
 - C. A 2-dimensional image volume reconstituted from a series of 2-dimensional images
 - D. A 2-dimensional image volume reconstituted from a series of 3-dimensional images
73. Upward creep of the heart observed during SPECT acquisition could be prevented by:
- A. Acquiring gated images
 - B. Adjusting patient stress dose
 - C. Allowing bed rest before SPECT
 - D. Adjusting patient rest dose
74. Beta (+) decay of a nucleus results in emission of a/an:
- A. Electron
 - B. Neutron
 - C. Positron
 - D. Proton
75. Which of the following belongs to the left cardiovascular system (select three)?
- A. The left side of the heart
 - B. The pulmonary arteries
 - C. The pulmonary veins
 - D. The right side of the heart
 - E. The systemic arterial system
 - F. The venous system
76. Medications such as calcium channel blocking drugs and beta-blockers administered on the day of exercise stress MPI may alter:
- A. The heart rate
 - B. The respiration rate
 - C. The body temperature
 - D. The basic metabolic rate

77. Tomographic reconstruction of projection images produces transaxial images which are:
- A. Perpendicular to the long axis of the patient
 - B. Parallel to the long axis of the patient
 - C. Horizontal to the long axis of the left ventricle
 - D. Vertical to the long axis of the left ventricle
78. How many separated channels does a Foley catheter have?
- A. One
 - B. Two
 - C. Three
 - D. Four
79. The LV ejection fraction (LVEF) measured from the GSPECT 8-frame acquisition when compared to the 16-frame acquisition is:
- A. 3 units lower
 - B. 13 units lower
 - C. 3 units higher
 - D. 13 units higher
80. The myocardial blood flow (MBF) in coronary beds without significant stenosis increases ~threefold with:
- A. Exercise
 - B. Dipyridamole
 - C. Dobutamine
 - D. Regadenoson
81. A vertical change in position of the heart that is usually noticed between the last frame of detector 2 and the first frame of detector 1 is called:
- A. Horizontal shift
 - B. Hurricane sign
 - C. Upward creep
 - D. Star artifact
82. A 51-year-old man presents to the emergency department with sudden onset of palpitations and mild lightheadedness. He had experienced briefer episodes over the last 2 months, but this episode persisted for 4 min. The ECG (Fig. 2.2) shows:
- A. Atrial fibrillation
 - B. Electronic ventricular pacemaker
 - C. Normal sinus rhythm
 - D. Ventricular bigeminy

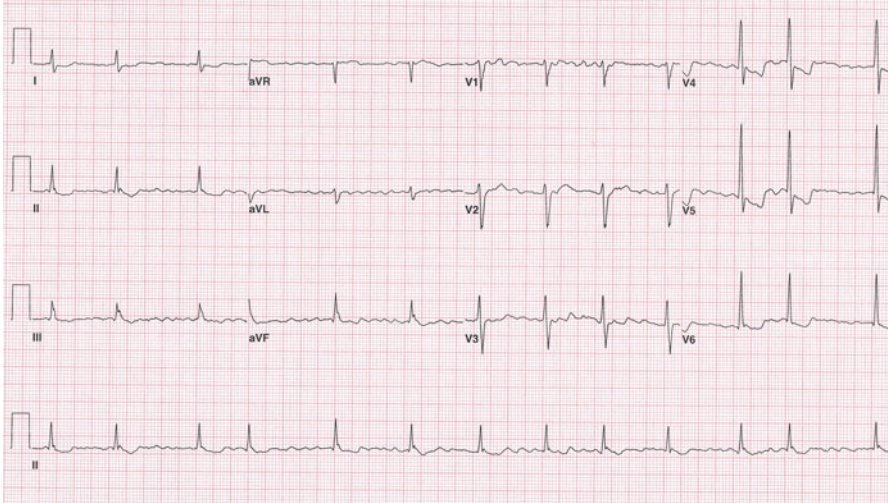


Fig. 2.2 Electrocardiogram

83. Thallium is predominantly cleared by:
- The hepatobiliary system
 - The kidneys
 - The skin
 - The respiratory system
84. Glycolysis is the metabolic pathway converting glucose 6-phosphate to:
- Acetate
 - Fructose
 - Pyruvate
 - Sucrose
85. The percentage of patients without CAD with a negative test result compared with the total number of patients tested without CAD describes the test:
- Specificity
 - Sensitivity
 - Accuracy
 - Reproducibility

86. Activation of adenosine A₂A receptors produces:
- A. Atrioventricular conduction delay
 - B. Bronchospasm
 - C. Coronary vasodilatation
 - D. Tachycardia
87. When performing a pharmacological stress test with Lexiscan, the myocardial perfusion imaging agent should be administered:
- A. 1–5 s before Lexiscan administration
 - B. Immediately after Lexiscan injection
 - C. Immediately after the saline flush
 - D. 10–20 s after the saline flush
88. Which of the following medications are commonly referred to as “blood thinners”?
- A. Antibiotics
 - B. Anticoagulants
 - C. Antiemetics
 - D. Antipyretics
89. The MPI test sensitivity for ischemia is enhanced by getting the patient to perform the exercise portion of the test to a maximal safe level defined as:
- A. The maximal 65 % of age-predicted heart rate is reached
 - B. The maximal 75 % of age-predicted heart rate is reached
 - C. The maximal 85 % of age-predicted heart rate is reached
 - D. The maximal 95 % of age-predicted heart rate is reached
90. According to the ASNC IMAGING GUIDELINES FOR NUCLEAR CARDIOLOGY PROCEDURES, all exercise tests should be limited by:
- A. Patient age
 - B. Achieved double product
 - C. Achieved 85 % of maximum heart rate
 - D. Symptoms
91. In hybrid imaging, an attenuation map represents the degree of photon attenuation and is acquired:
- A. For every patient
 - B. Daily
 - C. Weekly
 - D. For group of patients

92. Chest pain that develops commonly during pharmacologic vasodilator stress testing:
- A. Indicates severe CAD
 - B. Indicates poor prognosis
 - C. Is a nonspecific finding
 - D. Is a marker of vascular reactivity
93. All of the following appropriateness designation for cardiovascular tests are given in the appropriate use criteria (AUC) document EXCEPT:
- A. Appropriate
 - B. Uncertain
 - C. Expensive
 - D. Inappropriate
94. The relative differences in count values between myocardial pixels are displayed in the black and white images as a variation in:
- A. Brightness
 - B. Dimension
 - C. Shape
 - D. Sharpness
95. Uncharacteristic communications between the left and right sides of the heart known as a ventricular septal defect (VSD) initially results in:
- A. Pulmonary hypertension
 - B. A R-L shunt
 - C. A L-R shunt
 - D. A pulmonary embolism
96. Administered dose of which of the following pharmacologic stress agents is NOT weight-adjusted?
- A. Adenosine
 - B. Dipyridamole
 - C. Dobutamine
 - D. Regadenoson
97. Figure 2.3 displays images acquired during routine 32 frames multi-gated acquisition (MUGA) scan. The end diastole image is labeled:
- A. D
 - B. C
 - C. B
 - D. A

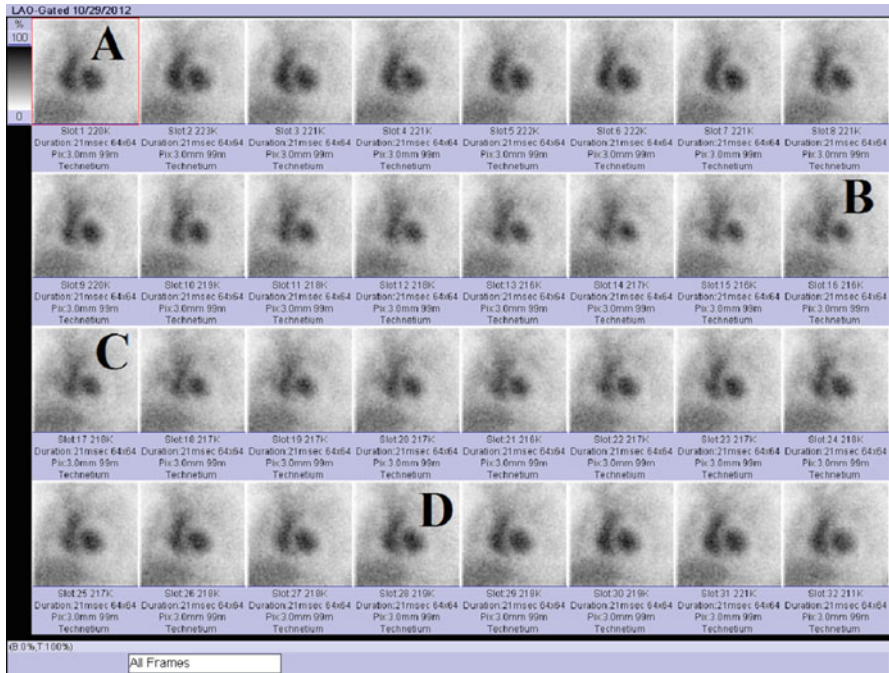


Fig. 2.3 MUGA scan

- 98. For a trained rescuer performing adult CPR, what do the 2010 American Heart Association (AHA) guidelines for CPR and ECC recommend as the first step in the CPR sequence?
 - A. Airway
 - B. Breathing
 - C. Chest compression
 - D. Defibrillation

- 99. Infusion of intravenous aminophylline antagonizes the effects of:
 - A. Atropine
 - B. The vasodilator stress agents
 - C. The inotropic stress agents
 - D. Propranolol

- 100. With increasing workloads, the normal systolic blood pressure of a healthy person:
 - A. Decreases progressively by 20 mmHg/stage
 - B. Doesn't change during exercise
 - C. Increases progressively to a peak response ranging from 160–200 mmHg
 - D. Increases progressively to a peak response ranging from 200–260 mmHg

101. Which of the following MPI protocols provides optimal defect contrast with minimal background activity?
- A. Same day low dose rest, high stress protocol
 - B. Same day low dose stress high dose rest protocol
 - C. Two-day protocol
 - D. Dual-isotope protocol
102. The view comprising oblique tomographic cuts generated by slicing along the short axis perpendicular to the long axis of the left ventricle is called:
- A. Long-axis view
 - B. Short-axis view
 - C. Vertical long-axis view
 - D. Horizontal long-axis view
103. Appropriate use criteria (AUC) assess all of the following aspects of cardiovascular testing EXCEPT:
- A. When to perform a test
 - B. How often to perform a test
 - C. How much does a test cost
 - D. In whom to perform a test
104. All of the following are cyclotron-produced positron emitters EXCEPT:
- A. F-18
 - B. N-13
 - C. O-15
 - D. Rb-82
105. Conception is unlikely to have happened:
- A. Within the first 10 day of the menstrual cycle
 - B. Within 10–15 days of the menstrual cycle
 - C. Within 16–20 days of the menstrual cycle
 - D. Within 21–25 days of the menstrual cycle
106. Soft tissue attenuation artifacts decrease the diagnostic accuracy of SPECT in myocardial perfusion imaging as a result of increase in:
- A. False positive rate
 - B. False negative rate
 - C. True positive rate
 - D. True negative rate
107. The recommended intravenous dose of Adenoscan for adults is:
- A. 100 mcg/kg/min infused for 6 min
 - B. 140 mcg/kg/min infused for 6 min
 - C. 100 mcg/kg/min infused for 3 min
 - D. 140 mcg/kg/min infused for 3 min

108. The insertion of an intravenous line is suggested for the radiopharmaceutical injection of rest and stress parts of MPI in order to:
- A. Reduce the possibility of an infiltrated dose
 - B. Reduce the possibility of motion artifacts
 - C. Increase patient comfort
 - D. Improve signal-to-noise ratio
109. All of the following parameters can be assessed by performing an exercise stress in conjunction with MPI EXCEPT the patient's:
- A. Functional capacity
 - B. Stress-induced electrocardiographic changes
 - C. Heart rate recovery
 - D. Stress-induced echocardiographic changes
110. A modified Bruce protocol is used for exercise testing in those patients who are:
- A. Assertive
 - B. Athletic
 - C. Old and frail
 - D. Young and strong
111. Which of the following statements describing properties of technetium-based MPI tracers or thallium is CORRECT?
- A. Technetium first-pass myocardial extraction is 85 %, its energy is lower than optimum for current gamma cameras
 - B. Thallium first-pass myocardial extraction is 60 %, its energy is lower than optimum for current gamma cameras
 - C. Thallium first-pass myocardial extraction is 85 %, its energy results in less scatter and soft tissue attenuation
 - D. Technetium first-pass myocardial extraction is 60 %, its energy results in less scatter and soft tissue attenuation
112. The heart responds to dobutamine infusion similarly to the way it responds to:
- A. Adenosine
 - B. Dipyridamole
 - C. Exercise
 - D. Regadenoson
113. An acceptance window of 20 % allows acquiring data from cardiac cycles having a duration within:
- A. ± 20 % of the mean R–R interval
 - B. ± 10 % of the mean R–R interval
 - C. ± 5 % of the mean R–R interval
 - D. ± 2 % of the mean R–R interval

114. Which of the following PET agents is classified as the freely diffusible tracer?
- A. F-18 fluorodeoxyglucose
 - B. N-13 ammonia
 - C. O-15 water
 - D. Rb-82
115. Present guidelines for the treatment of patients with acute myocardial infarction include all of the following options EXCEPT:
- A. Coronary revascularization
 - B. Medical therapy
 - C. Radiation therapy
 - D. Thrombolytic agents
116. Which of the following statements, describing extracardiac incidental findings (ECFs) on nuclear SPECT MPI, is FALSE?
- A. ECFs on nuclear SPECT MPI are common and can be easily identified
 - B. ECFs can be small or large and they can be single or multiple
 - C. Patients with ECFs may have symptoms that can often mimic cardiac symptoms
 - D. There is a significant variability in the incidence of reported ECFs, depending on the reader's skill
117. What is the correct order of injections when a pharmacological stress test with Lexiscan is performed?
- A. Saline flash, Lexiscan, radiotracer, saline flash
 - B. Lexiscan, saline flash, radiotracer, saline flash
 - C. Radiotracer, saline flash, Lexiscan, saline flash
 - D. Radiotracer, saline flash, Lexiscan, saline flash
118. The perfusion–metabolism mismatch pattern—reduced perfusion and preserved metabolism—has been considered the hallmark of:
- A. Hibernating myocardium
 - B. Normal myocardium
 - C. Scarred myocardium
 - D. Stunned myocardium
119. The distribution information obtained by the gated SPECT with Tc-99m-based tracers reflects the perfusion at the time of:
- A. Acquisition
 - B. Initial evaluation
 - C. Injection
 - D. Test termination

120. A measure of the work load of the heart, equal to systolic blood pressure multiplied by heart rate, is called:
- A. The double product
 - B. The heart rate recovery
 - C. The metabolic equivalent
 - D. The predicted heart rate
121. LVEF is derived from the end-diastolic volume (EDV) and the end-systolic volume (ESV) using the formula:
- A. $(EDV - ESV) / EDV \times 100$
 - B. $(EDV + ESV) / EDV \times 100$
 - C. $(EDV - ESV) / ESV \times 100$
 - D. $(EDV + ESV) / ESV \times 100$
122. Imaging after Tc-99m sestamibi administration is best done after a brief waiting period to allow for some liver and biliary clearance, but before significant accumulation of the radiotracer in the:
- A. Bladder
 - B. Stomach
 - C. Spleen
 - D. Transverse colon
123. Sestamibi and tetrofosmin are lipid-soluble cationic compounds with first-pass extraction fractions in the range of:
- A. 50 %
 - B. 60 %
 - C. 70 %
 - D. 80 %
124. F-18fluorodeoxyglucose is trapped in the myocyte as:
- A. F-18 FDG-6-phosphate
 - B. F-18 FDG-4-phosphate
 - C. F-18 FDG-2-phosphate
 - D. F-18 FDG-1-phosphate
125. The typical stroke volume (SV) of the left ventricle is approximately:
- A. 35 ml
 - B. 70 ml
 - C. 140 ml
 - D. 280 ml

126. Which of the following will increase the sensitivity of Tl-201 for detection of viable myocardium?
- A. Applying attenuation correction
 - B. Increasing the tracer dose
 - C. Obtaining gated images
 - D. Reinjecting the tracer
127. What is the recommended intravenous dose of Lexiscan?
- A. 4 ml (0.5 mg regadenoson)
 - B. 5 ml (0.2 mg regadenoson)
 - C. 5 ml (0.4 mg regadenoson)
 - D. 4 ml (0.4 mg regadenoson)
128. After oral carbohydrate loading, high myocardial uptake of F-18 FDG reflects increased myocardial glucose utilization due to the release of:
- A. Endogenous insulin
 - B. Exogenous insulin
 - C. Glucagon
 - D. Pyruvate
129. Arrhythmias, such as multiple PVCs, can adversely affect the gated blood pool study if these beats account for more than:
- A. 5 %
 - B. 10 %
 - C. 20 %
 - D. 30 %
130. In the Bruce protocol, the incline and speed of the treadmill are increased every 3 min through a total of:
- A. Five stages
 - B. Six stages
 - C. Seven stages
 - D. Eight stages
131. To minimize hepatobiliary and gastrointestinal interference, the optimal time imaging window for Tc-99m-labeled radiopharmaceuticals (Sestamibi or Tetrofosmin) is:
- A. 10 min
 - B. When radiotracer activity has cleared from the gastrointestinal tract and not concentrated in the liver
 - C. When radiotracer activity has cleared from the liver and not concentrated in the gastrointestinal tract
 - D. 30 min

132. The standard SPECT myocardial perfusion imaging projection views are acquired over:
- A. 90° arc
 - B. 180° arc
 - C. 270° arc
 - D. 360° arc
133. Which of the following X-ray photons emitted from Tl-201 decay are primarily captured during imaging?
- A. 75–80 keV
 - B. 135 keV
 - C. 167 keV
 - D. 135–167 keV
134. PET tracers: C-11 acetate and O₂-15 are markers of:
- A. Cell proliferation
 - B. Glucose utilization and metabolism
 - C. Membrane synthesis
 - D. Oxidative and oxygen metabolism
135. Figure 2.4 presents a screenshot of a standard LAO view MUGA scan. The arrow is pointing to the:
- A. Left atrium
 - B. Left ventricle
 - C. Right atrium
 - D. Right ventricle

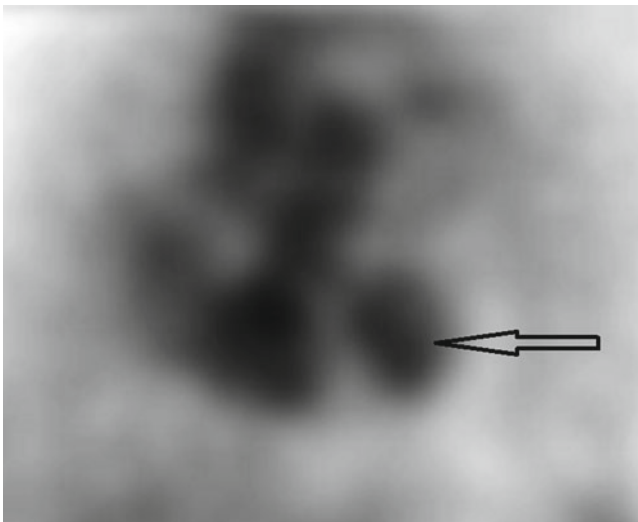


Fig. 2.4 Muga scan

136. Radiation exposure to patients from cardiac dual-isotope imaging (thallium and technetium) is approximately:
- A. 4–6 mSV
 - B. 8–10 mSV
 - C. 18–20 mSV
 - D. 25–30 mSV
137. The recommended 5 ml (0.4 mg regadenoson) intravenous dose of Lexiscan should be administered:
- A. As a 1 min continuous peripheral intravenous infusion
 - B. As a rapid (~10 s) injection
 - C. As a slow (~30 s) injection
 - D. As a 2-min continuous peripheral intravenous infusion
138. All patients undergoing MPI tests should receive a card documenting that they received a radioactive tracer for medical purposes. This card should include all of the following information EXCEPT:
- A. Facility name and location
 - B. Patient diagnosis
 - C. Patient first and last name
 - D. The date of the test
139. In patients with a smaller heart, the ESV is underestimated more than the EDV, which can result in:
- A. No change to the LVEF
 - B. An overestimation of the LVEF
 - C. An overestimation or an underestimation of the LVEF
 - D. An underestimation of the LVEF
140. Patients without flow limiting stenosis can increase myocardial blood flow during exercise by a factor of:
- A. 1–2
 - B. 2–3
 - C. 3–4
 - D. 4–5
141. The main disadvantage of the dual-isotope simultaneous acquisition protocol is:
- A. Attenuation
 - B. Downscatter
 - C. Motion artifacts
 - D. Study duration

142. During a gated blood pool acquisition, images of the heart are usually acquired in two or three standard projections. Which of the following views provide the best separation of the left and right ventricles?
- A. Anterior
 - B. Right anterior oblique
 - C. Left anterior oblique
 - D. Left lateral
143. All of the following Tc-99m-based tracers have received U.S. Food and Drug Administration (FDA) approval for detection of CAD EXCEPT:
- A. Pyrophosphate
 - B. Sestamibi
 - C. Teboroxime
 - D. Tetrofosmin
144. The advantages of PET myocardial perfusion imaging over SPECT include all of the following EXCEPT:
- A. Assessment of perfusion during treadmill exercise
 - B. Higher spatial resolution
 - C. Improved attenuation and scatter correction
 - D. Potential for quantifying regional blood flow
145. The fundamental hypothesis of myocardial perfusion SPECT imaging is that the radiotracer is distributed in the myocardium:
- A. Directly proportional to the dose of radiotracer at the time of injection
 - B. Directly proportional to the blood flow at the time of injection
 - C. Inversely proportional to the blood flow at the time of injection
 - D. Inversely proportional to the dose of radiotracer at the time of injection
146. Normal myocardial uptake of Tl-201 at stress indicates the presence of:
- A. Myocardial infarction
 - B. Myocardial ischemia
 - C. Viable myocardium
 - D. Dysfunctional myocardium
147. Tomographic reconstruction of the heart projection images produces transaxial images called:
- A. Short-axis images
 - B. Long-axis images
 - C. Horizontal images
 - D. Vertical images

148. A positron is a particle similar to an electron EXCEPT that it:
- A. Is heavier
 - B. Has a positive electric charge
 - C. Has no charge
 - D. Is slower
149. Which of the following is NOT a recommended use of Tl-201 as a MPI tracer?
- A. Assessment of LV function
 - B. Diagnostic assessment of CAD
 - C. Prognostic assessment
 - D. Viability assessment
150. Which of the following is the most reliable electrocardiographic marker of exercise-induced ischemia?
- A. T wave height decreased
 - B. J point depression
 - C. ST segment depression
 - D. P wave height increased
151. MPI images acquired 2 h after initial injection of Tc-99m sestamibi represent a “snapshot” of blood flow conditions and tracer uptake at:
- A. The time of exercise beginning
 - B. The time of injection
 - C. The time of exercise ending
 - D. The time of imaging
152. An infiltrated injection may compromise the MPI study by all of the following EXCEPT:
- A. Masking ischemia
 - B. Producing poor quality images
 - C. Altering distribution of the radiopharmaceutical
 - D. Masking motion artifacts
153. Which of the following software packages is NOT employed in the measurement and analysis of left ventricle perfusion and function?
- A. Emory Cardiac Toolbox (ECT)
 - B. Practice Management Software (PMS)
 - C. 4D-MSPECT
 - D. Quantitative Gated SPECT (QGS)
154. PET tracer F-18 FDG is a marker of:
- A. Cell proliferation
 - B. Glucose utilization and metabolism
 - C. Membrane synthesis
 - D. Oxidative and oxygen metabolism

155. Figure 2.5 presents LV volume curve derived from an 8-frame gated myocardial perfusion study using 4D-MSPECT. Calculated EF of LV is approximately:

- A. 47 %
- B. 60 %
- C. 71 %
- D. 85 %

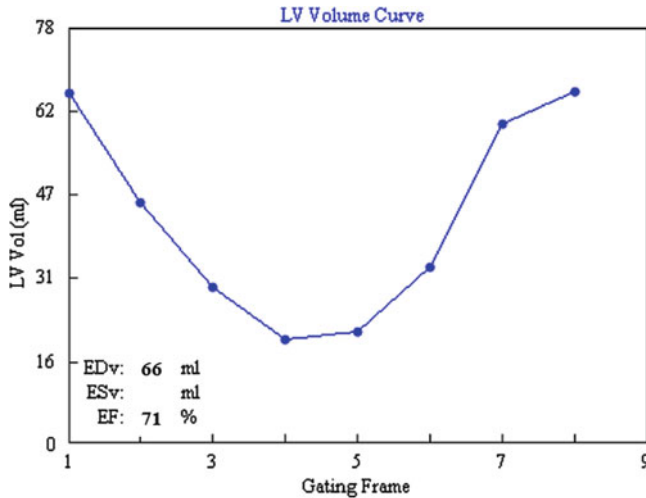


Fig. 2.5 Volume curve

156. The perfusion–metabolism match pattern—reduced perfusion and reduced metabolism—is indicative of:

- A. Hibernating myocardium
- B. Normal myocardium
- C. Scarred myocardium
- D. Stunned myocardium

157. The major pathway for excretion of Tc-99m sestamibi is the:

- A. Hepatobiliary system
- B. Skin
- C. Respiratory system
- D. Urinary tract

158. Tl-201 decays by electron capture to:

- A. Tl-202
- B. Tl-203
- C. Hg-201
- D. Hg-200

159. Patients undergoing tests with radionuclide administration should receive a card verifying that they collected a tracer dose of radioactivity for medical purposes. This card should include all of the following EXCEPT:
- A. The date of the test
 - B. The referring physician name
 - C. The location of the test facility
 - D. The type of test
160. The resistance, against which the left ventricle must eject its volume of blood during contraction is called:
- A. Afterload
 - B. Ejection fraction
 - C. Preload
 - D. Stroke volume
161. Which of the following views are obtained during the standard planar myocardial perfusion imaging acquisition?
- A. An anterior, a left lateral view, and a posterior view
 - B. A left anterior oblique, a left lateral view, and a posterior view
 - C. An anterior, a left anterior oblique, and a left lateral view
 - D. A left lateral view, a posterior and right posterior oblique view
162. Labeling of red blood cells with Tc-99m pertechnetate requires stannous pyrophosphate which is:
- A. A buffer
 - B. An oxidizing agent
 - C. A reducing agent
 - D. A stabilizer
163. Which of the following characteristics of Tl-201 limits its use in MPI SPECT imaging?
- A. High energy and short half life
 - B. High energy and long half life
 - C. Low energy and short half life
 - D. Low energy and long half life
164. Which of the following positron emitting tracers is most frequently used to assess myocardial viability?
- A. C-11 acetate
 - B. F-18 fluorodeoxyglucose
 - C. N-13 ammonia
 - D. Rb-82

165. The decision to temporarily stop medication prior to stress testing should always be done in consultation with the:
- A. Exercise physiologist
 - B. Hospital pharmacist
 - C. Referring physician
 - D. Supervising physician
166. Which of the following imaging protocols provides information on both stress-inducible ischemia and viability?
- A. F-18 FDG viability imaging
 - B. Tl-201 rest–redistribution imaging
 - C. Tl-201 stress–redistribution–re-injection imaging
 - D. Rb-82 perfusion imaging
167. Caffeine and methylxanthines limit the adenosine:
- A. Vasoconstricting effect
 - B. Bronchodilating effect
 - C. Vasodilating effect
 - D. Positive chronotropic effect
168. Stunned or hibernating myocardium is:
- A. Dysfunctional and nonviable
 - B. Nonfunctional but viable
 - C. Dysfunctional but viable
 - D. Nonfunctional and nonviable
169. Perfusion–metabolism mismatch—preserved metabolism in an area of decreased perfusion—is considered as the gold standard for:
- A. Myocardial infarction assessment
 - B. Myocardial viability assessment
 - C. Myocardial ischemia
 - D. Myocardial arrhythmia
170. A 39-year-old woman presents to doctor’s office with complaints of intermittent lightheadedness. She is asymptomatic and has no significant past medical, family, or social history. Her ECG (Fig. 2.6) shows:
- A. Atrial flutter
 - B. Electronic ventricular pacemaker
 - C. Normal sinus rhythm
 - D. Sinus bradycardia

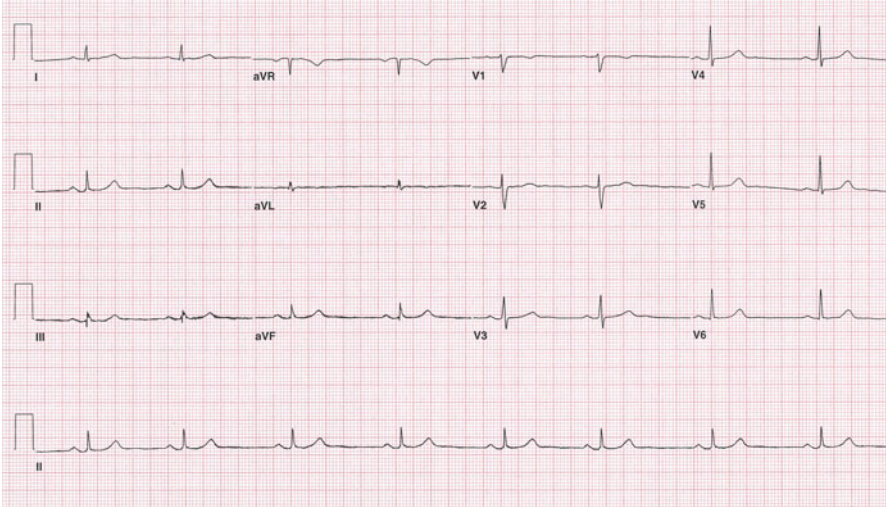
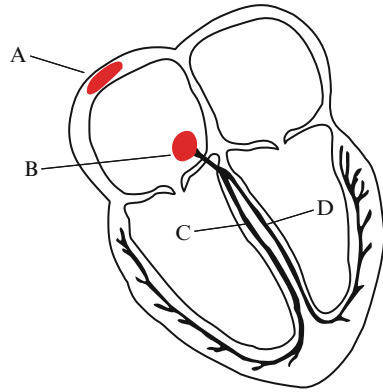


Fig. 2.6 Electrocardiogram

171. Which of the following gamma camera imaging techniques is DOSN'T assess ventricular function?
- A. Equilibrium gated radionuclide angiography
 - B. First-pass radionuclide angiography
 - C. Gated single photon emission computed tomography
 - D. Infarct avid imaging study
172. All of the following types of muscular contraction or exercise can be applied as a stress to the cardiovascular system EXCEPT:
- A. Isobaric
 - B. Isometric
 - C. Isotonic
 - D. Resistive
173. The major mechanism responsible for increasing coronary blood flow during stress involves a/an:
- A. Decrease in aortic diastolic pressure
 - B. Increase in aortic systolic pressure
 - C. Increase in coronary vascular resistance
 - D. Reduction in coronary vascular resistance
174. The physical half-life of Rb-82 is:
- A. 38 s
 - B. 58 s
 - C. 78 s
 - D. 98 s

175. Which of the following belongs do the right cardiovascular system (select three)?
- A. The left side of the heart
 - B. The pulmonary arteries
 - C. The pulmonary veins
 - D. The right side of the heart
 - E. The systemic arterial system
 - F. The venous system
176. Which of the following factors/conditions can produce a false negative MPI study?
- A. Left bundle branch block
 - B. Attenuation artifacts
 - C. Patient motion
 - D. Patient on calcium channel blockers
177. Tc-99m PYP has been used to image:
- A. Myocardial perfusion
 - B. Myocardial necrosis
 - C. Myocardial viability
 - D. Ventricular function
178. The cardiac measurement defined as the blood volume pumped out by the ventricle over 1 min time period is called the:
- A. Ejection fraction
 - B. End-diastolic volume
 - C. End-systolic volume
 - D. Cardiac output
179. Tc-99m-based MPI tracers are NOT recommended for:
- A. Assessment of LV function
 - B. Diagnostic assessment of CAD
 - C. Prognostic assessment
 - D. Viability assessment
180. Absolute contraindications for exercise stress testing include all of the following EXCEPT:
- A. Acute pericarditis
 - B. Decompensated congestive heart failure
 - C. Electrolyte abnormalities
 - D. Symptomatic cardiac arrhythmia

181. The most common computer-based methodology of global LV function assessment on GSPECT involves automated analysis of the:
- A. Apical and basal segments
 - B. Epicardial and endocardial borders
 - C. Apical segment and endocardial border
 - D. Basal segment and epicardial border
182. During pharmacologic stress, intravenous coronary arteriolar vasodilators can increase coronary blood flow up to:
- A. 1–2 times above the resting level
 - B. 2–3 times above the resting level
 - C. 3–4 times above the resting level
 - D. 4–5 times above the resting level
183. The magnitude of potential improvement of global LV function after revascularization is determined by the extent of:
- A. Ischemia
 - B. Viable dysfunctional myocardium
 - C. Viable nonfunctional myocardium
 - D. Scar tissue
184. The high kinetic energy of Rb-82 positrons, together with the ultra-short physical half-life, produces myocardial perfusion images of:
- A. Low count density and high spatial resolution
 - B. Low count density and low spatial resolution
 - C. High count density and low spatial resolution
 - D. High count density and high spatial resolution
185. The percentage of patients with CAD with a positive test result compared with the total number of patients tested with CAD describes the test:
- A. Specificity
 - B. Sensitivity
 - C. Accuracy
 - D. Reproducibility
186. Figure 2.7 displays the schematic drawing of the normal heart conduction system. The label A represents the:
- A. Atrioventricular node
 - B. Left bundle branch
 - C. Right bundle branch
 - D. Sinoatrial node

Fig. 2.7 Conduction system

187. Which of the following medications can be used to attenuate severe and/or persistent adverse reactions to Lexiscan?
- Aggrenox
 - Aminophylline
 - Aspirin
 - Atropine
188. The most common clinical manifestation of myocardial ischemia is:
- Angina pectoris
 - Myocardial infarction
 - Myocardial stunning
 - Unstable angina
189. SPECT MPI is limited by the relative nature of the perfusion information; some patients with angiographically significant CAD may manifest a normal SPECT result because of:
- Balanced ischemia
 - Irreversible ischemia
 - Reversible ischemia
 - Unbalanced ischemia
190. The double product units are:
- $\text{mmHg} \times \text{beats}/\text{min} \times 10^{-3}$
 - $\text{mmHg} \times \text{beats}/\text{h} \times 10^3$
 - $\text{mmHg} \times \text{beats}/\text{h} \times 10^{-3}$
 - $\text{mmHg} \times \text{beats}/\text{min} \times 10^3$
191. On the morning of the day of testing, diabetic patients referred for a cardiac stress testing procedure should:
- Take their regular dose of insulin; do not eat a breakfast
 - Take their regular dose of insulin; eat a light breakfast
 - Not take insulin; eat a light breakfast
 - Not take insulin; do not eat a breakfast

192. Which of the following MPI artifacts/findings can be resolved by performing delayed scanning?
- A. Apical thinning
 - B. Diaphragm attenuation
 - C. Liver attenuation
 - D. Upward creep
193. During an ECG-gated SPECT acquisition, the “gate” opens when the peak of a/an:
- A. P wave is detected
 - B. R wave is detected
 - C. T wave is detected
 - D. U wave is detected
194. The physical half-life of cyclotron produced N-13 ammonia is:
- A. 2 min
 - B. 5 min
 - C. 10 min
 - D. 20 min
195. Reversible myocardial contractile dysfunction, in the presence of normal resting myocardial blood flow, is called:
- A. Myocardial infarction
 - B. Myocardial ischemia
 - C. Stunned myocardium
 - D. Hibernating myocardium
196. In a typical gated SPECT acquisition, the first frame of the acquisition represents the:
- A. End-diastolic event
 - B. End-systolic event
 - C. Mid-diastolic event
 - D. Mid-systolic event
197. Which of the following parts of Title 10 Code of Federal Regulations is concerned with the medical use of byproduct material, including the ALARA program, licensing, required surveys, instrumentation, and training requirements?
- A. 15
 - B. 20
 - C. 35
 - D. 50

198. Visual comparison of a MPI stress and rest display revealing a perfusion defect that is seen on both the stress and rest images defines:
- A. A normal myocardium
 - B. An ischemic myocardium
 - C. A scarred myocardium
 - D. A stunned myocardium
199. Tc-99m emits 140 keV of photon energy and has a physical half-life of:
- A. 4 h
 - B. 5 h
 - C. 6 h
 - D. 7 h
200. Treadmill exercise ECG testing:
- A. Allows accurate localization of the site of myocardial ischemia
 - B. Allows assessment of a patient functional capacity
 - C. Allows measurement of left ventricle systolic function
 - D. Allows accurate assessment of the extent of myocardial ischemia
201. The image presented in Fig. 2.8 was obtained during diagnostic cardiac:
- A. Computed tomography study
 - B. Echocardiographic study
 - C. Magnetic resonance imaging
 - D. Myocardial perfusion imaging



Fig. 2.8 Cardiac study

202. Which of the following is NO longer recognized in 10 CFR Part 20 and consequently is being phased out as an official unit for dose of record?
- A. Curie
 - B. Rad
 - C. Rem
 - D. Roentgen
203. According to the NRC guidelines complete cessation of breastfeeding is suggested after administration of:
- A. Ga-67 citrate
 - B. Tc-99m methylene diphosphonate
 - C. Tc-99m pertechnetate
 - D. Xe-133 gas
204. Fatty acids are:
- A. Amino acids
 - B. Minerals
 - C. Lipids
 - D. Vitamins
205. The left main coronary artery (LM) derives from the left coronary sinus of Valsalva and gives origin to the left anterior descending coronary artery (LAD) and:
- A. The right coronary artery (RCA)
 - B. The left circumflex coronary artery (LCX)
 - C. The posterior descending artery (PDA)
 - D. The sinoatrial artery (SA)
206. Which of the following collimators is recommended for SPECT MPI?
- A. Low energy all purpose
 - B. Low energy high resolution
 - C. Low energy high sensitivity
 - D. Medium energy
207. Patients referred for MPI study should avoid taking Viagra (sildenafil) before the study in the event that:
- A. Aminophylline is needed to counteract stress bronchospasm
 - B. Nitroglycerine is needed to counteract stress-induced ischemia
 - C. Propranolol is needed to counteract stress tachycardia
 - D. Valium is needed to counteract stress-induced anxiety
208. Which of the following parameters from myocardial perfusion gated SPECT study DOESN'T describe diastolic function?
- A. Myocardial thickening
 - B. Peak to filling rate
 - C. Time to peak filling rate
 - D. The mean filling fraction

209. Which of the following parameters describe the total of ischemic or jeopardized myocardium?
- A. Ejection Fraction (EF)
 - B. Summed Stress Score (SSS)
 - C. Summed Rest Score (SRS)
 - D. Summed Difference Score (SDS)
210. The presented in Fig. 2.9 coronary angiogram shows:
- A. Normal coronary arteries
 - B. 80 % occluded LM
 - C. 80 % occluded LAD
 - D. 80 % occluded LCX



Fig. 2.9 Coronary angiogram

211. What area of myocardium is represented in the center of the SPECT MPI polar map?
- A. Apex
 - B. Anterior wall
 - C. Lateral wall
 - D. Septum

212. Echocardiography use in standard chemotherapeutic monitoring of LV function is precluded by its:
- A. Availability
 - B. Complexity
 - C. Low specificity
 - D. Low reproducibility
213. When the 2-day stress/rest protocol is employed, the stress study should be performed first because:
- A. The rest study can be omitted if the stress study is normal
 - B. The stress study can be repeated if the rest study is normal
 - C. There is no delay in reporting of the final analysis
 - D. There is no need to alter patient medications
214. Which of the following SPECT MPI protocols offers the best image quality?
- A. 2-day stress/rest protocols
 - B. Dual-isotope protocols
 - C. Same-day rest/stress protocols
 - D. Same-day stress/rest protocols
215. The image obtained during diagnostic cardiac angiography in Fig. 2.10 is called:
- A. Phase image
 - B. Sinogram
 - C. Spider view
 - D. Ventriculogram

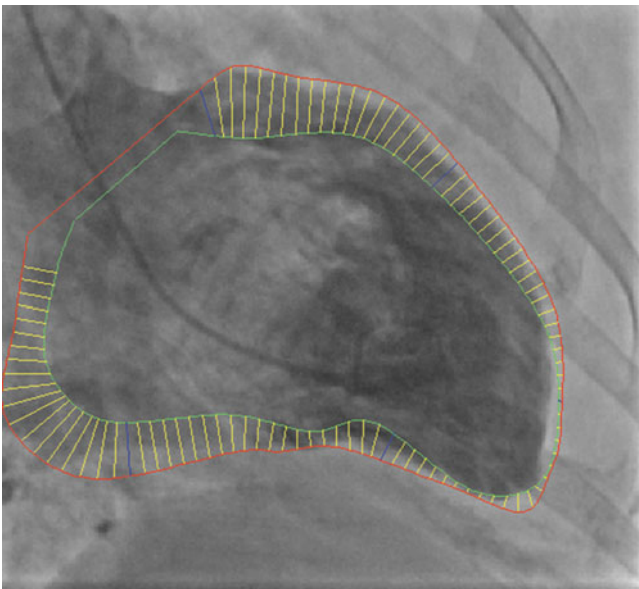


Fig. 2.10 Cardiac angiography

Answers

1. B. 85 %

The first-pass myocardial extraction of Tl-201 is ~ 85 %; however, only about 3–5 % of the total injected dose localizes in the myocardium when injected at peak exercise.

(Zaret and Beller 2005)

2. D. Creates less liver and gut activity

A well-known downside to technetium 99m-based imaging is the increased frequency of liver and gut activity in contrast to thallium-201.

(Zaret and Beller 2005)

3. A. 0–4

Perfusion is rated within each segment on a scale of 0–4, with 0 representing normal perfusion and 4 characterizing an extremely severe perfusion defect.

(Bonow et al. 2011)

4. B. 124 s

Measurements of myocardial blood flow necessitate close synchronization with the cyclotron O-15 production.

(Schelbert 2009)

5. B. Coronary artery disease

Atherogenesis is a process which leads to the formation of plaques made up of fatty materials. These plaques line the arteries, gradually constricting them. Inflammation plays an essential role in the pathobiology of a normal arterial wall becoming an atherosclerotic plaque.

(Strauss et al. 2004)

6. D. Severe ischemia

Ischemia-induced increase in left atrial and pulmonary pressures slows pulmonary transit of the tracer, allowing more time for removal or transudation into the interstitial spaces of the lung.

(Dilsizian et al. 2009)

7. B. Dipyridamole

Dipyridamole prevents intracellular reuptake and deamination of adenosine. The mechanism of inducing a perfusion abnormality is similar to that of adenosine, except true coronary steal occurs more frequently.

(Iskandrian et al. 2003)

8. B. Oximetry

Oximetry, performed noninvasively, can be employed to monitor arterial oxygen saturation, as long as a good signal pulse is obtained.

(Jubran May 18 [2012](#))

9. D. Thallium-201

Peak myocardial concentration of thallium occurs within 5 min of injection, with rapid clearance from the intravascular compartment. The scintigraphic images obtained early after injection reflect the blood flow conditions at the time of tracer administration.

(Bonow et al. [2011](#))

10. B. $HR = 220 - \text{age}$ (in years)

This formula tends to overestimate the maximum heart rate in the female population. A more accurate formula, offered in a study published in the journal, *Medicine & Science in Sports & Exercise*, is $206.9 - (0.67 \times \text{age})$.

(Bonow et al. [2011](#))

11. C. Infarction

The summed stress score (SSS) characterizes the extent and severity of stress perfusion abnormality, the magnitude of perfusion defects related to both ischemia and infarction.

(Bonow et al. [2011](#))

12. B. First-pass radionuclide angiography

FPRNA is a useful technique for the measurement of the right ventricular (RV) function and quantification of a cardiac shunt.

(Nichols et al. [1997](#))

13. B. Performing delay imaging

The use of Tc-99m based agents with gated SPECT imaging is the well documented method of improving MPI specificity.

(Bonow et al. [2011](#))

14. A. An electron

A positron and an electron undergo mutual annihilation, and according to the law of conservation of energy, their masses are converted to 2 annihilation photons of energy, (gamma rays), each of energy about 511 Kev and moving in 2 opposite directions.

(Lin and Alavi [2009](#))

15. A. stress-to-rest perfusion

CFR provides a functional assessment of the severity of coronary stenosis—reduced CFR is seen in patients with hyperlipidemia; lowering cholesterol improves the CFR.

(Yoshinaga et al. 2003)

16. C. diastolic blood pressure decreases

In healthy patients during exercise, systolic blood pressure, mean arterial pressure, and pulse pressure usually increase. Diastolic blood pressure does not change considerably.

(Bonow et al. 2011)

17. B. The ramp filter

The Butterworth, Parzen, and Hamming are low pass filters that let low frequencies through. The Butterworth filters are the best of this group because the mathematical formula contains not only a cut-off frequency parameter but also the parameter called the order (roll-off).

(Christian et al. 2004)

18. A. Avoid direct metal to skin contact

The electrode fluid column can dry out over time with resulting poor-quality tracings.

(Bonow et al. 2011)

19. C. extracardiac activity

Extracardiac structure near the heart can produce counts that may reach the detector (falsely hotter cardiac region) or may cause a “ramp filter” or “negative lobe” artifact (falsely cold).

(Bonow et al. 2011)

20. B. 3.5 ml O₂/kg/min of body weight

MET is useful to assess disability and standardize the reporting of submaximal and peak exercise workloads when different protocols are used.

(Bonow et al. 2011)

21. B. Faster

Thallium clearance is more rapid from normal myocardium with high thallium activity compared with myocardium with reduced thallium activity (differential washout).

(Baggish and Boucher 2008)

22. B. Improving imaging characteristics

Adding exercise to vasodilator stress stimulates a blood flow to the skeletal musculature and away from intra-abdominal organs such as the liver. Low-level exercise is also an effective way of weakening vasodilator-related side effects. (Thomas et al. 2000)

23. C. The summed difference score (SDS)

The summed difference score (SDS) is derived by subtracting the summed rest score (SRS) from the summed stress score (SSS). (Bonow et al. 2011)

24. D. N-13 ammonia as a perfusion tracer and FDG as a metabolic marker of glucose use

A pattern FDG uptake in areas of hypoperfusion (described as “FDG/blood flow mismatch”) suggests viable but hibernating myocardium. (Lin and Alavi 2009)

25. A. Atheroma

The process that causes atheroma is termed atherosclerosis. Atheromas are confined within the wall of the vessel and typically occupy a fraction of the vessel circumference, and often extend from 1 to 2 cm. (Strauss et al. 2004)

26. B. End-systolic

One of the frames in the middle of the acquisition (frame 4 in a typical gated SPECT acquisition where R-R interval is divided into eight frames) represents end-systolic events. (Germano and Berman 2006)

27. C. Normal sinus rhythm

Common characteristics of sinus rhythms include: upright P waves that are similar in appearance, PR intervals of normal duration, and normal QRS complexes, provided that no ventricular abnormalities are present. By convention, normal sinus rhythm is usually defined as sinus rhythm with a heart rate between 60 and 100 beats/min. (Goldberger 2006)

28. D. Viability study

Hibernation, and/or stress-induced ischemia demonstrated by SPECT imaging, is suggesting that this subpopulation of patients with heart failure may benefit from a noninvasive search for viability and ischemia. (Cleland et al. 2003)

29. C. SPECT has shown a superior diagnostic performance when subanalyzed for gender
PET overperforms SPECT when subanalyzed also for body mass index; the ability to identify multivessel ischemia with PET is significantly higher (74 % vs 41 %) than with SPECT perfusion imaging.
(Bateman et al. [2006](#))
30. A. There are technical difficulties in monitoring systolic blood pressure
A Gradual, reproducible decline in systolic blood pressure of 10 mmHg or more may indicate transient left ventricular dysfunction or an improper decrease in systemic vascular resistance, and is an indication to cease exercise if it is accompanied by other evidence of ischemia.
(Bonow et al. [2011](#))
31. A. A bull's eye
A polar map (bull's eye) representation—provides an overview of the entire three-dimensional myocardium in a two-dimensional plot.
(Bonow et al. [2011](#))
32. D. Vascular space
Ventricular cavity counts are used to generate a time–activity curve, from which functional parameters are derived.
(Paul and Nabi [2004](#))
33. A. Additive to information from more available or less expensive tests
Stress MPI data have been shown to have incremental prognostic value when added, for example, to clinical data information, stress ECG findings, and the Duke Treadmill Score.
(Zaret and Beller [2005](#))
34. B. 1 month
The physical half-life of Sr-82 is approximately 25 days. The generator can be eluted with >90 % yield every 10 min.
(Takalkar et al. [2011](#))
35. B. A twofold to threefold
Even though physical stress remains the preferred stress method for MPS, many patients are unable to exercise because of, e.g., arthritis, peripheral vascular disease, asthma, congestive heart failure, muscle diseases—for these patients, pharmacological stress is used as an alternative to physical exercise.
(Iskandrian et al. [2003](#))

36. A. Dynamic exercise

Static exercise is isometric exercise that generates force with little muscle shortening that produces a greater blood pressure response than dynamic exercise. (Williams et al. 2007)

37. C. 12 h

Ingestion of caffeine decreases the ability to detect reversible ischemic defect. Products containing methylxanthines, including caffeinated coffee, tea, or other caffeinated beverages, caffeine-containing drug products, and theophylline should be avoided for at least 12 h before a scheduled radionuclide MPI. (Astellas July 28 2012)

38. A. First-pass extraction fraction

With conventional SPECT imaging, the primary limitation is that the nonlinear relation of extracted tracer to myocardial blood flow imposed by lower first-pass myocardial extraction causes a significant underestimation of exercise or vasodilator-induced increased blood flow and underestimation of flow reduction caused by a flow-limiting stenosis. (Bonow et al. 2011)

39. B. Is not adequately visualized

Outlining of the LV myocardium and LV cavity is achieved by delineating the epicardial and endocardial borders on the perfusion image. (Paul and Nabi 2004)

40. B. 64° and 72° F

Room temperature should be between 64° and 72° F (18° and 22° C) and humidity should not exceed 60 %. (Bonow et al. 2011)

41. B. Local myocardial perfusion

Simultaneously with washing out, thallium will be redelivered to the myocardium from a large reservoir in the blood pool— a region of ischemic but viable myocardium which initially has less than normal uptake will become equal to normal regions over time (“redistribution”). (Gibbons 2000)

42. D. 10 min after the exercise stress injection and 30–45 min after the pharmacological stress injection

Imaging is best done after a brief waiting period to allow for some liver and biliary clearance, but before significant accumulation can occur in the transverse colon. (Baggish and Boucher 2008)

43. B. slip ring technology

High-speed SPECT technology delivers true three-dimensional, patient-specific images localized to the heart. Compared with the traditional SPECT cameras, the high-speed SPECT systems can provide up to eightfold increase in count rates which results in reducing imaging times and radiation dose to patients.

(Erlandsson et al. [2009](#))

44. B. Hyperinsulinemic euglycemic clamp protocol

The utilization of the euglycemic hyperinsulinemic glucose clamp delivers excellent image quality, commonly displays uniform tracer uptake, and permits PET studies to be performed under steady and standardized metabolic conditions.

(Ghosh et al. [2010](#))

45. A. Infarcted myocardium

Patients with dysfunctional, but viable myocardium are likely to benefit from revascularization, whereas patients without viable myocardium will not benefit.

(Schinkel et al. [2007](#))

46. B. Ischemic myocardium

Myocardial ischemia progresses when coronary blood flow becomes insufficient to meet myocardial oxygen demand; myocardial cells switch from aerobic to anaerobic metabolism, with a gradual impairment of metabolic, mechanical, and electrical tasks.

(Bonow et al. [2011](#))

47. D. Sinus node dysfunction

Lexiscan can depress the SA and AV nodes and may cause first-, second-, or third-degree AV block or sinus bradycardia requiring intervention. Patients with implanted pacemaker scan undergo Lexiscan stress testing.

(Astellas July 28 [2012](#))

48. C. Oil

The areas of electrode application are also rubbed with fine sandpaper or a rough material to reduce skin resistance.

(Bonow et al. [2011](#))

49. C. 73 h

Tl-201 is generated in a cyclotron and must be delivered from a radiopharmacy.

(Early and Sodee [1995](#))

50. B. A treadmill speed of 1.7 mph and a grade of 10°

A standard maximal exercise treadmill protocol begins with a treadmill speed of 1.7 mph and a grade of 10° and increases both speed and grade every 3 min. (Bonow et al. 2011)

51. C. Delivers a higher radiation dose

The selection of radiotracer for MPI does not notably affect the distinction between the presence or absence of CAD. (Bonow et al. 2011)

52. C. R–R interval

Acquisition starts with the R wave on the ECG, which corresponds to the end diastole. The R wave to R wave interval (RR interval) is the inverse of the heart rate. (Paul and Nabi 2004)

53. C. McKesson Practice Choice Software

Methods of quantitative analysis of MPI have been developed to eliminate intraobserver and interobserver variability in the visual analysis of myocardial perfusion images. (Ficaro et al. 2012)

54. B. Energy of 3.15 MeV and average range of 2.8 mm

The physical characteristics of the positron emitted by Rb-82 are not completely optimal for imaging, resulting in somewhat impaired spatial resolution compared with F-18. (Takalkar et al. 2011)

55. C. 58 %

Ejection fraction (EF) represents the volumetric fraction of blood pumped out of the ventricle (heart) with each heart beat or cardiac cycle. Normal range 55–70 % (Schlosser et al. 2005)

56. B. At the onset of an ischemic response

C. Immediately after stopping exercise

F. The end of each stage of exercise

In the recovery phase the heart rate, blood pressure, and ECG should be recorded each minute for at least 5–10 min. (Bonow et al. 2011)

57. D. Second- or third-degree AV block

Adenosine should not be administered in patients with sinus node disease and second- or third-degree AV block (except in patients with a functioning artificial pacemaker).

(Astellas March 28 2012)

58. C. Doppler echocardiography

The advent of hybrid PET-CT has resulted in the unique opportunity to combine CT-derived morphologic information with PET-derived functional, physiologic, and biologic information.

(Heller et al. 2009)

59. A. End-diastole

Several dynamic images covering the length of the cardiac cycle—represented by the R–R interval—are acquired at equal intervals during an ECG-gated acquisition.

(Paul and Nabi 2004)

60. A. Accuracy

Accuracy can be calculated by using the formula: $(TP + TN) / (TP + FP + TN + FN)$ where: TP-true positive, TN-true negative, FP-false positive, and FN-false negative.

(Koller 2002)

61. D. Patients with sinus rhythm

GSPECT should not be performed in patients with severe arrhythmia, such as atrial fibrillation, frequent premature ectopic beats, and heart block.

(Paul and Nabi 2004)

62. B. Tc-99m has a higher emission energy and a shorter half-life than Tl-201

Tc-99m has a higher emission energy and a shorter half-life than Tl-201, which permits administration of a higher dose with resulting improved image quality and contrast, and less soft tissue attenuation.

(Early and Sodee 1995)

63. C. Left bundle branch block

Breast and diaphragmatic attenuation, motion artifacts, processing errors, and cardiomyopathy can also result in false positive MPI.

(Zaret and Beller 2005)

64. B. Rb-82

Almost 21 years ago, the FDA approved Cardiogen-82 (Rubidium Rb-82 Generator) for MPI studies based on PET. Rb-82 has a short half-life (75 s), and is derived from strontium-82 (Sr-82), which has a half-life of 25 days. Rb-82 is collected from the generator column by injecting a solution of normal saline through the column.

(Heller et al. 2009)

65. B. ml O₂/min per 100 g

Myocardial oxygen consumption is required to regenerate ATP that is utilized by membrane transport mechanisms and by myocyte contraction and relaxation.

(Klabunde July 21 2012)

66. D. Creates less liver and gut activity

A well-known downside to technetium 99m-based imaging is the increased frequency of liver and gut activity in contrast to thallium-201.

(Zaret and Beller 2005)

67. B. Flushing

The most common adverse reactions associated with adenosine infusion are flushing and chest discomfort. Adenosine is a potent peripheral vasodilator and can cause significant hypotension; however, patients with an intact baroreceptor reflex mechanism are able to maintain blood pressure and tissue perfusion by increasing heart rate and cardiac output.

(Astellas March 28 2012)

68. B. Anticoagulants

Heparin is a naturally occurring anticoagulant produced by basophils and mast cells and is not used orally; it is faster acting, as warfarin, given orally, usually takes a couple of days to reach the correct level.

(Kowalczyk and Donnett 1996)

69. A. adenosine, D. dipyridamole, E. regadenoson

Adenosine, regadenoson, and dipyridamole produce coronary vasodilation with resulting hyperemia. The detection of differences in coronary hyperemia between narrowed and normal vascular regions is the basis for production of perfusion defects by MPI.

(Zaret and Beller 2005)

70. A. Acute pulmonary embolism

Absolute contraindications for exercise stress testing also include uncontrolled hypertension and uncontrolled, symptomatic cardiac arrhythmias.

(Henzlova et al. 2010)

71. C. A moderate pretest likelihood of disease
All diagnostic tests are of greatest value when there is an intermediate probability of disease, in the range of 50 %, and when the uncertainty is greatest. (Zaret and Beller 2005)
72. A. A 3-dimensional image volume can be reconstituted from a series of 2-dimensional images
Tomographic reconstruction concept assumes that a 3-dimensional image volume can be reconstituted from a series of 2-dimensional images acquired at an adequate number of projections around the object being acquired, usually along an arc spanning at least 180°. (Germano 2001)
73. C. Allowing bed rest before SPECT
Gravity has significant physiologic effects on the positions of organ systems, and a 5-min bed rest before SPECT acquisition appears to deliver enough time for the heart to adapt itself to its new position. (Karacalioglu et al. 2006)
74. C. Positron
A positron rapidly annihilates with an electron, giving off two 511-keV photons, which travel in opposite (~1,800) directions. (Bengel et al. 2009)
75. A. The left side of the heart, C. The pulmonary veins, E. The systemic arterial system
The right cardiovascular system comprises of the venous system returning deoxygenated blood to the heart, the right side of the heart, and the pulmonary arteries supplying blood to the lungs for gas exchange. (MacDonald and Burrell 2008)
76. A. The heart rate
Calcium channel blocking drugs and beta-blocking drugs should be withheld on the day of diagnostic studies, though this should be done only if approved by the referring physician. (SNM May 28 2012)
77. A. Perpendicular to the long axis of the patient
Transaxial is defined directed at right angles to the long axis of the body or a part. (Christian et al. 2004)

78. B. Two

One channel is open at both ends and permits urine to drain out into a collection bag. The other passage has a valve on the outside end and links to a balloon at the tip; the balloon is inflated with sterile water when it lies inside the bladder, in order to prevent it from sliding out.

(Kowalczyk and Donnett 1996)

79. A. 3 units lower

The 16-frame acquisition more precisely identifies the end systolic frame than the 8-frame acquisition.

(Germano et al. 1995)

80. A. Exercise

The MBF increases ~threefold with exercise, 2.5-fold with dobutamine, and three- to fivefold with vasodilator stressors.

(Iskandrian and Garcia 2012)

81. C. Upward creep

Upward creep of the heart during SPECT acquisitions may cause reconstruction artifacts and, therefore, false positive reversible defects.

(Karacalioglu et al. 2006)

82. A. Atrial fibrillation

AF is characterized by rapid, erratic electrical discharge that comes from multiple atrial ectopic foci. No organized atrial depolarizations are detectable. Atrial electrical activity on the ECG appears as irregular f (fibrillation) waves, varying continuously in amplitude, polarity, and frequency. Atrial fibrillation symptoms include heart palpitations, shortness of breath, and weakness.

(Goldberger 2006)

83. B. Kidneys

Intravenous administration of Tl 201 is characterized by rapid biexponential clearance from the blood, with about 91.5 % of blood radioactivity declining with a half-life of approximately 5 min, and the remainder with a half-life of about 40 h. Tl-201 is taken up by cardiac myocytes via the Na–K ATPase pump.

84. C. Pyruvate

The free energy released in this process is used to form the high-energy compounds ATP (adenosine triphosphate) and NADH (reduced nicotinamide adenine dinucleotide)

(Ghosh et al. 2010)

85. A. Specificity

Sensitivity relates to the test's ability to identify positive results.

Accuracy is the number of correct findings, regardless of whether the patient has CAD.

(Munro [2005](#))

86. C. Coronary vasodilatation

The production of cyclic AMP, stimulation of potassium channels, and decreased intracellular calcium uptake are responsible for coronary vasodilatation induced by adenosine.

(Heller et al. July 22 2011)

87. D. 10–20 s after the saline flush

The radiotracer may be injected directly into the same catheter as Lexiscan.

(Astellas July 28 2012)

88. B. Anticoagulants

Anticoagulants, also referred to as blood-thinners, are used to stop platelets present in the blood plasma from clotting; they reduce risk for heart attack, stroke, and blockages in arteries and veins.

(Kowalczyk and Donnett [1996](#))

89. C. The maximal 85 % of age-predicted heart rate is reached

The currently used equation underestimates HR max in older adults and as a result underestimates the true level of physical stress imposed during exercise testing, and the fitting intensity of prescribed exercise programs.

(Burrell and MacDonald [2006](#))

90. D. Symptoms

In maximal (symptom-limited) stress testing, the patient continues to exercise at increasing levels until chest discomfort, significant hypertension or hypotension, gait problems, or severe dyspnea, etc. occurs.

(Henzlova et al. [2010](#))

91. A. For every patient

The attenuation correction map refers to automated techniques that accommodate the intensity of the myocardial perfusion image to display the estimated degree of soft tissue attenuation on different regions of the heart and is patient specific.

(O'Connor and Kemp [2006](#))

92. C. Is a nonspecific finding

Chest pain during vasodilator ST is a nonspecific finding because of involvement of adenosine A1 receptors in the nociceptive pathway influencing the sensation of chest pain.

(Udelson et al. [2004b](#))

93. C. Expensive

A numerical score is assigned to each of the groups—inappropriate 1–3, uncertain 4–6, appropriate 7–9, and the level of evidence is provided if available.

(Hendel et al. [2009](#))

94. A. Brightness

The common exemplification is the higher the number of counts the brighter the pixel.

In color images the relative differences in count values are represented by different colors.

(Iskandrian and Garcia [2012](#))

95. C. A L-R shunt

L-R develops because of the higher left-sided pressures; however, under chronic conditions right-sided heart pressures often increase, and may eventually even exceed left-sided pressures, producing a swap of flow and a R-L shunt.

(MacDonald and Burrell [2008](#))

96. D. Regadenoson

The recommended dose of Lexiscan is 0.4 mg regadenoson/5 ml administered by rapid intravenous injection and followed immediately by a saline flush and the radiopharmaceutical.

([Astellas March, 2012](#))

97. D. A

The end diastolic image is in frame # 1; the end systolic image is in frame # 16. A patient's LVEF and other quantitative information are obtained from the image that shows the best separation between the LV and RV, with visualization of the septal wall, which can usually be obtained with a left anterior oblique view. A minimum of 16 frames per R-R interval are required for an accurate assessment of ventricular wall motion and assessment of ejection fraction.

(Christian et al. [2004](#))

98. C. Chest compression

In the A-B-C sequence, chest compressions are often pushed back while the responder opens the airway to give mouth-to-mouth breaths, retrieves a barrier device, or collects and connects ventilation equipment.

(AHA May 25 2012)

99. B. The vasodilator stress agents

As adenosine has a very short half-life (~20–30 s), administration of aminophylline is rarely required during adenosine testing; simply stopping the infusion results in cessation of symptoms within 20–30 s.

(Ficaro et al. 2012)

100. C. Increases progressively to a peak response ranging from 160–200 mmHg

The higher range of the systolic blood pressure can be observed in older patients with more resistant vascular systems.

(Ellestad 2003)

101. C. Two-day protocol

The 2-day protocol is well suited to image obese patients and allows elimination of day 2 study if the stress study is normal.

(Husain 2007)

102. B. Short-axis view

The short-axis tomograms are displayed with the apical slices always shown first, then progressing serially toward the cardiac base. The left ventricle to the viewer's right and the right ventricle to the viewer's left. The superior surface is at the top and the inferior surface at the bottom.

(The Society of Nuclear Medicine July 1992)

103. C. How much does a test cost

The guidelines have been developed in the context of scientific data, the health environment, the patient's profile, and the physician's judgment.

(Hendel et al. 2009)

104. D. Rb-82

Cardiogen-82® (Rubidium Rb-82 Generator) contains accelerator produced strontium Sr-82 adsorbed on stannic oxide in a lead-shielded column and provides a means for obtaining sterile nonpyrogenic solutions of rubidium chloride Rb-82 injection.

(Rubidium Rb-82 Generator Sept 21 2012)

105. A. Within the first 10 day of the menstrual cycle
If, despite the patient being pregnant, the test cannot be postponed; particular attention should be provided to optimize the exposure to both the expectant mother and the unborn child.
(Grainger et al. [2001](#))
106. A. Increase in false positive studies
Attenuation artifacts are commonly revealed as a lasting perfusion defect that may incorrectly be accounted for as evidence of a coronary artery disease. Furthermore, these “defects” may display reversibility with changes in position and be confounded with myocardial ischemia.
(Zaret and Beller [2005](#))
107. B. 140 mcg/kg/min infused for 6 min
The recommended intravenous total dose of Adenoscan for adults is 0.84 mg/kg.
([Astellas March 28 2012](#))
108. A. Reduce the possibility of an infiltrated dose
If there is any uncertainty with respect to an infiltrated dose, a static image of the injection site should be acquired. The intravenous line used should be wiped clean afterward and disposed of properly.
(Burrell and MacDonald [2006](#))
109. D. Stress-induced echocardiographic changes
Completing the exercise stress in combination with MPI allows incorporating supplementary information on functional capacity, stress-induced electrocardiographic changes or arrhythmias, and use of heart rate reserve and heart rate recovery in the assessment of CAD probability or prognosis.
(Mark and Lauer [2003](#))
110. C. Old and frail
The modified Bruce protocol, which starts at a lower workload than the standard test, is typically used for exercise testing within 1 week of myocardial infarction, for elderly or sedentary patients, and for patients who are expected to have poor exercise tolerance for other reasons.
([MedicineNet.com May 10 2012](#))
111. D. Technetium first-pass myocardial extraction is 60 %; its energy results in less scatter and soft tissue attenuation
None of the clinically obtainable SPECT perfusion tracers have all of the properties of an ideal perfusion tracer; nevertheless, regional differences in myocardial tracer uptake during exercise or pharmacologic stress have provided important diagnostic as well as prognostic information.
(Ficaro et al. [2012](#))

112. C. Exercise

Dobutamine is a direct-acting inotropic agent whose primary activity results from stimulation of the β receptors of the heart producing a dose-related increase in heart rate, blood pressure, and increased myocardial contractility. ([Dobutamine Feb 23 2012](#))

113. B. $\pm 10\%$ of the mean R–R interval

When the acceptance window is restricted, arrhythmic beats are rejected and the acquisition may be prolonged considerably. (Paul and Nabi [2004](#))

114. C. O-15 water

Freely diffusible tracers accumulate and wash out from myocardial tissue as a function of blood flow, and they do not depend on a metabolic trapping mechanism. (Bonow et al. [2011](#))

115. C. Radiation therapy

Morbidity and mortality due to MI can be reduced significantly if patients and witnesses recognize symptoms early, activate the EMS system, and in that way shorten the time to definitive treatment. (Akinpelu October 11 [2012](#))

116. A. ECFs on nuclear SPECT MPI are common and can be easily identified

Extracardiac incidental findings are observed in 1.7 % (0–2.8 %) of all cases, and 50 % of these are unsuspected prior to the study. (Iskandrian and Garcia [2012](#))

117. B. Lexiscan, saline flush, radiotracer, saline flush

The myocardial perfusion imaging agent should be injected 10–20 s after the saline flush directly into the same catheter as Lexiscan. ([Astellas July 28 2012](#))

118. A. Hibernating myocardium

Higher degrees of mismatch have been shown to be associated with improved LV function with revascularization. (Ghosh et al. [2010](#))

119. C. Injection

Because there is minimal redistribution of the radiopharmaceutical over time, imaging can be postponed and still provide accurate information about myocardial perfusion at the time of injection. (Wheat and Currie [2005](#))

120. A. The double product

The double product is used as an indirect measure of myocardial oxygen demand—the peak rate-pressure product can be used to characterize cardiovascular performance.

(Bonow et al. [2011](#))

121. A. $(EDV-ESV)/EDV \times 100$

The largest volume and the smallest volume represent the end-diastolic volume (EDV) and the end-systolic volume (ESV), respectively.

(Paul and Nabi [2004](#))

122. D. Transverse colon

A fatty meal may be used to speed hepatobiliary clearance of the sestamibi; however, there can be intense activity in the colon later, especially in patients with a high splenic flexure.

(Baggish and Boucher [2008](#))

123. B. 60 %

Myocardial uptake and clearance kinetics of both tracers are similar.

(Baggish and Boucher [2008](#))

124. A. F-18 FDG-6-phosphate

The 2' hydroxyl group ($-\text{OH}$) in normal glucose is needed for further glycolysis. F-18FDG is missing 2' hydroxyl and consequently FDG cannot be further metabolized in cells.

(Ghosh et al. [2010](#))

125. B. 70 ml

Stroke volume (SV) is the volume of blood pumped from one ventricle of the heart with each beat-normal range 55–100 ml.

(Schlosser et al. [2005](#))

126. D. Reinjection

After Tl-201 reinjection, approximately 50 % of regions with fixed defects on stress-redistribution imaging show significant enhancement of the tracer uptake, suggestive of improvement in regional LV function.

(Udelson et al. [2004a](#))

127. C. 5 ml (0.4 mg regadenoson)

Lexiscan is supplied in a single-use prefilled syringe: Injection solution containing regadenoson 0.4 mg/5 ml (0.08 mg/ml).

(Astellas July 28 2012)

128. A. Endogenous insulin

Released endogenous insulin also inhibits free fatty acids release from adipocytes leading to reduced circulating FFA.

(Fallavollita et al. [2010](#))

129. B. 10 %

In patients with atrial fibrillation, there may be considerable beat-to-beat variability, and the mean EF obtained during the period of acquisition may underestimate the actual LVEF.

(Dilsizian et al. [2009](#))

130. C. Seven stages

The protocol has seven stages, each taking 3 min, resulting in 21 min' exercise for a complete test.

([Hill and Timmis June 12 2012](#))

131. C. When radiotracer activity has cleared from the liver and not concentrated in the gastrointestinal tract

If there is a significant splanchnic or bowel overlap with the inferior wall, drinking water or milk or eating fatty food should be tried before repeating delayed imaging.

(Zaret and Beller [2005](#))

132. B. 180° arc

Projection views opposite the heart, i.e., LPO through RAO, spot considerably less myocardial activity due to attenuation through the patient's chest; those views provide mostly noise and scatter to the reconstruction, degrading overall resolution and contrast.

(Eisner et al. [1986](#))

133. A. 75–80 keV

The electron capture decay of thallium produces 88 photons at 70 to 80 keV and approximately 12 gamma photons at 135 and 167 keV for each 100 disintegrations. In spite of the excellent myocardial extraction and flow kinetic properties of thallium, its energy spectrum of 75–80 keV is suboptimal for conventional gamma cameras (ideal photopeak in the 140-keV range).

(Baggish and Boucher [2008](#))

134. D. Oxidative and oxygen metabolism

The cardiac muscle has a large number of mitochondria, enabling continuous aerobic respiration via oxidative phosphorylation, numerous myoglobins (oxygen-storing pigment), and a good blood supply, which provides nutrients and oxygen.

(Ghosh et al. [2010](#))

135. B. Left ventricle

The angle of the LAO projection is modified to obtain the best possible separation of the left and right ventricle. Tilting the detector head caudally will help separate the left ventricle from the left atrium.

(Christian et al. 2004).

136. D. 25–30 mSV

The American Society of Nuclear Cardiology strongly discourages use of dual isotope imaging on a routine basis with the exception of the assessment of myocardial viability.

(Cerqueira et al. 2010)

137. B. As a rapid (~10 s) injection

A 5 ml saline flush should be administered immediately after the injection of Lexiscan.

(Astellas July 28 2012)

138. B. Patient diagnosis

These patients may activate the alarms of the highly sensitive radiation detectors commonly used in public places, e.g., airports, government buildings, etc., by the Department of Homeland Security.

(Baggish and Boucher 2008)

139. B. An overestimation of the LVEF

An apparent shrinkage in the LV cavity observed in these patients is due to the partial-volume effect; zooming during the acquisition or reconstruction may reduce this error.

(Paul and Nabi 2004)

140. C. 3–4

The necessitated increase in blood flow must result from a decrease in vascular resistance, not through increase in blood pressure.

(Bonow et al. 2011)

141. B. Downscatter

The impact of scattered and primary photons from the first radionuclide into the photopeak window of the second radionuclide causes a significant degradation of image quality, image resolution, and quantitation errors.

(Henzlova et al. 2010)

142. C. Left anterior oblique

Images of the heart are usually acquired in two or three standard projections: anterior, “best septal” left anterior oblique (best separation of the left and right ventricles) and optional left lateral (or left posterior oblique). (Zaret and Beller 2005)

143. A. Pyrophosphate

Even though sestamibi, teboroxime, and tetrofosmin have received FDA approval, at present, only sestamibi and tetrofosmin are available for clinical use. (Baggish and Boucher 2008)

144. A. Assessment of perfusion during treadmill exercise

The relatively short half-lives of both ^{82}Rb -82 and ^{13}N ammonia limit the utility of PET perfusion studies to patients undergoing pharmacologic stress only. (Bonow et al. 2011)

145. B. Directly proportional to the blood flow at the time of injection

Generally, myocardial radiotracer uptake is linearly related to myocardial blood-flow under conditions of ischemia and mildly hyperemic flow; a linear relationship between myocardial perfusion radiotracer uptake and regional myocardial blood flow is preserved. At hyperemic flows, a relative decrease or “roll-off” in radiotracer extraction may be observed. (Iskandrian and Garcia 2012)

146. C. Viable myocardium

Stress defects with redistribution (reversible defects) on 3- to 4-h delayed images is also a manifestation of viable myocardium. (Schinkel et al. 2007)

147. A. Short-axis images

For the reason that the orientation of the heart relative to the patient’s long axis differs from patient to patient, it has become a customary way to reorient the transaxial images into short-axis images. (Christian et al. 2004)

148. B. Has a positive electric charge

The performance of positrons in tissue is very similar to beta particles; however, once a positron has been slowed down by atomic collisions, it is annihilated by interaction with an electron from a nearby atom. (Adam et al. 2008)

149. A. Assessment of LV function

Tl-201 has potential physical limitations for acquiring reliable ECG gated data, because the limited clinical dose and low energy compared with Tc-99m result in poor image quality, especially in ECG-gated images; the precision and accuracy of LVEF measurements with Tl-201 is debatable, particularly in cases of extended perfusion defects and poor count statistics.

(Baggish and Boucher 2008)

150. C. ST segment depression

The specificity of ST segment depression as the principal indicator of myocardial ischemia is limited. Decreased T waves, depressed J points and increased P waves are, among other, normal electrocardiographic changes observed during exercise.

(Banerjee et al. 2012)

151. B. The time of injection

As there is minimal clearance from the myocardium after initial uptake of this tracer, images acquired later than the initial injection represent a “snapshot” of blood flow and tracer uptake at the time of injection.

(Gibbons et al. 2000)

152. D. Masking motion artifacts

Since Tc-99m sestamibi, Tc-99m tetrofosmin, and Tl-201 can be picked up by tumors, visualization of lymph node activity on the cine raw data images ensuing from an infiltrated dose may mistakenly lead to an examination for malignancy.

(Williams et al. 2003)

153. B. Practice Management Software (PMS)

Direct comparison between these software packages showed excellent correlations in LV volumes and LVEF measurements.

(Nakajima et al. 2001)

154. B. Glucose utilization and metabolism

F-18 fluorodeoxyglucose has already set a standard in clinical care as a marker of glucose utilization in tissues exhibiting high glycolytic rates, including a broad spectrum of cancer types and ischemic but viable myocardium.

(Ghosh et al. 2010)

155. C. 71 %

Ejection fraction (%) = $[ED(\text{net}) - ES(\text{net})] \div ED \times 100$.

(Christian et al. 2004)

156. C. Scarred myocardium

The extent of scar has also been shown to be important in the prediction of LV function recovery after revascularization.

(Ghosh et al. [2010](#))

157. A. Hepatobiliary system

The high hepatic concentration may result in liver-dominant SPECT images with compromised cardiac resolution.

(Baggish and Boucher [2008](#))

158. C. Hg-201

Tl-201 has half-life of 73 h, emits Hg X-rays (~70–80 keV) and photons of 135 and 167 keV in 10 % total abundance. The lower-energy X-rays are captured during imaging.

(Baggish and Boucher [2008](#))

159. B. The referring physician name

For at least several hours after Tc-99m technetium-based MPI tracer injection and for a number of days after Tl-201 administration, patients may trigger the alarms of the highly sensitive radiation detectors now commonly used in public places.

(Baggish and Boucher [2008](#))

160. A. Afterload

Preload - the initial stretching of the cardiac myocytes prior to contraction- the end-diastolic volume (EDV) at the beginning of systole.

(Bonow et al. [2011](#))

161. C. An anterior, a left anterior oblique, and a left lateral view

The two-dimensional nature of planar imaging, in each of the standard views there is substantial overlap of myocardial regions; the tomographic (SPECT) perfusion imaging techniques replaced planar imaging as the standard acquisition and display methodology.

(Germano and Berman [2006](#))

162. C. A reducing agent

^{99m}Tc Technetium pertechnetate is bound to red blood cells using a variety of techniques. Three methods include the In Vivo Method, the Modified In Vivo/ In Vitro Method, and the In Vitro Method.

(Saha [2004](#))

163. D. Low energy and long half-life

The long half-life requires lower doses to minimize risk of radiation exposure; the low energy leads to more image attenuation, especially in obese patients. (Baggish and Boucher 2008)

164. B. F-18 fluorodeoxyglucose

F-18FDG—a glucose analog in which one OH group is replaced by an F-18 atom—the initial tracer uptake in myocytes is comparable to glucose uptake. (Schinkel et al. 2007)

165. C. Referring physician

If the test is ordered for diagnostic purposes, beta-blocking and calcium-blocking medications, if possible, should be stopped 24 h before, or at the least on, the day of the procedure. Nitrates should not be taken on the day of the stress test.

(Zaret and Beller 2005)

166. C. Tl-201 stress–redistribution–rejection imaging

The early uptake of Tl-201 largely depends on regional perfusion, while sustained uptake on cell membrane integrity (myocyte viability).

(Schinkel et al. 2007)

167. C. Vasodilating effect

Caffeine and methylxanthines block the adenosine receptors on arterial smooth muscle cells (A2b receptors) responsible for vasodilation in most vascular beds.

(Burrell and MacDonald 2006)

168. C. Dysfunctional but viable

Stunned or hibernating myocardium is dysfunctional but viable and has the potential to return to normal or improved contractile function with revascularization.

(Takalkar et al. 2011)

169. B. Myocardial viability assessment

Distinction of the viable myocardium from the nonviable myocardium before surgical intervention is imperative—dysfunctional but viable myocardium is potentially reversible and patients often benefit from surgery when quality of life and survival is considered.

(Zaret and Beller 2005)

170. D. Sinus bradycardia

Sinus bradycardia is a rhythm in which fewer than the normal—60–100 beats per minute—number of impulses arise from the sinoatrial (SA) node. Sinus bradycardia always needs to be interpreted in clinical context because it may be a normal variant or may be due to drug effect/toxicity, sinus node dysfunction, etc. Symptoms may include syncope, dizziness, lightheadedness, chest pain, shortness of breath.

(Goldberger 2006)

171. D. Infarct avid imaging study

Tc-99m-pyrophosphate myocardial scintigraphy does not provide information on the ventricular function; it is concentrated in the injured myocardium, primarily in areas of irreversibly damaged myocardial cells.

(Zaret and Beller 2005)

172. A. Isobaric

Isotonic exercise-dynamic or locomotory- primarily provides a volume load to the left ventricle. The cardiovascular response is proportional to the size of the muscle mass and the intensity of the exercise.

(Ellestad 2003)

173. D. Reduction in coronary vascular resistance

The major determinants of coronary blood flow include aortic diastolic pressure, which varies little during exercise, from the resting value, and a reduction in coronary vascular resistance, which is the major mechanism responsible for increasing coronary blood flow during stress.

(Bonow et al. 2011)

174. C. 78 s

In spite of an ultrashort half-life, Rb-82 offers distinct logistical advantages. It is available through a generator that typically is operated by a semi-automated intravenous infusion system that makes possible close synchronization between pharmacologic or other stress interventions and the tracer administration.

(Schelbert 2009)

175. B. The pulmonary arteries, D. The right side of the heart, F. The venous system

The left cardiovascular system consists of the pulmonary veins returning oxygenated blood to the heart, the left side of the heart, and the systemic arterial system transporting blood to the body.

(MacDonald and Burrell 2008)

176. D. Patient on calcium channel blockers

Improper dietary/medication restrictions, e.g., caffeine consumption for pharmacologic stress studies, poor technique, and increased distance between patient and detector, can also result in false negative MPI.

(Zaret and Beller 2005)

177. B. myocardial necrosis

Tc-99m labeled pyrophosphate has been shown to bind to areas of necrosis and is believed to bind exposed mitochondrial calcium. (20 mCi min 4 h delay, within 12 h – 10 days post MI).

(Zaret and Beller 2005)

178. D. cardiac output

Cardiac output = Stroke Volume \times Heart rate

An average resting cardiac output—5.6 L/min for a human male and 4.9 L/min for a female.

(Guyton and Hall 2006)

179. D. Viability assessment

There is minimal redistribution of these tracers compared with thallium.

(Baggish and Boucher 2008)

180. C. Electrolyte abnormalities

Acute myocarditis, poorly controlled congestive heart failure, and uncontrolled cardiac arrhythmias with hemodynamic compromise are also absolute contraindications for exercise stress.

(Henzlova et al. 2010)

181. B. Epicardial and endocardial borders

Multiple two-dimensional contours of the epicardial and endocardial borders of all of the tomograms in all three orthogonal planes are then reconstructed to create a surface-rendered three-dimensional display representing global LV function across a typical cardiac cycle.

(Germano and Berman 2006)

182. D. 4–5 times above the resting level

Myocardial regions supplied by stenotic coronary arteries have an attenuated hyperemic response. During exercise stress, coronary blood flow can increase approximately two to three times above resting levels.

(Bonow et al. 2011)

183. B. Viable dysfunctional myocardium

A dysfunctional territory with normal or only mildly reduced tracer uptake has a high likelihood of improved function after revascularization.

(Bonow 2002)

184. B. Low count density and low spatial resolution

Although myocardial perfusion images obtained with Rb-82 display lower count density and spatial resolution, the images are usually of good diagnostic quality.

(Schelbert 2009)

185. B. Sensitivity

Specificity relates to the ability of the test to identify negative results.

(Munro 2005)

186. D. Sinoatrial node

The SA node, a small mass of specialized cardiac tissue, is made up of Purkinje fibers, ganglion cells, and nerve fibers. It is located in the posterior wall of the right atrium of the heart that acts as a pacemaker by generating the electric impulses of the heartbeat at regular intervals.

(Bonow et al. 2011)

187. B. Aminophylline

Aminophylline may be administered in doses ranging from 50 mg to 250 mg by slow intravenous injection (50 mg to 100 mg over 30–60 s).

(Astellas July 28 2012)

188. A. Angina pectoris

Angina pectoris is caused by chemical and mechanical stimulation of sensory afferent nerve endings in the coronary vessels and myocardium and transmitted to the cerebral cortex.

(Alaeddini July 24 2012)

189. A. Balanced ischemia

Incorporation of other findings, including regional functional abnormalities from the gated portion of the examination, can be used to estimate more correctly the probability of disease and its extent.

(Dilsizian et al. 2009)

190. A. $\text{mm Hg} \times \text{beats}/\text{min} \times 10^{-3}$

Most healthy individuals develop a peak rate pressure product of $20\text{--}35 \text{ mmHg} \times \text{beats}/\text{min} \times 10^{-3}$.

(Bonow et al. 2011)

191. B. Take their regular dose of insulin; eat a light breakfast
Some labs advise patients, if they own a glucose monitor, to bring it with them to check their blood sugar levels before and after their exercise stress test. (Diabetes and Stress Tests June 03 2012)
192. D. Upward creep
Delayed scanning time is also recommended in the presence of artifacts caused by increased liver activity (inferior or inferolateral defects are worse on resting images and with pharmacological agents). (Karacalioglu 2006)
193. B. R wave is detected
ECG guides the acquisition so that the resulting set of SPECT images shows the heart as it contracts over the interval from one R wave to the next. (Germano and Berman 2006)
194. C. 10 min
Because of the 10 min half-life, N-13 ammonia is logistically less demanding than oxygen-15–labeled (O-15) water that has a half-life of only 124 s. (Schelbert 2009)
195. C. Stunned myocardium
Hibernating myocardium is ischemic myocardium supplied by a narrowed coronary artery, in which ischemic cells remain viable, but contraction is chronically depressed. (Schinkel et al. 2007)
196. A. End-diastolic event
At a heart rate of 60 beats/min, each of the eight frames would comprise 125 ms—the first 125 ms after the peak of the initial R wave, and all imaging data that are recorded in frame 1 represent the end diastolic event. (Germano and Berman 2006)
197. C. 35
NRC regulations that govern most nuclear medicine operations may be found in the CFR 10 parts 20, 30, and 35. (Mettler and Guiberteau 2006)
198. C. A scarred myocardium
Myocardial scarring is fibrous tissue that replaces normal tissue destroyed by injury or disease pertaining to the muscular tissue of the heart, e.g., myocardial infarction, surgical repair of congenital heart disease. (Ghosh et al. 2010)

199. C. 6 h

Tc-99m is eluted from molybdenum Mo-99 in a generator and decays by isomeric transition with a physical T_{1/2} of 6.0 h.

(Early and Sodee 1995)

200. B. Allows assessment of patient functional capacity

Treadmill exercise ECG testing is widely available, inexpensive, and allows assessment of patient functional capacity. Imaging studies are indicated to localize the site or extent of myocardial ischemia and to assess myocardial viability.

(Weiner 2012)

201. A. Computed tomography study

3D volume rendered computed tomography (3D-CT) produces detailed, three-dimensional models that can be rotated and viewed in any orientation to provide a more natural and functional view of the patient's anatomy.

(Ropers et al. 2001)

202. D. Roentgen

Roentgen (R)—the dose of ionizing radiation that will produce 1 electrostatic unit of electricity in 1 cc of dry air—will still be seen on radiation survey instruments, and on radiation surveys, until the older models can be replaced. The radiation dose of record must be provided in rad or rem.

(NRC Accessed October 21 2012)

203. A. Ga-67 citrate

Only brief interruption (hours to days) of breast feeding is advised for Tc-99m macroaggregated albumin, Tc-99m pertechnetate, Tc-99m RBCs, 99mTc-WBCs, I-123 metaiodobenzylguanidine, and Tl-201.

(NRC Accessed Sept 1 2012)

204. B. Lipids

FAs are important component of lipids (fat-soluble components of living cells) in plants, animals, and microorganisms. Oleic acid, because it contains one double bond, is also denoted to as monounsaturated. Fatty acids that have multiple double bonds, e.g., linoleic acid are called polyunsaturated. Polyunsaturated fats are liquid at room temperature.

(Statkiewicz-Sherer et al. 2011)

205. B. The left circumflex coronary artery (LCX)

The LCX runs in the left atrial-ventricular sulcus and gives origin to obtuse marginal branches (OM), named from proximal to distal, OM1, OM2, OM3, and so on.

(Smuclovsky 2009)

206. B. Low energy high resolution

A high resolution collimator is recommended when imaging time can be extended and when good anatomical information is needed.

(Sharp et al. 2005)

207. B. Nitroglycerine is needed to counteract stress-induced ischemia

Nitroglycerine should not be given to a person who has recently taken Viagra, since the combination can cause a serious drop in blood pressure.

(Viagra Accessed Nov 23 2012)

208. A. Myocardial thickening

Parameters of diastolic function require a considerably greater number of gating intervals than are commonly exercised.

(Khalil 2011)

209. D. Summed Difference Score (SDS)

Summed Difference Score (SDS) is the difference between SSS and SRS.

(Fuster et al. 2007)

210. A. Normal coronary arteries

Similar to all planar angiograms, coronary angiograms are luminograms—one cannot see the wall of the vessel, only the contrast-filled lumen. Many times, it is difficult to grade a stenosis as having a single percentage value, and a range of percentage values is applied. Arteries that are totally occluded are referred to as total or 100 % occlusions.

(Ho and Reddy 2011)

211. A. Apex

The polar map represents the entire left ventricular volume, separated from the rest of the heart, with the tip of the apex turned toward the viewer in the center of the map.

(Zaret and Beller 2005)

212. D. Low reproducibility

Repeated analyses of the same ECHO recordings underestimate the clinically relevant interobserver reproducibility obtained by separate examinations by ~40 % for most measurements of LV function. Radionuclide gated equilibrium blood pool imaging provides rapid assessment with little discomfort but the high quantitative reproducibility.

(Ho and Reddy 2011)

213. A. The rest study can be omitted if the stress study is normal

The stress-rest sequence has theoretical advantages since a significant percentage of patients will have normal stress studies, thereby avoiding additional radiation exposure from a rest study.

(Ho and Reddy 2011)

214. A. 2-day stress/rest protocols

Two high doses on two separate days of Tc-99m labeled compounds produce the elevated high count rate, which enables high-quality images. The main disadvantage is the delay in reporting of the final analysis.

(Ho and Reddy 2011)

215. D. Ventriculogram

Left ventriculography is performed with coronary angiography, whereby a catheter is advanced into the left ventricle and contrast medium injected. Visualization of the left ventricle chamber allows assessment of the left ventricle function, e.g., measurement ejection fraction.

(Ho and Reddy 2011)

References and Suggested Readings

- Adam A, Dixon KA, Grainger GR, Allison JD. Adam: Grainger & Allison's diagnostic radiology. 5th ed. St. Louis, MO: Churchill Livingstone; 2008.
- AHA. http://www.heart.org/fidc/groups/heart-public/@wcm/@ecc/documents/downloadable/ucm_317350.pdf.
- Akinpelu, D. ed. Treadmill stress testing. <http://emedicine.medscape.com/article/1827089>. Accessed 11 Oct 2012.
- Alaeddini J. Angina pectoris. <http://emedicine.medscape.com/article/150215-overview#a0104>. Accessed 24 July 2012
- Astellas. <http://www.astellas.us/docs/>.
- Baggish LA, Boucher AC. Radiopharmaceutical agents for myocardial perfusion imaging. *Circulation*. 2008;118:1668–74.
- Banerjee A, Newman DR, Van den Bruel A, Heneghan C. Diagnostic accuracy of exercise stress testing for coronary artery disease: a systematic review and meta-analysis of prospective studies. *Int J Clin Pract*. 2012;66(5):477–92.
- Bateman TM, Heller GV, McGhie AI, et al. Diagnostic accuracy of rest/stress ECG-gated Rb-82 myocardial perfusion PET: comparison with ECG-gated Tc-99m sestamibi SPECT. *J Nucl Cardiol*. 2006;13:24–33.
- Bengel MF, Higuchi T, et al. Cardiac positron emission tomography. *J Am Coll Cardiol*. 2009;54:1–15.
- Bonow RO. Myocardial viability and prognosis in patients with ischemic left ventricular dysfunction. *J Am Coll Cardiol*. 2002;39:1159.
- Bonow RO, Mann LD, Zipes PD, et al. Braunwald's heart disease – a textbook of cardiovascular medicine. 9th ed. Philadelphia, PA: Elsevier Saunders; 2011.
- Burrell S, MacDonald A. Artifacts and pitfalls in myocardial perfusion imaging. *J Nucl Med Technol*. 2006;34:193–211.

- Cerqueira MD, Allman KC, Ficaro EP, et al. Recommendations for reducing radiation exposure in myocardial perfusion imaging. *J Nucl Cardiol*. 2010;17:709.
- Christian PE, Bernier DR, Langan JK. *Nuclear medicine and PET: technology and techniques*. 5th ed. St. Louis, MO: Mosby; 2004.
- Cleland JG, Pennell DJ, Ray SG, et al. Myocardial viability as a determinant of the ejection fraction response to carvedilol in patients with heart failure (CHRISTMAS trial): randomised controlled trial. *Lancet*. 2003;362:14.
- Diabetes and Stress Tests. <http://diabetes.webmd.com/diagnosing-stress-tests?> Accessed June 03 2012.
- Dilsizian V, Narula J, Braunwald E, editors. *Atlas of nuclear cardiology*. 3rd ed. Philadelphia, PA: Current Medicine; 2009.
- Dobutamine. <http://www.drugs.com/pro/dobutamine.html>
- Early PJ, Sodee BD. *Principles and practice of nuclear medicine*. 2nd ed. St. Louis, MO: Mosby; 1995.
- Eisner RL, Nowak DJ, Pettigrew R, et al. Fundamentals of 180 degree acquisition and reconstruction in SPECT imaging. *J Nucl Med*. 1986;27:1717–28.
- Ellestad MH. *Stress testing: principles and practice*. 5th ed. New York: Oxford University Press; 2003.
- Erlandsson K, Kacperski K, van Gramberg D, Hutton BF. Performance evaluation of D-SPECT: a novel SPECT system for nuclear cardiology. *Phys Med Biol*. 2009;54:2635.
- Fallavollita JA, Luisi Jr AJ, Yun E, Dekemp RA, Canty Jr JM. An abbreviated hyperinsulinemic-euglycemic clamp results in similar myocardial glucose utilization in both diabetic and non-diabetic patients with ischemic cardiomyopathy. *J Nucl Cardiol*. 2010;17:637–45.
- Ficaro EP, Hansen CL, American Society of Nuclear Cardiology: *Imaging Guidelines for Nuclear Cardiology Procedures*. Available at: <http://www.asnc.org/imageuploads/ImagingGuidelinesComplete070709.pdf>. Accessed 22 May 2012.
- Fuster V, O'Rourke RA, Walsh RA, Wilson P. *Hurst's the heart*. 12th ed. New York: McGraw Hill; 2007.
- Germano G. Technical aspects of myocardial SPECT imaging. *J Nucl Med*. 2001;42:1499–507.
- Germano G, Berman DS, editors. *Clinical gated cardiac SPECT*. Armonk, NY: Blackwell Futura; 2006.
- Germano G, Kiat H, Kavanagh PB, et al. Automatic quantification of ejection fraction from gated myocardial perfusion SPECT. *J Nucl Med*. 1995;36(11):2130–47.
- Ghosh N, Rimoldi EO, Beanlands SBR, et al. Assessment of myocardial ischaemia and viability: role of positron emission tomography. *Eur Heart J*. 2010;31:2984–95.
- Gibbons JR. *Imaging techniques. Myocardial perfusion imaging*. *Heart*. 2000;83:355–60.
- Gibbons RJ, Miller TD, Christian TF. Infarct size measured by single photon emission computed tomographic imaging with 99mTc-sestamibi: a measure of the efficacy of therapy in acute myocardial infarction. *Circulation*. 2000;101:101.
- Goldberger LA. *Clinical electrocardiography: a simplified approach*. 7th ed. St Louis, MO: Mosby Elsevier; 2006.
- Grainger GR, Allison JD, Adam A, Dixon KA. *Grainger & Allison's diagnostic radiology: a textbook of medical imaging*. 4th ed. London: Harcourt Publishers; 2001.
- Guyton A, Hall EJ. *Textbook of medical physiology*. 11th ed. Philadelphia, PA: Elsevier; 2006.
- Heller VG, Lundbye BJ, Kapetanopoulos A. Vasodilator stress radionuclide myocardial perfusion imaging: testing methodologies and safety. <http://www.uptodate.com>
- Heller G, Calnon D, Dorbala S. Recent advances in cardiac PET and PET/CT myocardial perfusion imaging. *J Nucl Cardiol*. 2009;16(6):962–9.
- Hendel CR, et al. ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM 2009 appropriate use criteria for cardiac radionuclide imaging. *J Am Coll Cardiol*. 2009;53(23):2201–29.
- Henzlova JM, Cerqueira DM, Christopher L, HC H, et al. ASNC imaging guidelines for nuclear cardiology procedures. Stress protocols and tracers. *J Nucl Cardiol*. 2010;17:646–54.
- Hill J, Timmis A. *ABC of clinical electrocardiography. Exercise tolerance testing*. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1123032/pdf/1084.pdf>.

- Ho BV, Reddy PG. Cardiovascular imaging. 1st ed. St Louis, MO: Saunders; 2011.
- Husain SS. Myocardial perfusion imaging protocols: is there an ideal protocol? *J Nucl Med Technol.* 2007;35:3–9.
- Iskandrian EA, Garcia VE. Atlas of nuclear cardiology: imaging companion to Braunwald's heart disease. Philadelphia, PA: Elsevier Saunders; 2012.
- Iskandrian AE, Verani MS, et al. Nuclear cardiac imaging and principles applications. 3rd ed. New York: Oxford University Press; 2003.
- Jubran A. Pulse oximetry. <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC137227/>.
- Karacalioglu OA, Jata B, Kilic S, et al. A physiologic approach to decreasing upward creep of the heart during myocardial perfusion imaging. *J Nucl Med Technol.* 2006;34:215–9.
- Khalil MM, editor. Basic sciences of nuclear medicine. Berlin: Springer; 2011.
- Klabunde ER. Cardiovascular physiology concepts. <http://www.cvphysiology.com/CAD/CAD003.htm>
- Koller D. Assessing diagnostic performance in nuclear cardiology. *J Nucl Cardiol.* 2002;9:114–23.
- Kowalczyk N, Donnett AK. Integrated patient care for the imaging professional. 1st ed. St. Louis, MO: Mosby; 1996.
- Lin CE, Alavi A. PET and PET/CT. A clinical guide. 2nd ed. New York, NY: Thieme; 2009.
- MacDonald A, Burrell AS. Infrequently performed studies in nuclear medicine: part 1. *J Nucl Med Technol.* 2008;36:132–43.
- Mark DB, Lauer MS. Exercise capacity: the prognostic variable that doesn't get enough respect. *Circulation.* 2003;108:1534.
- MedicineNet.com. Definition of Bruce protocol. <http://www.medterms.com/script/main/art.asp?articlekey=30741>
- Mettler FA, Guiberteau MJ. Essentials of nuclear medicine imaging. 5th ed. Philadelphia, PA: Saunders Elsevier; 2006.
- Munro HB. Statistical methods for health care research. 5th ed. Philadelphia, PA: Lippincott Williams & Wilkins; 2005.
- Nakajima K, Higuchi T, Taki J, Kwano M, Tonami N. Accuracy of ventricular volume and ejection fraction measured by gated myocardial perfusion SPECT: comparison of 4 software programs. *J Nucl Med.* 2001;42:1571–8.
- Nichols K, DePuey EG, Rozanski A. First-pass radionuclide angiocardiology with single-crystal gamma cameras. *J Nucl Cardiol.* 1997;4:61–73.
- NRC. <http://www.nrc.gov/reading-rm/basic-ref/teachers/05.pdf>
- O'Connor MK, Kemp BJ. Single-photon emission computed tomography/computed tomography: basic instrumentation and innovations. *Semin Nucl Med.* 2006;36:258266.
- Paul KA, Nabi AH. Gated myocardial perfusion SPECT: basic principles. Technical aspects, and clinical applications. *J Nucl Med Technol.* 2004;32:179–87.
- Ropers D, Moshage W, Daniel WG, Jessl J, Gottwik M, Achenbach S. Visualization of coronary artery anomalies and their anatomic course by contrast-enhanced electron beam tomography and three-dimensional reconstruction. *Am J Cardiol.* 2001;87:193–7.
- Rubidium Rb-82 Generator. <http://www.nuclearonline.org/PI/Cardiogen.pdf>. Accessed Sept 21 2012.
- Saha GB. Fundamentals of nuclear pharmacy. 5th ed. New York, NY: Springer; 2004.
- Schelbert RH. Quantification of myocardial blood flow: what is the clinical role? *Cardiol Clin.* 2009;27:277–89.
- Schinkel FLA, Poldermans D, Elhendy A, Bax JJ. Assessment of myocardial viability in patients with heart failure. *J Nucl Med.* 2007;48:1135–46.
- Schlosser T, Pagonidis K, Herborn UC, et al. Assessment of left ventricular parameters using 16-MDCT: Results. *Am J Roentgenol.* 2005;184(3):765–73.
- Sharp FP, Gemmell GH, Murray DA, editors. Practical nuclear medicine. 3rd ed. London: Springer; 2005.
- Smuclovsky C. Coronary artery CTA. A case based atlas. Berlin: Springer; 2009.

- SNM. Society of Nuclear Medicine Procedure Guideline for Myocardial Perfusion Imaging. http://interactive.snm.org/docs/pg_ch02_0403.pdf.
- Statkiewicz-Sherer MA, Ritenour ER, Visconti PJ. Radiation protection in medical radiography. 6th ed. Maryland Heights, MO: Mosby; 2011.
- Strauss WH, Grewal KR, Pandit-Taskar N. Molecular imaging in nuclear cardiology. *Semin in Nucl Med*. 2004;XXXIV(1):47–55.
- Takalkar A, Agarwal A, Adams S, et al. Cardiac Assessment with PET. *PET Clin*. 2011;6:313–26.
- The Society of Nuclear Medicine, the American Heart Association, the American College of Cardiology. Standardization of cardiac tomographic imaging. *J Nucl Med*. 1992;33(7):1434–5.
- Thomas GS, Prill NV, Majmundar H, Fabrizi RR, Thomas JJ, Hayashida C, et al. Treadmill exercise during adenosine infusion is safe, results in fewer adverse reactions, and improves myocardial perfusion image quality. *J Nucl Cardiol*. 2000;7:439–46.
- Udelson JE, Bonow RO, Dilsizian V. The historical and conceptual evolution of radionuclide assessment of myocardial viability. *J Nucl Cardiol*. 2004a;11:318.
- Udelson JE, Heller GV, Wackers FJ, et al. A randomized, controlled dose-ranging study of the selective adenosine A2A receptor agonist binodenoson for pharmacologic stress as an adjunct to myocardial perfusion imaging. *Circulation*. 2004b;109:457.
- Viagra. http://www.viagra.com/?source=google&HBX_PK=s_viagra&o=23121503116637479310&skwid=43100000390696855.
- Weiner AD. Stress testing to determine prognosis and management of patients with known or suspected coronary heart disease. www.uptodate.com.
- Wheat MJ, Currie MG. Rest versus Stress Ejection Fraction on Gated Myocardial Perfusion SPECT. *J Nucl Med Technol*. 2005;33:218–23.
- Williams MA, Haskell WL, Ades P, et al. Resistance exercise in individuals with and without cardiovascular disease: 2007 update. A Scientific Statement from the American Heart Association Council on Clinical Cardiology and Council on Nutrition, Physical Activity, and Metabolism. *Circulation*. 2007;116:572.
- Williams KA, Hill KA, Sheridan CM. Noncardiac findings on dual-isotope myocardial perfusion SPECT. *J Nucl Cardiol*. 2003;10:395–402.
- Yoshinaga K, Katoh C, Noriyasu K, et al. Reduction of coronary flow reserve in areas with and without ischemia on stress perfusion imaging in patients with coronary artery disease: A study using oxygen 15-labeled water PET. *J Nucl Cardiol*. 2003;10:275–83.
- Zaret BL, Beller GA. *Clinical nuclear cardiology: state of the art and future directions*. 3rd ed. Philadelphia, PA: Mosby; 2005.



<http://www.springer.com/978-1-4614-8644-2>

Nuclear Cardiology Study Guide
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Certification Exams

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2014, XV, 281 p. 34 illus., 24 illus. in color., Softcover

ISBN: 978-1-4614-8644-2