Nuclear Medicine in Acute Care

5

5.1 Nuclear Cardiology and Cardiac Transplantation

1. What is the gold standard diagnostic test for cardiac transplant rejection?
   (a) PET
   (b) ^{123}I-IPPA
   (c) MRI
   (d) Endomyocardial biopsy
2. All of the following radionuclide imaging methods are examined for the diagnosis of cardiac transplant rejection *except*:
   (a) ^{99m}Tc-annexin V
   (b) Radiolabeled somatostatin analog
   (c) ^{111}In-antimyosin
   (d) ^{11}C-MQNB

5.1.1 Answer

	A	B	C	D
1				*
2				*

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5.2 Cardiovascular Conditions: Venous Thrombosis

1. Regarding radionuclide venography (RNV):
   (a) The negative RNV cannot exclude the presence of deep vein thrombosis (DVT).
   (b) It can be used as a screening test.
   (c) In ascending dynamic RNV, the injection is performed antecubitally.
   (d) In static RNV, the administration of radiopharmaceutical is usually performed in the pedal veins.
2. Impedance plethysmography (IPG):
   (a) IPG can detect most calf thrombi.
   (b) IPG is unable to detect thrombi that produce obstruction in the thigh.
   (c) Congestive heart failure can lead to false-negative results.
   (d) Peripheral arterial disease can reduce the accuracy of the test.
3. All of the following statements regarding Doppler ultrasonography are true *except*:
   (a) It has high accuracy in patients with initial episodes of DVT.
   (b) False-positive results are generally related to incompressibility of the iliac and femoral veins.
   (c) It fails to distinguish between recent and chronic thrombi.
   (d) Collateral formations, which are best seen on RNV, are also visualized on ultrasonography.
4. What is the most common site of bilateral DVT and its rate?
   (a) Femoro–saphenous junction, 30%
   (b) External–internal iliac junction, 40%
   (c) Ilio–femoral junction, 18%
   (d) Iliac–IVC junction, 20%
5. Which of the following findings on static RNV is the most indicative of acute DVT?
   (a) A focal hot spot with a network of collaterals on ^{111}In-platelet scan
   (b) A segmental hot spot with a network of collaterals on ^{111}In-platelet scan
   (c) A focal hot spot without a network of collaterals on ^{111}In-platelet scan
   (d) A segmental hot spot without a network of collaterals on ^{111}In-platelet scan
6. What is the mechanism of ^{111}In-platelet accumulation in regions of active thrombosis?
   (a) Chemisorption
   (b) Compartmental localization
   (c) Cell sequestration
   (d) Capillary blockade

7. Which item is NOT correct about ^{99m}Tc-apcitide scan?
   (a) It is a synthetic peptide.
   (b) It binds to glycoprotein IIa and IIIb receptors on the surface of the platelets.
   (c) It has high sensitivity for distinguishing acute and chronic thrombosis.
   (d) Aspirin and heparin increase the incidence of false-negative results.
8. What is the dilution effect in venography?
   (a) It represents the complete vascular occlusion where dilution occurs.
   (b) A normal condition indicating the perfusion of organs with drainage to the corresponding vessels.
   (c) It indicates hemangioma in the corresponding vessels.
   (d) This condition is observed in vascular grafts and indicates a partial occlusion.
9. A patient with a history of deep vein thrombosis underwent thrombolytic therapy. On radionuclide venography 9 months after the base scan, the involved vein is thinner than the opposite site and has less activity. In addition, collaterals are also observed. Which item is the most probable?
   (a) The findings represent a deficiency in resolving the thrombosis.
   (b) Thrombosis is progressing.
   (c) Thrombosis is resolving.
   (d) Venography is NOT indicated for follow-up.
10. On radionuclide venography:
   (a) The frog leg position is helpful for the differentiation of superficial and deep veins.
   (b) A high volume of pertechnetate significantly decreases the image quality especially in post-phlebitic syndrome.
   (c) A tourniquet can help to increase the radiotracer entrance into the superficial veins.
   (d) A hot spot pattern is the pathognomonic sign of deep vein thrombosis.
11. Which of the following statements regarding ascending dynamic radionuclide venography is NOT correct?
   (a) Obstruction of popliteal vessels is usually associated with frequent collaterals.
   (b) Obstruction of iliac vessels is usually associated with frequent collaterals.
   (c) The extent of collateral network depends on grade, size, and age of vein thrombosis.
   (d) The absence of the observation of a vein is NOT indicative of an obstruction in the entire length of the vein.
12. Which of the following statements about the diagnosis of deep vein thrombosis (DVT) is NOT correct?
   (a) Sonography of regions inferior to the knee is less valuable.
   (b) ^{99m}Tc-apcitide is valuable for the diagnosis of acute DVT.
   (c) If the patient is overweight, ^{99m}Tc-apcitide is less valuable.
   (d) ^{99m}Tc-apcitide can also be used for the diagnosis of DVT in the upper limbs.

13. All of the following veins can be evaluated properly by ultrasonography *except*:
    (a) Iliac vein
    (b) Popliteal vein
    (c) Femoral vein
    (d) Posterior tibial vein
14. All of the following statements regarding the sonographic assessment of the lower limb veins are correct *except*:
    (a) Compressability assessment has sensitivity of 90–95%.
    (b) Non-visibility of thrombosis in the proximal veins does NOT exclude thrombosis in the system.
    (c) A duplicated deep vein causes a false-positive result.
    (d) The value of sonography in addition to the detection of thrombosis is the diagnosis of underlying conditions.
15. What is the next step for the evaluation of a patient with signs and symptoms suggestive of acute DVT if Doppler ultrasonography is normal?
    (a) CT scan
    (b) Contrast venography
    (c) ^{99m}Tc-apcitide
    (d) MRI
16. ^{99m}Tc-apcitide and contrast venography are the most consistent in:
    (a) DVT of the calf.
    (b) DVT of the knee.
    (c) DVT of the thigh.
    (d) Consistency is equal for all three regions.
17. What is the main effect of anticoagulant administration on the outcome of ^{99m}Tc-apcitide scan?
    (a) Increase in the incidence of false-negative outcomes
    (b) Increase in the incidence of false-positive outcomes
    (c) Decrease in the incidence of false-negative outcomes
    (d) No effect
18. What is the target organ of the ^{99m}Tc-apcitide scan?
    (a) Bladder
    (b) Gallbladder
    (c) Lungs
    (d) Liver
19. Deep vein thrombosis (DVT):
    (a) Most patients with pulmonary emboli do NOT exhibit DVT.
    (b) Sonography is recommended for screening high-risk asymptomatic patients.
    (c) The accuracy of MRI for the detection of DVT is low.
    (d) The accuracy of CT scan for the detection of DVT is low.

5.2.1 Answer

	A	B	C	D
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19	*			

5.3 Pulmonary Embolism

1. In pulmonary embolism (PE):
   (a) A low false-positive rate of the D-dimer test enables it to be used as a screening tool.
   (b) In a high clinical suspicion, a normal D-dimer assay should preclude imaging to ascertain PE.
   (c) Ultrasound has replaced conventional venography in detecting thrombus above the knee.
   (d) Postmortem studies have shown that 20% of hospitalized patients have PE.
2. Which sign of PE on plain chest radiography is rare?
   (a) Westermark's sign
   (b) Fleischner sign
   (c) Hampton's hump sign
   (d) Cavitation
3. What is the gold standard for examining PE?
   (a) CT pulmonary angiography
   (b) MR angiography
   (c) Pulmonary angiography
   (d) Ventilation/perfusion scan
4. The absorbed radiation dose attributable to CT pulmonary angiography is approximately equivalent to:
   (a) 40 chest radiographs
   (b) 140 chest radiographs
   (c) 400 chest radiographs
   (d) 240 chest radiographs
5. The accuracy of a single-slice CTPA for the detection of subsegmental PE is …, and the rate of pure subsegmental PE is ….
   (a) <10%, 50%
   (b) <25%, 30%
   (c) <10%, 30%
   (d) <25%, 50%
6. Complete matching on the V/Q scan is seen in:
   (a) Pleural effusion
   (b) Lobar pneumonia
   (c) Bronchial asthma
   (d) Gross cardiomegaly
7. Which pulmonary vasculitis disease affects medium-sized and large arteries of the pulmonary vasculature and gives V/Q scans indistinguishable from PE?
   (a) Systemic lupus erythematosus (SLE)
   (b) Polyarteritis nodosa
   (c) Wegener's granulomatosis
   (d) Takayasu's arteritis

8. What is the technique of choice for the demonstration of chronic thromboembolic pulmonary hypertension (CTEPH)?
   (a) MR angiography
   (b) V/Q scan
   (c) CT angiography
   (d) V/Q scan + chest radiograph
9. Compared with CTPA, V/Q scan is considered the initial examination for patients with:
   (a) Cardiorespiratory diseases
   (b) A consolidation on chest radiograph
   (c) Objective risk factor
   (d) Normal chest radiograph
10. What is the best radiologic method for the detection of pulmonary emboli?
   (a) CT with contrast
   (b) CT angiography
   (c) MRI
   (d) MRI angiography
11. What is the most suitable radiopharmaceutical for a pulmonary ventilation scan in a pregnant woman with suspected emboli?
   (a) ^{99m}Tc-DTPA aerosol
   (b) ^{133}Xe
   (c) ^{81m}Kr
   (d) ^{99m}Tc-technegas
12. Regarding ventilation/perfusion scan, the defect in ventilation scan is worse than that of perfusion. Which of the following diseases should be considered?
   (a) COPD
   (b) Cardiomegaly
   (c) Lobar pneumonia
   (d) All of the above
13. On a V/Q scan, an incomplete match indicates:
   (a) Asthma
   (b) Infarct
   (c) Pleural effusion
   (d) Sickle cell disease
14. Which statement regarding ventilation scan is NOT correct?
   (a) The down-scatter effect of high-energy Kr on Tc gate is important.
   (b) ^{99m}Tc-colloid scan can be utilized as aerosol.
   (c) ^{99m}Tc-technegas precipitation is less observed in the central airway than ^{99m}Tc-DTPA.
   (d) Aerosol scan can be performed before or after perfusion scan.

15. Regarding pulmonary perfusion scan, the reduction of particle number is NOT required in:
    (a) Pregnancy.
    (b) Pulmonary hypertension.
    (c) Right-to-left shunt.
    (d) Reduction of particle number is required for all items.
16. What is the most common source of non-acute emboli-mediated V/Q mismatch?
    (a) Previous unresolved pulmonary emboli
    (b) Pulmonary vasculitis
    (c) Fibrosing mediastinitis
    (d) Hilar carcinoma
17. Reversed mismatch is NOT a common finding in:
    (a) Lobar pneumonia
    (b) Pleural effusion
    (c) Cardiomegaly
    (d) Pulmonary vasculitis
18. The probability of pulmonary emboli is … when triple-match defects are observed on a pulmonary V/Q scan.
    (a) Low
    (b) High
    (c) Intermediate
    (d) Negative study
19. When PIOPED II criteria are applied, which finding is indicative of a low probability for pulmonary emboli?
    (a) Single-matched defect
    (b) Non-segmental defects
    (c) Subsegmental defects
    (d) Non-high/Non-low defects
20. Which of the following diseases represents ventilation defects in addition to perfusion defects?
    (a) Pleural effusion
    (b) Cardiac arrhythmia
    (c) Pulmonary infarction
    (d) Pulmonary hypertension
21. According to PIOPED II criteria, what is the likelihood of pulmonary emboli when perfusion defects are smaller than radiographic defects?
    (a) Very low
    (b) Low
    (c) Moderate
    (d) High

22. Pulmonary perfusion scan is requested for a patient with hemoptysis, dyspnea, and pleurisy. What is the possibility of pulmonary emboli before scintigraphy?
    (a) 29%
    (b) 31%
    (c) 74%
    (d) 87%
23. What is the reason for the hepatosplenic uptake on a pulmonary perfusion scan?
    (a) Right-to-left cardiac shunt
    (b) Free technetium in the radiotracer
    (c) Reduced technetium in the ^{99m}Tc- MAA complex
    (d) High level of aluminum in the kit
24. Which of the following statements about the recommendations for Tc-MAA application on a pulmonary perfusion scan is NOT correct?
    (a) Storing of the kit in a refrigerator before and after preparation.
    (b) Shaking of the prepared tracer in all stages.
    (c) The minimum number of administered particles for a uniform picture is one million.
    (d) Injection of the drug with larger needles.
25. Which of the following radiotracers does NOT need advanced equipment for radioprotection on a pulmonary ventilation scan?
    (a) ^{99m}Tc-technegas
    (b) ^{81m}Kr
    (c) ^{133}Xe
    (d) a and b
26. What is the reason behind the high activity of the head and kidneys on a pulmonary perfusion scan?
    (a) Inappropriate particle size
    (b) Possibility of metastasis
    (c) Existence of free technetium
    (d) Right-to-left shunt
27. What is the reason for a hot spot on a pulmonary perfusion scan?
    (a) Administration of radiotracer in the prone position
    (b) Obstruction of airways
    (c) Perfusion defect
    (d) Entrance of blood to the syringe
28. Activity is observed in the trachea and stomach during a pulmonary ventilation scan:
    (a) Left-to-right shunt.
    (b) The exam is performed by ^{99m}Tc-DTPA.
    (c) The exam is performed by ^{133}Xe.
    (d) The aerosol production system is contaminated.

29. In which patients is the reduction of particle count required?
    (a) Elderly patients
    (b) Patients with a high risk of emboli
    (c) Patients with asthma
    (d) Patients with pulmonary hypertension
30. On a perfusion–ventilation scan:
    (a) ^{133}Xe ventilation scan after a perfusion scan is the most appropriate scan because of the high quality of wash-out images.
    (b) A perfusion scan should be performed before a ventilation scan because if it is normal, there would be no need for a ventilation scan.
    (c) An aerosol scan is usually performed before a perfusion scan in the upright position.
    (d) A ventilation scan with carbon-labeled particles has a notable advantage over an aerosol scan.
31. Which of the following statements on V/Q SPECT is true?
    (a) V/Q SPECT has higher sensitivity and specificity than V/Q planar in the detection of PE.
    (b) The detection rates of the subsegmental defects are the same.
    (c) The V/Q SPECT should be conducted in a sitting position.
    (d) The ventilation SPECT is undertaken immediately after the perfusion SPECT without patient movement.
32. What is the radiotracer of choice for the evaluation of infants, children, or patients with low compliance?
    (a) ^{99m}Tc aerosols
    (b) ^{81}-Kr
    (c) ^{133}Xe
    (d) ^{81}-Rb
33. Regarding the pulmonary perfusion scan for pregnant women:
    (a) A pulmonary perfusion scan is recommended before ventilation scan.
    (b) A pulmonary ventilation scan is recommended before perfusion scan.
    (c) The sequence of the ventilation and perfusion scans is NOT important.
    (d) Ventilation and perfusion scans are contraindicated in pregnancy.
34. A middle-aged patient with acute dyspnea is evaluated. Chest X-ray is normal. V/Q scan finds a single segmental perfusion defect with a medium-size and normal ventilation. No risk factor for emboli and no evidence for DVT are found. What is the next step?
    (a) Pulmonary artery angiography
    (b) Pulmonary angiography with computerized tomography
    (c) Intravenous heparin and anticoagulant
    (d) Repeat of V/Q scan after 1 week

35. Two regions with large segmental perfusion defects are observed on the pulmonary perfusion scan of a patient suspected of having pulmonary emboli. Ventilation scan on the same day is required to interpret the study. Which of the following radiopharmaceuticals requires the computerized subtraction of ventilation and perfusion images for a precise interpretation?
    (a) ^{127}Xe
    (b) ^{81m}Kr
    (c) ^{99m}Tc-DTPA aerosol
    (d) ^{133}Xe
36. What is the advantage of ^{133}Xe on a pulmonary ventilation scan?
    (a) The possibility of imaging in different projections
    (b) Low energy of gamma ray
    (c) The possibility of a dynamic imaging of ventilation
    (d) High image resolution
37. What is the cigar sign?
    (a) Enlargement of a tight pulmonary artery on pulmonary radiography.
    (b) It is equivalent to the fissure sign on a pulmonary perfusion scan.
    (c) It is observed on a pulmonary ventilation scan.
    (d) It is observed on both pulmonary perfusion and ventilation scans.
38. The focal retention of xenon is reported on a pulmonary ventilation scan. What is the most probable diagnosis?
    (a) Pneumonia
    (b) Chronic bronchitis
    (c) Pulmonary emboli
    (d) Congestive heart failure
39. What is the maximum acceptable interval between chest X-ray and pulmonary perfusion if the goal is to compare the two tests?
    (a) 48 h
    (b) 5 days
    (c) 12 h
    (d) 4 h
40. What is the best injection technique if the goal is the homogenous diffusion of ^{99m}Tc-MAA in the entire field of both lungs?
    (a) Sitting position, slow and deep breathing, bolus injection of the radiopharmaceutical
    (b) Sitting position, breath-holding, bolus injection of the radiopharmaceutical
    (c) Supine position, breath-holding, radiopharmaceutical injection for 10 s
    (d) Supine position, slow breathing, radiopharmaceutical injection for 10 s
41. Ventilation and CXR are normal. However, an intermediate defect in the posterior inferior segment of the left lower lobe is observed on the perfusion scan. What is the possibility of pulmonary emboli according to the modified PIOPED criteria?
    (a) Very low
    (b) Low
    (c) Intermediate
    (d) High

42. What is the probability of pulmonary emboli according to the modified PIOPED criteria and to the following V/Q scan and CXR results? "Large perfusion defects that involve all lateral inferior and posterior inferior segments as well as the upper segment of the right lower lobe. Minor infiltration in the upper segment of the right lower lobe in CXR. Ventilation scan is normal."
    (a) Very low
    (b) Low
    (c) Intermediate
    (d) High
43. What is the probability of pulmonary emboli according to the modified PIOPED criteria and to the following V/Q scan and routine imaging methods? "Intermediate perfusion and ventilation defect in the lateral inferior segment of the right lower lobe, with a corresponding consolidation in the CXR."
    (a) Very low
    (b) Low
    (c) Intermediate
    (d) High
44. What is the probability of pulmonary emboli according to the modified PIOPED criteria and to the following V/Q scan and CXR results? "Two defects on the perfusion scan: one involves 75% of the lateral segment of the right middle lobe, and the other involves 90% of the upper segment of the right lower lobe. Ventilation scan is normal, whereas CXR shows Westermark's sign in the right lower lobe."
    (a) Very low
    (b) Low
    (c) Intermediate
    (d) High
45. For the diagnosis of pulmonary emboli with PET scan:
    (a) On-site cyclotron is NOT required.
    (b) Ventilation scan is performed with ^{15}O-CO_2.
    (c) A rapid washout of CO_2 is observed in the embolic region.
    (d) A perfusion scan is performed.
46. The pulmonary perfusion scan shows a large perfusion defect corresponding to the CXR finding. What is the possibility of pulmonary emboli according to the Biello criteria?
    (a) High
    (b) Intermediate
    (c) Low
    (d) Very low
47. CT angiography demonstrates pulmonary emboli in a 69-year-old patient with dyspnea. Which abnormality is the least possible on chest X-ray?
    (a) Hampton's hump
    (b) Patchy opacities
    (c) Pleural effusion
    (d) Atelectasis

48. A ventilation–perfusion scan is performed for a patient with dyspnea. Multiple large matched defects are observed, and some regions have normal perfusion. Conversely, CXR is normal. What is the probability of pulmonary emboli?
    (a) Low
    (b) Intermediate
    (c) High
    (d) Very low
49. An 87-year-old woman with a history of COPD suddenly experiences dyspnea. V/Q scan shows a dominant hypoventilation and hypoperfusion region that completely occupies a lobe. What is the next recommended step?
    (a) Pulmonary arteriography
    (b) Bronchoscopy
    (c) Repeat after 48 h
    (d) MRI
50. About 5 cc of a solution containing 20 mCi of pertechnetate is added to a kit containing 150,000 particles of MAA. How much (cc) of this radiopharmaceutical must be injected for a perfusion scan of a patient with pulmonary hypertension?
    (a) 0.5
    (b) 0.7
    (c) 0.9
    (d) 1.5
51. Which item is NOT correct about ventilation scan?
    (a) The half-life of ^{127}Xe is greater than that of ^{133}Xe.
    (b) Ventilation scintigraphy with ^{127}Xe produces better-quality images than that with ^{133}Xe.
    (c) A medium-energy collimator must be applied for the scan with ^{127}Xe.
    (d) A ventilation scan with ^{127}Xe after a perfusion scan decreases the quality of images.
52. A defect is found on the perfusion scan of a patient with a history of dyspnea. The size of this defect in the CXR is greater than that on a perfusion scan. What is the risk of pulmonary emboli based on the PIOPED II criteria?
    (a) Very low
    (b) Low
    (c) Intermediate
    (d) High
53. Multiple hot spots are found in both lung fields on a pulmonary perfusion scan of a patient with suspected pulmonary emboli. What is the next suitable intervention?
    (a) Anticoagulants
    (b) Follow-up without treatment
    (c) Pulmonary ventilation scan
    (d) Repeat of the perfusion scan

54. In which view of the pulmonary perfusion scan is the observation of the stripe sign NOT reliable?
    (a) Anterior
    (b) Posterior
    (c) Posterior oblique
    (d) Lateral
55. Which statement about the radiation exposure of a patient on a pulmonary perfusion scan is correct?
    (a) It is less than the exposure on a chest X-ray.
    (b) It is equivalent to the exposure on a chest X-ray.
    (c) It is much less than the exposure on a lung CT.
    (d) It is equivalent to the exposure on a lung CT.
56. Pulmonary perfusion and ventilation scan is requested for a patient suffering from COPD. Which radiopharmaceutical is the most appropriate for a pulmonary ventilation scan?
    (a) ^{133}Xe-gas
    (b) ^{81m}Kr-gas
    (c) ^{99m}Tc-technegas
    (d) ^{99m}Tc-DTPA aerosol
57. A pulmonary perfusion scan is requested for a patient. The rapid termination of the scan is considered because of agitation and poor general condition. Which of the following scan views can be omitted?
    (a) Anterior
    (b) Posterior oblique
    (c) Anterior oblique
    (d) Lateral
58. A 39-year-old breastfeeding woman with dyspnea and hemoptysis is referred for a pulmonary perfusion scan. Which of the following statement about the discontinuation of breastfeeding after the ^{99m}Tc-MAA scan is correct?
    (a) Breastfeeding can be continued.
    (b) Breastfeeding must be discontinued for 24 h.
    (c) Breastfeeding must be discontinued at a time interval of 24–48 h after injection.
    (d) Breastfeeding must be discontinued at a time interval of 6–24 h after injection.
59. A patient is referred for a pulmonary perfusion scan. Which statement about the labeling of the MAA kit and its storage is correct?
    (a) It must be used in 3 h after labeling.
    (b) The labeled kit must be stored in a refrigerator.
    (c) The kit must be stored at room temperature before labeling.
    (d) The pH of the kit must be 8–9.

60. A patient is referred with a history of trauma and dyspnea from last week. A reverse mismatched defect is observed on the V/Q scan. What is the most probable cause of this pattern?
    (a) Acute pulmonary thromboemboli
    (b) Fat emboli
    (c) Functional intrapulmonary right-to-left shunt
    (d) Pulmonary vasculitis
61. A patient with an endobronchial obstruction due to a mucous plug is referred for a V/Q scan. What is the expected scan pattern?
    (a) A region with hypoperfusion and hypoventilation occupying a complete lobe
    (b) Segmental mismatched defect
    (c) Non-segmental mismatched defect
    (d) Normal scan
62. A patient with severe respiratory problems is referred for a pulmonary perfusion/ventilation scan. Which of the following radiopharmaceuticals can be used if a negative pressure room is NOT available?
    (a) ^{133}Xe gas
    (b) ^{127}Xe gas
    (c) ^{81m}Kr gas
    (d) ^{99m}Tc-technegas
63. In which of the following conditions should the minimum particle count be injected for a pulmonary perfusion scan?
    (a) Heart failure
    (b) COPD
    (c) Pulmonary hypertension
    (d) Systemic hypertension
64. Which of the following diseases has a similar pattern to that of emboli on a pulmonary perfusion/ventilation scan?
    (a) Bacterial pneumonia
    (b) Heart failure
    (c) COPD
    (d) Pulmonary vasculitis
65. What is the most common clinical symptom of pulmonary emboli?
    (a) Pleuritic pain
    (b) Tachypnea
    (c) Tachycardia
    (d) Cough
66. If the goal is to conduct a ventilation scan, which of the following radiotracers must be used before a perfusion scan?
    (a) ^{127}Xe
    (b) ^{81}Kr
    (c) DTPA aerosol
    (d) ^{133}Xe

67. A 56-year-old man is referred with dyspnea and chest pain. Multiple match defects in both lungs are observed on the perfusion and ventilation scans. What is the most probable diagnosis?
    (a) Pulmonary emboli
    (b) Pulmonary artery hypoplasia
    (c) Vasculitis
    (d) Asthma
68. New defects are found in the repeat of a pulmonary perfusion scan 1 week after the first scan of a patient with pulmonary emboli. Which of the following statements is NOT correct?
    (a) They can be due to the resolution of large defects and obstruction of other capillaries.
    (b) Changes in the regional pulmonary blood pressure can convert partial obstruction to complete obstruction.
    (c) They can be due to increased pleural effusion or pulmonary edema.
    (d) They are definitely due to the repeat of emboli.
69. Which of the following situations can cause a multifocal increase in uptake on a pulmonary perfusion scan with ^{99m}Tc-MAA?
    (a) Clotting in radiotracer syringe
    (b) Multiple pulmonary emboli
    (c) Presence of free ^{99m} technetium
    (d) Pulmonary parenchymal disease
70. What is the most common differential diagnosis of acute emboli on a pulmonary perfusion scan?
    (a) Fat emboli
    (b) Bronchogenic carcinoma
    (c) Vasculitis
    (d) Incomplete resolution of previous thromboemboli
71. Which of the following groups of patients with suspected emboli does NOT have the required criteria for the indication of venography of the lower extremities?
    (a) Normal V/Q scan, strong clinical suspicion
    (b) Low probability on the V/Q scan, intermediate clinical suspicion
    (c) Intermediate probability on the V/Q scan, low clinical suspicion
    (d) High probability on the V/Q scan, strong clinical suspicion
72. A patient is suspected of having pulmonary emboli. In which of the following conditions is pulmonary angiography with contrast contraindicated?
    (a) Peptic ulcer
    (b) Left bundle branch block
    (c) History of thrombocytopenia due to heparin
    (d) Intracranial neoplasm
73. Which of the following items is NOT necessary for a pulmonary perfusion scan?
    (a) Radiotracer injection in the supine position
    (b) Avoidance of clotting in the syringe
    (c) Imaging in the supine position
    (d) Shaking of the syringe before injection

74. All statements about pulmonary emboli are correct *except*:
    (a) Resolution begins 2 weeks after thrombosis.
    (b) One-third of patients are asymptomatic.
    (c) Dyspnea and tachypnea are the most critical clinical findings.
    (d) Radiologic findings are NOT specific.
75. On a perfusion scan with MAA:
    (a) The minimum count of administered particles is 500,000.
    (b) The minimum count of administered particles is 60,000–100,000.
    (c) The number of administered particles is equal between children and adults.
    (d) The number of administered particles is NOT important or harmful.
76. What is the first diagnostic step in diagnosing pulmonary emboli?
    (a) CXR and ECG
    (b) Measurement of the D-dimer
    (c) Pulmonary perfusion scan
    (d) Spiral CT scan
77. The stripe sign is observed on a pulmonary scan. What is the most probable diagnosis?
    (a) Pulmonary emboli
    (b) Pulmonary obstructive disease
    (c) Bronchogenic carcinoma
    (d) Pulmonary hypertension
78. Which of the following pulmonary ventilation radiotracers is produced by cyclotron?
    (a) ^{133}Xe
    (b) ^{81m}Kr
    (c) ^{99m}Tc-DTPA aerosol
    (d) ^{127}Xe
79. Which of the following pulmonary ventilation radiotracers is NOT appropriate for the measurement of regional ventilation?
    (a) ^{99m}Tc-DTPA aerosol
    (b) ^{133}Xe
    (c) ^{81m}Kr
    (d) ^{127}Xe
80. If … is used for a pulmonary perfusion scan, then the subsequent ventilation scan is NOT reliable.
    (a) ^{133}Xe
    (b) ^{81m}Kr
    (c) ^{99m}Tc-DTPA aerosol
    (d) ^{127}Xe
81. Which of the following interventions is rational if the goal is to prevent a false-positive interpretation in future scans of patients with acute pulmonary emboli and susceptibility for frequent embolism?
    (a) Radiography of lungs 3 months after acute emboli
    (b) Baseline CT scan 3 months after acute emboli
    (c) Baseline V/Q scan 3 months after acute emboli
    (d) Baseline MRI 3 months after acute emboli

82. Which of the following statements about chest X-ray for the evaluation of pulmonary emboli is NOT correct?
    (a) Radiographic findings are non-specific but suggestive.
    (b) Diaphragmatic rising and consolidation is a common finding.
    (c) Improvement of parenchymal defects takes about 1–4 weeks.
    (d) Cavitation is common in pulmonary infarction despite the absence of a secondary infection.
83. All of the following situations are considered contraindications for pulmonary artery arteriography *except*:
    (a) High risk for anticoagulant therapy
    (b) High right ventricular and pulmonary artery pressures
    (c) Renal failure
    (d) Left bundle branch block
84. About the pulmonary artery arteriography of patients with confirmed pulmonary emboli:
    (a) DVT is positive in more than 50% of these patients.
    (b) DVT is positive in less than 20% of these patients.
    (c) NO evident relationship exists between DVT and pulmonary emboli.
    (d) All patients have a history of DVT.
85. Which of the following parameters is indirectly represented by the total count of ^{81m}Kr in pulmonary static images?
    (a) Tidal volume
    (b) End-expiration volume
    (c) End-inspiration volume
    (d) Proximal respiratory zone volume
86. In the laboratory analysis of the D-dimer:
    (a) High incidence of false-negative results.
    (b) Rule out pulmonary emboli in patients with a low probability of pulmonary emboli.
    (c) It is NOT indicated as a screening method.
    (d) It is a completely specific test.
87. A segmental mismatched defect with an intermediate size is observed on a V/Q scan. What is the most probable diagnosis?
    (a) Pulmonary emboli with high probability
    (b) Pulmonary emboli with intermediate probability
    (c) Pulmonary emboli with low probability
    (d) Bronchogenic carcinoma
88. If two or more mismatched large perfusion defects are observed on a V/Q scan, what is the probability of pulmonary emboli according to the modified PIOPED criteria?
    (a) Low
    (b) High
    (c) Intermediate
    (d) Negative

89. On the perfusion/ventilation scan, the patterns of all of the following situations are similar to that of emboli *except*:
    (a) Atelectasis
    (b) Chronic perfusion insufficiency due to previous emboli
    (c) Intravenous addicts
    (d) Hilar or mediastinal diseases (usually bronchogenic carcinoma)
90. A 54-year-old patient with dyspnea is presented. Chest X-ray is normal. Perfusion of the left lung is normal, but the absence of the perfusion of the right lung is observed. What is the probability of pulmonary emboli according to the PIOPED II criteria?
    (a) High
    (b) Intermediate
    (c) Low
    (d) Very low
91. A woman on her nineth month of pregnancy is referred to the emergency room with sudden dyspnea and cough. Swelling of the superficial veins of the leg and tenderness of the leg are observed upon physical examination. What is the recommended method for diagnosis?
    (a) Thoracic CT
    (b) Lung perfusion scan
    (c) Pulmonary CT angiography
    (d) Treatment according to the primary diagnosis without nuclear imaging
92. What is the most common nonfatal complication of contrast pulmonary angiography?
    (a) Hemoptysis
    (b) Renal failure
    (c) Arrhythmia
    (d) Pneumonia
93. Which of the following methods provides the most diagnostic information aside from that on the ruling out of pulmonary emboli?
    (a) Perfusion/ventilation scan
    (b) Pulmonary angiography with contrast
    (c) Doppler sonography
    (d) CT angiography
94. If the pulmonary perfusion scan is normal for a patient with suspected pulmonary emboli, then a ventilation scan:
    (a) Is NOT required
    (b) Is required
    (c) Must be delayed
    (d) b and c
95. Which of the following diseases is associated with the Westermark's sign?
    (a) Localized pleural effusion
    (b) Pulmonary infarction
    (c) Regional oligemia
    (d) Pulmonary vascular dilatation

96. Which of the following diseases is associated Hampton's hump sign?
    (a) Localized pleural effusion
    (b) Pulmonary infarction
    (c) Weakened pulmonary vessels
    (d) Pulmonary vascular dilatation
97. Which of the following diseases is associated with the Fleischner sign?
    (a) Localized pleural effusion
    (b) Pulmonary infarction
    (c) Weakened pulmonary vessels
    (d) Prominent central pulmonary artery
98. A 44-year-old woman with a history of immobility for 3 months due to femoral neck fracture is presented with cough, chest pain, and dyspnea. She is taking OCP and antihypertensive drugs. She has tachycardia, tachypnea, and fever upon clinical examination. In addition, CXR shows a pleural-based infiltration and plural effusion. Her perfusion lung scan is unremarkable. What is the best next diagnostic test?
    (a) Ventilation scan
    (b) Pulmonary angiography
    (c) Spiral CT scan
    (d) Sputum smear
99. All the following statements regarding the assessment of pulmonary emboli on chest X-ray are true *except*:
    (a) Localized peripheral oligemia is the most common finding on chest X-ray.
    (b) Dilatation of the central pulmonary artery is commonly due to huge emboli.
    (c) Wedge-shaped opacity commonly occurs in the posterior and lateral costophrenic regions.
    (d) Opacity following emboli is resolved in 7–10 days.
100. Which of the following properly describes fat pulmonary embolism?
    (a) It occurs in the first 24 h post-trauma.
    (b) It develops hemorrhagic pulmonary edema with an air space pattern.
    (c) It is usually accompanied with pleural effusion.
    (d) CT angiography is the diagnostic modality of choice.
101. The lung perfusion scan shows a 2 cm defect without activity, whereas the ventilation scan and chest X-ray are normal. What is the probability of a pulmonary embolism occurring?
    (a) Less than 5%
    (b) 5–20%
    (c) 20–80%
    (d) More than 80%
102. Which of the following findings on central pulmonary emboli without infarction is the least likely to be found?
    (a) Localized peripheral oligemia
    (b) Volume loss
    (c) Distended proximal vessels
    (d) Air space opacification

103. A 58-year-old male smoker with suspected pulmonary embolism (PE) is presented. Based on clinical indicators, the probability for PE is high. Basal haziness and chronic obstructive pulmonary disease (COPD) changes on the chest X-ray are seen. What is the next best step?
    (a) CT angiography
    (b) D-dimer assay if it is abnormal and then CT angiography
    (c) V/P scan if the probability is high and then commencement of therapy
    (d) V/P scan if the probability is high and then CT angiography
104. A 39-year-old lady is presented to a university clinic with recent dyspnea and chest pain. CXR shows a density in the lower left lobe. In addition, a severe perfusion defect on the perfusion scan in the left lower lung with normal ventilation is reported. What is the most appropriate diagnosis?
    (a) Left lung emboli
    (b) Left lung infarction
    (c) Left lung emboli accompanied with infarction
    (d) Left lung pneumonia
105. The following is reported on a lung perfusion/ventilation scintigraphy: severe perfusion defect with a moderate ventilation defect in the left lower lung. What is the most appropriate diagnosis?
    (a) Left lung emboli
    (b) Left lung infarction
    (c) Left lung emboli accompanied with infarction
    (d) Left lung pneumonia
106. Which is the most accurate modality for the diagnosis of pulmonary emboli?
    (a) HRCT
    (b) Lung perfusion/ventilation scintigraphy
    (c) Angiography
    (d) MRI
107. To diagnose pulmonary emboli (PE), a V/Q scan should be performed rather than CT in all of the following conditions *except*:
    (a) Normal chest X-ray
    (b) Pregnancy
    (c) Low probability of PE
    (d) Patient in intensive care
108. Which ventilation scan produces the lowest radiation to a patient?
    (a) Xe.
    (b) Kr.
    (c) Tc-DTPA aerosol.
    (d) Radiation exposure is equal in all three tests.
109. In which of the following situations is a pulmonary perfusion scan NOT indicated for the diagnosis of pulmonary emboli?
    (a) Renal failure.
    (b) Anaphylactic reaction to contrast media.
    (c) Pregnancy.
    (d) Pulmonary perfusion scan is the method of choice in all patients with suspected pulmonary emboli.

110. Which of the following items is the advantage of CT pulmonary angiography (CTPA) over V/Q SPECT?
    (a) Radiation dose
    (b) Technical failure rate
    (c) Role and accuracy in follow-up
    (d) Specificity
111. Which of the following items is the advantage of V/Q SPECT/CT over V/Q SPECT?
    (a) Sensitivity
    (b) Specificity
    (c) Possible allergic reaction
    (d) Technical failure rate

5.3.1 Answer

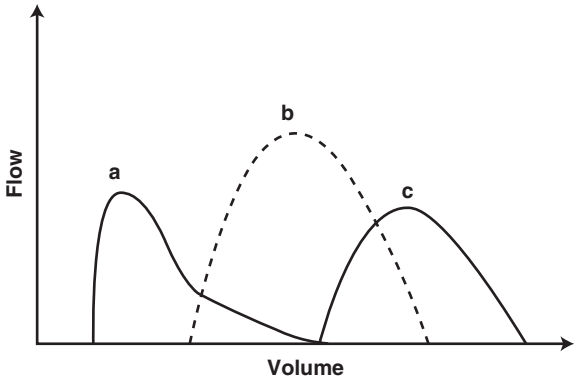
	A	B	C	D		A	B	C	D
1			*		**56**	*			
2				*	**57**			*	
3			*		**58**		*		
4			*		**59**		*		
5		*			**60**			*	
6			*		**61**	*			
7				*	**62**				*
8		*			**63**			*	
9				*	**64**				*
10		*			**65**		*		
11			*		**66**				*
12				*	**67**				*
13		*			**68**				*
14				*	**69**	*			
15	*				**70**				*
16	*				**71**				*
17				*	**72**		*		
18			*		**73**			*	
19		*			**74**	*			
20			*		**75**		*		
21	*				**76**	*			
22			*		**77**		*		
23			*		**78**				*
24			*		**79**	*			
25		*			**80**	*			
26				*	**81**			*	
27				*	**82**				*
28		*			**83**	*			
29				*	**84**	*			

30		*			**85**	*			
31	*				**86**		*		
32		*			**87**		*		
33	*				**88**		*		
34		*			**89**	*			
35			*		**90**			*	
36			*		**91**		*		
37	*				**92**			*	
38		*			**93**	*			
39			*		**94**	*			
40				*	**95**			*	
41			*		**96**		*		
42				*	**97**				*
43			*		**98**				*
44				*	**99**		*		
45		*			**100**	*			
46		*			**101**			*	
47	*				**102**				*
48	*				**103**	*			
49		*			**104**	*			
50	*				**105**		*		
51				*	**106**			*	
52	*				**107**				*
53				*	**108**			*	
54				*	**109**				*
55				*	**110**				*
					111		*		

5.4 Non-embolic Disease of the Lungs

1. What is the best ventilation agent for the assessment of parenchymal lung diseases?
   (a) ^{133}Xe
   (b) ^{99m}Tc-DTPA aerosol
   (c) ^{81m}Kr
   (d) Technegas
2. Which radioaerosol is NOT used for the assessment of mucociliary clearance (MCC)?
   (a) ^{99m}Tc-sulfur colloid
   (b) ^{99m}Tc-HAS
   (c) ^{99m}Tc-iron oxide
   (d) ^{99m}Tc-DTPA
3. Mucociliary clearance (MCC) is normal in:
   (a) Chronic bronchitis
   (b) Acute asthma
   (c) Emphysema
   (d) Cystic fibrosis
4. Which radiopharmaceutical is NOT used in lung clearance studies?
   (a) 51Cr-EDTA
   (b) ^{99m}Tc-DTPA
   (c) ^{99m}Tc-HMPAO
   (d) ^{99m}Tc-HAS
5. The Marquardt–Levenberg method is used in:
   (a) Pulmonary endothelial study
   (b) Lung clearance study
   (c) Mucociliary clearance (MCC) study
   (d) V/Q study
6. Which test is recommended to diagnose COPD at the earliest time?
   (a) Pulmonary endothelial study
   (b) Mucociliary clearance (MCC) study
   (c) Lung clearance study
   (d) V/Q study
7. Which radiopharmaceutical is used on a pulmonary endothelial study?
   (a) ^{113m}In-transferrin
   (b) ^{99m}Tc-sulfur colloid
   (c) 51Cr-EDTA
   (d) ^{99m}Tc-HMPAO
8. Which of the following conditions result in the rapid clearance of mucociliary?
   (a) Smoking
   (b) Cystic fibrosis
   (c) Glucocorticoid administration
   (d) Oxygen therapy

9. Which statement corresponds to the pulmonary perfusion scan in a patient with primary pulmonary hypertension after a unilateral lung transplant?
   (a) Approximately symmetric perfusion on both sides.
   (b) Transient reduction in the perfusion of the transplanted lung.
   (c) Perfusion is mostly shifted to the transplanted lung.
   (d) Increased perfusion to the native lung that is reversed after a few weeks.
10. Which radiotracer is recommended for the differentiation of pulmonary Kaposi's sarcoma from lymphoma?
   (a) Thallium
   (b) Gallium
   (c) In-111-labeled liposome
   (d) FDG-PET
11. Perihilar pulmonary absorption is observed on the gallium scan of a patient with AIDS. Which one is the most probable?
   (a) Pneumocystis carinii
   (b) Infection with mycobacterium avium-intracellulare
   (c) Lymphocytic interstitial pneumonia
   (d) Diffuse infiltrative lymphocytosis syndrome
12. Which of the following better defines "curve a" in the expiration phase of pulmonary flow–volume graphs?
   (a) Normal inspiration
   (b) Obstructive lung disease
   (c) Restrictive lung disease
   (d) Normal expiration



13. A pulmonary perfusion/ventilation scan is performed on a 38-year-old woman with sudden dyspnea and chest pain. The right lung does NOT appear on the perfusion scan and is smaller than the left lung on the ventilation scan. Radiography outcome is normal. What is the most probable diagnosis?
   (a) Previous surgery of the right lung
   (b) Extensive emboli
   (c) Extensive atelectasis
   (d) Takayasu disease

14. A homogenous view is reported in the washing phase of a ^{133}Xe ventilation scan. However, the wash-out phase shows a slow, nonhomogenous activity with retention of radioactivity in some spots. What is the most probable diagnosis?
    (a) Obstructive airway disease
    (b) Pulmonary emboli
    (c) Multiple tumoral lesions
    (d) Restrictive lung disease
15. Which of the following diseases is represented by an abnormal pulmonary ventilation scan?
    (a) Neoplasm-induced vascular pressure
    (b) Pulmonary vasculitis
    (c) Pulmonary infarction
    (d) Pulmonary emboli
16. Which radiopharmaceutical is NOT used for the evaluation of the activity of sarcoidosis?
    (a) Ga-67
    (b) F-18-FDG
    (c) Tc-99m-octreotide
    (d) All of the above
17. In the evaluation of a shunt in a child with Fallot's tetralogy:
    (a) Particle count must be less than 10,000.
    (b) Freshly prepared kits should be used.
    (c) Both.
    (d) None.
18. What is the minimum volume of a detectable hemoptysis with a labeled RBC scan?
    (a) 30 ml/24 h
    (b) 40 ml/24 h
    (c) 50 ml/24 h
    (d) 60 ml/24 h
19. Which of the following indices is used for the evaluation of intrathoracic shunts on a pulmonary perfusion scan?
    (a) Activity of the brain/lung
    (b) Activity of the right kidney/administered dose
    (c) Activity of the lung/right kidney
    (d) Activity of the brain/administered dose
20. In which of the following diseases is an alveolar clearance scan with radioaerosol indicated?
    (a) Chronic obstructive pulmonary disease (COPD)
    (b) Bronchiectasis and cystic fibrosis
    (c) Dysfunction of the pulmonary vascular endothelium such as acute respiratory distress syndrome (ARDS)
    (d) Interstitial lung disease (ILD)

21. What are the corresponding changes in alveolar compliance (AC) and airway resistance (AR) in a 55-year-old woman with idiopathic pulmonary fibrosis?
    (a) Decrease in AC, increase in AR
    (b) Decrease in AC, decrease in AR
    (c) Increase in AC, increase in AR
    (d) Increase in AC, decrease in AR
22. What are the corresponding changes in alveolar compliance (AC) and airway resistance (AR) in a 69-year-old man with chronic bronchitis?
    (a) Decrease in AC, increase in AR
    (b) Decrease in AC, decrease in AR
    (c) Increase in AC, increase in AR
    (d) Increase in AC, decrease in AR
23. Which item is NOT an indication for a quantitative pulmonary scan?
    (a) Evaluation and follow-up of patients with a congenital complicated heart disease
    (b) Before surgery or radiotherapy in patients with lung cancer
    (c) Infarction due to pulmonary emboli
    (d) Follow-up of patients with a lung transplant
24. Pneumonectomy of the right lung is indicated because of a right-to-left functional shunt for a 67-year-old patient with dyspnea. FVE1 is 1300 ml before surgery, and the proportion of the right lung in the conjugated image is 40% of the total. Which statement about the possibility of pneumonectomy is correct?
    (a) Dorsal image must be used for this evaluation; therefore, the calculated percentage of perfusion is not reliable.
    (b) Complete pneumonectomy of the right lung is possible.
    (c) Only partial pneumonectomy of the right lung is possible.
    (d) Pneumonectomy is NOT possible.
25. ^{99m}Tc-MAA injection is performed on the foot of a child with a Glenn shunt (SVC anastomosis of the right pulmonary artery) because of Fallot's tetralogy. What is the scan appearance?
    (a) All of the tracer accumulates in the right lung.
    (b) All of the tracer accumulates in the left lung.
    (c) Some of the radiopharmaceutical accumulates in the left lung and some in the systemic organs.
    (d) Some of the radiopharmaceutical accumulates in the right lung and some in the systemic organs.
26. A 75-year-old man underwent one-lung transplantation. V/Q scan is performed on the following day. A substantial shift of perfusion occurs toward the transplanted lung with a small shift of ventilation. What is the primary cause of the disease?
    (a) Pulmonary fibrosis
    (b) Chronic pulmonary emboli
    (c) Primary pulmonary hypertension
    (d) Emphysema

27. A patient is referred to the nuclear medicine center to evaluate the opening of a peritoneovenous shunt. The intraperitoneal administration of ^{99m}Tc-MAA is used for the scan. There is NO activity in the shunt or lungs until 1 h after injection. What is the best intervention for this patient?
    (a) Delayed imaging until 6 h
    (b) Reinjection of activity and imaging for 1 more hour
    (c) Immediate performance of thorax SPECT
    (d) Termination of the study and report of complete obstruction of the shunt
28. The focal retention of xenon is reported on a pulmonary ventilation scan. What is the most probable diagnosis?
    (a) Pneumonia
    (b) Chronic bronchitis
    (c) Pulmonary emboli
    (d) Congestive heart failure
29. Pulmonary perfusion scan is conducted on a patient with a history of dyspnea and cor pulmonale evidence. Which of the following patterns is indicative of a primary idiopathic pulmonary hypertension?
    (a) Non-segmental patchy defects
    (b) Segmental defects
    (c) Large defects
    (d) Solitary lobar defect
30. A patient with a history of severe primary pulmonary hypertension underwent surgery with no complication. A quantitative pulmonary perfusion scan is conducted. What is the perfusion of the transplanted lung immediately after and 1 month after surgery, respectively?
    (a) Approximately 90% and gradually decreases
    (b) Approximately 70% and gradually increases
    (c) Approximately 65% with no change over time
    (d) Approximately 20% and gradually increases
31. Which of the following methods is the most sensitive for the evaluation of obstructive airway diseases?
    (a) CXR
    (b) ^{133}X-single breath image
    (c) ^{133}X-equilibrium wash-in image
    (d) ^{133}X-wash-out phase
32. Pulmonary perfusion scan is performed for the detection of emboli, and activity is observed in the systemic organs. Which of the following views is recommended for the differentiation of a right-to-left shunt from the presence of free technetium–pertechnetate?
    (a) Kidneys
    (b) Thyroid
    (c) Stomach
    (d) Brain

33. Pulmonary clearance:
    (a) Clearance of the upper segments is faster than that of the lower segments because of the chronic administration of crack.
    (b) Rate of clearance decreases in alveolitis.
    (c) The normal rate of clearance is 20–30% per min.
    (d) It is NOT valuable for the early diagnosis of interstitial pneumonitis in AIDS.
34. Which of the following drugs does NOT inhibit mucociliary clearance in a breathing system?
    (a) Benzodiazepines
    (b) Glucocorticoids
    (c) Opiates
    (d) Barbiturates
35. What is the pattern of a ^{67}Ga pulmonary scan in patients with progressed systemic multiple sclerosis with pulmonary involvement?
    (a) Diffuse uptake mainly in the lower zones matched with chest X-ray.
    (b) Diffuse uptake mainly in the lower zones mismatched with chest X-ray.
    (c) Diffuse uptake mainly in the upper zones matched with chest X-ray.
    (d) Global multifocal pulmonary uptake mismatched with chest X-ray.
36. What is the formula for calculating the penetrating index in a mucociliary clearance study?
    (a) Peripheral activity of the right lung/central activity of the right lung
    (b) Central activity of the right lung/peripheral activity of the right lung
    (c) Peripheral activity of the left lung/central activity of the left lung
    (d) Central activity of the left lung/peripheral activity of the left lung
37. In which of the following conditions is right lung perfusion greater than that of the left lung?
    (a) Interventricular septal defect
    (b) Pulmonary artery stenosis
    (c) Pulmonary artery valve stenosis
    (d) Pulmonary artery stenosis and left-to-right shunt
38. What is the recommended method for bronchoscopy selection after the aspiration of a small material in children?
    (a) ^{133}Xe ventilation scan
    (b) Radiography
    (c) Fluoroscopy
    (d) MRI
39. What is the recommended radiotracer for the evaluation of pulmonary hemorrhage?
    (a) ^{99m}Tc-DTPA aerosol
    (b) ^{99m}Tc-SC
    (c) ^{99m}Tc-MAA
    (d) ^{99m}Tc-DTPA

40. Mucociliary (MCC) clearance:
    (a) MCC is normal in stable asthma patients.
    (b) ^{99m}Tc-MAA is the most common radioaerosol for the evaluation of MCC.
    (c) Oxygen therapy can cause mucociliary dysfunction.
    (d) The initial rapid phase represents the non-mucociliary clearance from the tracheobronchial tree.
41. Which of the following cells does NOT express transferrin receptors?
    (a) Lung cancer cells
    (b) Alveolar macrophages in pulmonary idiopathic fibrosis
    (c) Epithelioid cells of granuloma in sarcoidosis
    (d) Alveolar cells in interstitial pneumonia
42. Regarding the clearance of ^{99m}Tc-DTPA aerosol:
    (a) Clearance is slow in patients with adult respiratory distress syndrome.
    (b) Clearance is fast in smokers.
    (c) Clearance decreases in alveolitis.
    (d) Clearance decreases in children with hyaline membrane disease.
43. A 29-year-old woman comes to your clinic with acute dyspnea. Chest X-ray shows a decreased volume with attenuated vessels in the right lung. Ventilation/perfusion scintigraphy reveals a markedly diminished ventilation, delay in washout, vascular flow, and unilateral perfusion in the right lung. What is the most likely diagnosis?
    (a) Swyer–James syndrome
    (b) Primary central pulmonary artery occlusion
    (c) Hyponastic lung
    (d) Follicular bronchiolitis
44. All statements regarding pulmonary scintigraphy in children are correct *except*:
    (a) The number of alveoli increases fast in neonates and during the first and reaches the level of adults at the age of 8 years.
    (b) The injected particle count should not exceed 50,000 in neonates and 165,000 at the age of 1 year.
    (c) The recommended particle count is less than 10,000 for cases with severe neonatal lung disease.
    (d) The recommended particle count is about 100,000 for the quantitative evaluation of the right-to-left shunt
45. Which of the following radiotracers can be used for the measurement of mucociliary clearance?
    (a) ^{99m}Tc-MAA
    (b) ^{99m}Tc-SC
    (c) Tc-DTPA aerosol
    (d) a and b

5.4.1 Answer

	A	B	C	D
1				*
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29	*			
30	*			
31				*
32				*
33	*			
34	*			
35		*		
36	*			
37	*			
38	*			
39		*		
40		*		
41				*
42		*		
43	*			
44				*
45				*

5.5 Gastrointestinal Bleeding

1. Which of the following agents is NOT used in Meckel's diverticulum scintigraphy?
   (a) Pentagastrin
   (b) Barium sulfate
   (c) Cimetidine
   (d) Glucagon
2. What pathological condition is associated with false-positive Meckel's diverticulum scintigraphy?
   (a) Duplication cyst
   (b) Intussusception
   (c) AVM
   (d) All of the above
3. Which item is NOT recommended to find the source of occult gastrointestinal bleeding on a ^{99m}Tc-labelad RBC scan?
   (a) Utilization of cinematic images
   (b) Shielding of the liver and spleen
   (c) Utilization of a large-field camera
   (d) In vitro labeling of RBC
4. In Meckel's diverticulum scan:
   (a) A positive Tc scan is still possible when parietal cells are absent in Meckel's diverticulum.
   (b) Similar to cimetidine, glucagon administration before scan reduces the Tc secretion and is beneficial.
   (c) Images are taken in two phases, namely, angiographic and static, for 30 min.
   (d) Fasting before scintigraphy is NOT necessary, especially for children.
5. If the goal is to localize the GI bleeding with labeled RBC scintigraphy, then:
   (a) Hemorrhagic gastritis is specifically detectable.
   (b) If bleeding appears in late views, the error of localization increases.
   (c) Vasopressin should be administered after a positive scan.
   (d) Cinematic images are not recommended.
6. Which item about the criteria for the diagnosis of GI bleeding with RBC is NOT correct?
   (a) Dynamic or serial static imaging should be applied.
   (b) Abnormal activity increases over time.
   (c) A focal region with an accumulated uptake that does not move along the intestine is the most specific finding.
   (d) Abnormal activity can move opposite of intestinal motility.

7. Meckel's scan is requested for a 16-month-old girl with melena. The patient underwent barium study 1 day ago, and she has taken cimetidine for 2 days. Which statement is correct?
   (a) The scan is negative regarding the existence of ectopic gastric mucosa.
   (b) The scan must be repeated.
   (c) Cimetidine administration is not sufficient.
   (d) The results are indicative of intestinal duplication.
8. ^{99m}Tc RBC scan is requested for the evaluation of GI bleeding. A high uptake in the stomach is observed at 1 h images without focal abdominal or pelvis activity. Which statement regarding the mentioned view is NOT correct?
   (a) It is associated with the time of generator elution.
   (b) It is associated with the RBC labeling technique.
   (c) Neck scintigraphy can help in the diagnosis.
   (d) Repeat of scan with ^{99m}Tc-SC is useful.
9. ^{99m}Tc-sulfur colloid scan is performed on a 34-year-old patient with melena for the localization of bleeding. Which of the following should be observed?
   (a) Fasting for at least 2 h.
   (b) The radiotracer must be changed if hepatic cirrhosis is predicted.
   (c) Imaging begins with 30 frames, with each frame for 60 s (a total of 30 min imaging).
   (d) 10 mCi of the radiotracer is administered through IV.
10. A 67-year-old woman with abdominal pain and a history of gastric cancer is evaluated. Liver hemangioma scintigraphy is requested because of the suspicious findings on CT scan from the previous day. The patient takes antihypertensive and antidiabetic medications. Which of the following agents or drugs does NOT affect the labeling of RBC?
    (a) Metformin
    (b) Recent contrast media
    (c) Amlodipine
    (d) Propranolol
11. In which of the following scintigraphy evaluations is fasting NOT required?
    (a) Gastric emptying scintigraphy for the diagnosis of gastric delay
    (b) Esophagus transit scintigraphy for the diagnosis of esophageal functional disorders
    (c) Bile duct scintigraphy for the diagnosis of acute cholecystitis
    (d) RBC scan for the diagnosis of GI bleeding
12. On the scintigraphic study of GI bleeding:
    (a) Some experts consider ^{111}In-RBC suitable for the detection of chronic intermittent GI bleeding.
    (b) If the hepatic function is normal, the serum half-life of Tc-sulfur colloid should be about 12.5–13.5 min.
    (c) ^{111}In is preferred over labeled Tc-pertechnetate for the diagnosis of active bleeding.
    (d) ^{99m}Tc-sulfur colloid is recommended for the diagnosis of upper GI bleeding.

13. In the scintigraphic detection of GI bleeding:
    (a) In vivo labeling of RBC increases the labeling efficiency in comparison with the in vitro method.
    (b) The required time for detecting the minimum volume of bleeding is longer for ^{99m}Tc-RBC than for sulfur colloid.
    (c) The sensitivity of the RBC scan for the diagnosis of intermittent bleeding is lesser than that of sulfur colloid scan.
    (d) Scintigraphy is more important than endoscopy if the goal is to detect upper GI bleeding.
14. In GI bleeding:
    (a) Scintigraphy after the once or twice passing of a substantial amount of blood with stool is NOT effective in the localization of bleeding.
    (b) Abdominal scan with RBC or sulfur colloid as a screening test is not helpful for the diagnosis of bleeding.
    (c) Radioisotope screening is NOT beneficial in the determination of time and region of invasive interventions.
    (d) If localization is not successful after the IV administration of a radiopharmaceutical, Tc-sulfur colloid enema may be used.
15. In Meckel's diverticulum scan:
    (a) Time has NO effect on the better observation of stomach mucosa after injection.
    (b) Fasting is NOT required for the scan.
    (c) Cimetidine does NOT inhibit the tracer uptake.
    (d) Gastric suction is always necessary.
16. Meckel's diverticulum scan is requested for a 4-year-old boy with mild diarrhea. What is the drug of choice for reducing intestinal peristalsis and the prolongation of washout?
    (a) Glucagon
    (b) Cimetidine
    (c) Pentagastrin
    (d) Diphenoxilate
17. Which item does NOT induce false-positive results in the ^{99m}Tc-RBC scan for GI bleeding?
    (a) Hemangioma
    (b) Alternative spleen
    (c) Esophageal varices
    (d) Necrotic tumor
18. Which item is the cause of both false-positive and false-negative findings on Meckel's diverticulum scan?
    (a) Bowel inflammation
    (b) Vascular aneurysm
    (c) Volvulus
    (d) Intussusceptions

19. For the preparation of a patient before Meckel's diverticulum scan:
    (a) Fasting is NOT required.
    (b) Bladder emptying is NOT required.
    (c) Laxative administration increases the diagnostic accuracy.
    (d) A recent study with oral barium brings false-negative results.
20. In which of Meckel's diverticulum imaging methods can stenosis of the diverticulum opening cause false-negative results?
    (a) Small intestine enterolysis
    (b) Small intestine transit
    (c) ^{99m}Tc- pertechnetate scan
    (d) Contrast angiography
21. Labeled RBC scintigraphy is performed for the evaluation of GI bleeding. A focal increase in uptake is observed in the RUQ persisting for 24 h. Which item corresponds to this finding?
    (a) The bleeding source is in the hepatic flexure.
    (b) The bleeding source is in the contact site of the jejunum with an ascending colon.
    (c) Retention in the renal pelvis is possible.
    (d) Liver hemangioma canNOT be excluded.
22. Total blood volume is measured on nuclear medicine based on:
    (a) Reverse transition
    (b) Isotope dilution
    (c) Reverse isotope dilution
    (d) Plasma dilution
23. Evaluation of GI bleeding in nuclear medicine:
    (a) Delayed imaging with labeled RBC provides prognostic value.
    (b) Confirmation of the bleeding is the main objective of the study.
    (c) Movement of activity in the intestine does NOT disturb accurate localization.
    (d) If sulfur colloid is used, serial imaging with reinjection of the radiopharmaceutical is NOT possible.
24. An area of increased red cell activity that does not move or progress within the bowel is usually NOT due to the site of
    (a) Ectatic aorta
    (b) Collateral vessels
    (c) Active bleeding
    (d) Aneurysm
25. False-positive findings as a result of urinary excretion of free pertechnetate can be eliminated when the images are acquired in the
    (a) Lateral view
    (b) Cinematic mode
    (c) Oblique view
    (d) SPECT

26. What percentage of patients with GI bleeding is positive only in delayed images?
    (a) Less than 30%
    (b) 30–50%
    (c) More than 70%
    (d) 27%
27. In Meckel's diverticulum scan:
    (a) Time passing after the radiotracer injection does NOT affect the appearance of gastric mucus.
    (b) Fasting is NOT required for the scan.
    (c) Cimetidine does NOT inhibit the uptake of the radiotracer.
    (d) Gastric suction is always necessary.
28. Which of the following situations does NOT induce false-positive findings in ^{99m}Tc-sulfur colloid scan for GI bleeding?
    (a) Paget's disease
    (b) Uptake in the transplanted kidney
    (c) Hemangioma
    (d) Ectopic spleen
29. A patient with a history of GI bleeding is presented. A focal region of uptake in the abdomen without a change of location during uptake is observed in ^{99m}Tc-sulfur colloid scan. What is the most probable diagnosis?
    (a) Paget's disease
    (b) Transplanted kidney
    (c) Extramedullary hematopoiesis
    (d) Accessory or ectopic spleen
30. If the goal is to enhance the sensitivity of Meckel's diverticulum scan with pertechnetate, which of the following drugs is NOT recommended?
    (a) Cimetidine
    (b) Phenobarbital
    (c) Glucagon
    (d) Pentagastrin
31. For the detection of acute GI bleeding:
    (a) ^{99m}Tc-SC scan cannot detect venous bleedings.
    (b) Angiography can detect a small amount of bleeding.
    (c) Varices and vascular disorders can be mistaken for bleeding in the initial views of the scan.
    (d) A constant focal activity in an abnormal region is primarily suggestive of bleeding.
32. A 3-year-old child is referred because of rectorrhage. What are the most probable diagnosis and radiotracer of choice, respectively?
    (a) Arteriovenous malformation, labeled RBC
    (b) Meckel's diverticulum, technetium–pertechnetate
    (c) Intestinal polyp, labeled RBC
    (d) Peptic ulcer, ^{99m}Tc-sulfur colloid

33. If the goal is to evaluate GI bleeding, what is the advantage of ^{99m}Tc-sulfur colloid over labeled RBC?
    (a) Ability to detect intermittent bleeding
    (b) Higher efficiency in detecting upper GI bleeding
    (c) Ability to detect a very low amount of bleeding
    (d) Possibility of the longer monitoring of a patient
34. Which of the following situations can cause false-negative findings in Meckel's diverticulum?
    (a) Ectopic kidney
    (b) Arteriovenous malformation
    (c) Necrotic mucosa
    (d) Inflammatory bowel disease
35. In the evaluation of gastrointestinal bleeding with labeled RBC:
    (a) Regional accumulation and bilateral spreading in delayed images indicate hemorrhage.
    (b) In vivo labeling of RBC is more efficient than in vitro.
    (c) Presence of free technetium in the kit does NOT affect the incidence of false-positive findings or the interpretation of the scan.
    (d) ^{99m}Tc-SC scan is more valuable than this method for evaluating intermittent bleeding.
36. Which of the following items increases the sensitivity of Meckel's diverticulum scan?
    (a) Bladder filling
    (b) Administration of glucagon
    (c) Administration of potassium perchlorate before scan
    (d) Feeding of the patient
37. What is the recommended radioisotope for the measurement of blood volume?
    (a) 57-Co
    (b) ^{111}-In
    (c) 51-Cr
    (d) 125-I
38. Which of the following items significantly decreases the labeling efficiency of Tc-labeled RBC?
    (a) Heparin
    (b) Fluoxetine
    (c) Anti-RBC antibody
    (d) Tetracycline
39. Which phrase regarding RBC labeling is NOT correct?
    (a) Technetium binds to globulin after cell entry.
    (b) Inadequate stannous ion increases free technetium and causes a higher background.
    (c) Higher stannous ion causes the reduction of technetium before cell entry and decreases the background.
    (d) Heparin induces the oxidation of stannous ion.

40. Which of the following factors can cause false-negative results on ^{99m}Tc scan for the diagnosis of Meckel's diverticulum?
    (a) Intussusception
    (b) Intestinal obstruction
    (c) Enteroliths in Meckel's diverticulum
    (d) Appendicitis
41. What is the best radiopharmaceutical for gastrointestinal (GI) bleeding?
    (a) ^{111}In-DTPA
    (b) ^{99m}Tc-sulfur colloid
    (c) ^{99m}Tc-DTPA
    (d) ^{99m}Tc-RBC
42. In RBC labeling with a modified in vivo method:
    (a) Incubation temperature decreases and hematocrit less than 20% inhibits labeling.
    (b) Incubation temperature increases and hematocrit less than 20% inhibits labeling.
    (c) Incubation temperature decreases and hematocrit more than 20% inhibits labeling.
    (d) Incubation temperature increases and hematocrit more than 20% inhibits labeling.
43. About the scintigraphic evaluation of gastrointestinal bleeding:
    (a) ^{111}Indium scintigraphy is more effective than ^{99m}Tc scan in detecting active bleeding.
    (b) The anatomic cause of bleeding can be discovered by scintigraphy, thus making it a suitable alternative for angiography or endoscopy.
    (c) If angiography is negative, scintigraphy alone canNOT be used for surgery.
    (d) A differential diagnosis of small intestinal bleeding from large intestinal bleeding can be performed according to the scan pattern.
44. Which of the following diseases is the least associated with ileum bleeding?
    (a) Crohn's disease
    (b) Intestinal infections
    (c) Neoplasm
    (d) Angiodysplasia
45. Which of the following statements regarding the study of gastrointestinal bleeding with ^{99m}Tc-sulfur colloid is NOT correct?
    (a) If the scan is negative, touché rectal method is recommended.
    (b) Constant activity is indicative of ectopic or accessory spleen.
    (c) Paget's disease and extramedullary hematopoiesis can cause false-positive results.
    (d) RAO view is recommended to attenuate the effect of liver activity.
46. In which region is gastrointestinal bleeding best localized?
    (a) Stomach
    (b) Duodenum
    (c) Small intestine
    (d) Colon

47. What is the minimum amount of detectable bleeding by scan?
    (a) 0.01 ml/min
    (b) 0.1 ml/min
    (c) 1 ml/min
    (d) 10 ml/min
48. A 38-year-old man is presented to the hospital with repeated rectal bleeding. His barium enema is unremarkable. What should be the next step for management?
    (a) Abdominal CT scan
    (b) RBC scintigraphy
    (c) Arteriography
    (d) Colonoscopy
49. What is the most sensitive modality for the evaluation of traumatic pancreas?
    (a) CT scan
    (b) MRI
    (c) Radionuclide scintigraphy
    (d) Ultrasonography
50. Which of the following statements about Meckel's diverticulum is NOT correct?
    (a) Meckel's diverticulum is a remnant of the vitelline duct, which is normally obliterated by 5–9 weeks of intrauterine life but persists in 1.5–3% of the population.
    (b) Complications occur in 10–20% of patients.
    (c) About 80% of symptomatic patients are under the age of 15 years.
    (d) Obstruction is the most common complication of Meckel's diverticulum in children.

5.5.1 Answer

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5.6 Cholescintigraphy

1. What is the preferred cholescintigraphic tracer for patients with serum bilirubin higher than 10 mg/dl?
   (a) Disofenin
   (b) Mebrofenin
   (c) HIDA
   (d) DISIDA
2. In which case can morphine be administrated with confidence on cholescintigraphy?
   (a) Hyperamylasemia
   (b) Dilated cystic duct
   (c) During the first 60 min of examination in critically ill patients
   (d) Complete hepatic elimination of radioactivity
3. What is the most common source of false-positive findings in the diagnosis of acute cholecystitis?
   (a) Chronic cholecystitis
   (b) Prolonged fasting
   (c) Acalculous cholecystitis
   (d) Hepatitis
4. The rim sign on the HIDA scan:
   (a) It appears because of gallbladder perforation.
   (b) It appears because of a high radioactive entry to hepatic parenchyma due to overeating and inflammation.
   (c) Initial views are the best time for its observation.
   (d) When observed, it does not exclude morphine administration.
5. A rim sign is observed on the HIDA scan of a patient with pain in the RUQ. What is the most probable diagnosis?
   (a) Gallbladder dyskinesia
   (b) Gangrenous cholecystitis
   (c) Chronic cholecystitis
   (d) Biliary leakage
6. HIDA scan is performed on a 45-year-old woman with abdominal pain. About 0.5 h after beginning the scan and with the onset of clearance from hepatic parenchyma, an active margin of the gallbladder fossa is detected without the appearance of the gallbladder. Which item is the most appropriate decision to make?
   (a) Morphine injection
   (b) Cholecystokinin injection
   (c) Termination of scan
   (d) Continuation of scan for at least 4 h to observe the gallbladder

7. Cholecystography:
   (a) It is less sensitive for acalculous cholecystitis than for cholecystolithiasis.
   (b) The acceptable contraction of the gallbladder after CCK injection does NOT exclude cholecystitis.
   (c) Neither sonography nor CT scan can help in the diagnosis of pericholecystic abscess in patients with toxic acute cholecystitis.
   (d) Calcium blockers has NO effect on the CCK function.
8. About patients with cholecystectomy and Sphincter of Oddi dysfunction (SOD):
   (a) Biliary scintigraphy is NOT indicated for the follow-up of patients after the endoscopic opening of the Sphincter of Oddi.
   (b) Abnormal scintigraphy in patients with symptoms of relapse after treatment is NOT effective for diagnosis or therapy.
   (c) Abnormal scintigraphy before manometery increases the possibility of SOD.
   (d) Normal scintigraphy is NOT effective in diagnosing the obstruction of the Sphincter of Oddi.
9. Which finding in cholecystography is associated with the acute obstruction of the common bile duct?
   (a) Gallbladder appears 1 h after radiopharmaceutical injection.
   (b) Gallbladder does NOT appear even after morphine injection or delayed scan.
   (c) Gallbladder does NOT appear 30 min after morphine injection or delayed scan (after 4 h).
   (d) Bile ducts do NOT appear 1 h after radiopharmaceutical injection despite the notable liver uptake.
10. In patients with suspected acute cholecystitis examined by cholescintigraphy, which of the following basic imaging patterns is seen with the LEAST frequency?
   (a) Normal
   (b) Persistent GB non-visualization
   (c) Delayed GB visualization
   (d) Obstructive
11. A 58-year-old woman is referred to the emergency room with abdominal pain. Mirizzi syndrome is suggested by abdominal CT scan and ERCP. Which of the following findings is expected in cholecystography?
   (a) Gallbladder absence in delayed images up to 4 h after intestinal observation of activity
   (b) Intestinal observation of activity before 1 h and appearance of the gallbladder after another 1 h
   (c) Appearance of the gallbladder in 1–4 h with EF of less than 40%
   (d) Appearance of the gallbladder before 1 h with EF of more than 40%

12. Hepatobiliary scintigraphy is performed on a 63-year-old man with abdominal pain. Pericholecystic hot rim and a defect in the gallbladder are observed in 4 h. What is the most probable diagnosis?
    (a) Biloma due to a perforated gallbladder
    (b) Hydropic gallbladder
    (c) Gangrenous acute cholecystitis
    (d) Simultaneous chronic and acute cholecystitis
13. A scan is requested to rule out acute cholecystitis in a 46-year-old man with serum bilirubin of 12 mg/100 ml. What is the recommended dose of the technetium-labeled IDA agent?
    (a) 4 mCi
    (b) 6 mCi
    (c) 8 mCi
    (d) 10 mCi
14. What percentage of patients with symptomatic or asymptomatic chronic cholecystitis demonstrates a normal pattern?
    (a) Less than 30%
    (b) 30–50%
    (c) 55–85%
    (d) More than 86%
15. What is the diagnostic procedure of choice for the high clinical suspicion of a significant biliary tract complication following surgery?
    (a) ERCP
    (b) Cholescintigraphy
    (c) PTC
    (d) Sonography
16. Which statement about cholescintigraphy is NOT correct?
    (a) The rim sign on the scan is specific and sufficient for the diagnosis of acute cholecystitis, and morphine or delayed scan is NOT required for confirmation.
    (b) Scan findings are normal at least in 86–99% of cases with or without symptoms of chronic cholecystitis.
    (c) The absence of the appearance of the gallbladder and the rim sign after radiotracer injection in some patients is due to chronic cholecystitis confirmed by pathology.
    (d) The diagnostic accuracy of a morphine injection to confirm the opening of the cystic duct is similar to that of delayed scan (after 3 h or 4 h).
17. Hepatobiliary scintigraphy is performed on a patient with pain in the RUQ. Which of the following findings is indicative of acute cholecystitis?
    (a) Absence of the appearance of the gallbladder up to 2 h after radiotracer injection
    (b) Absence of the appearance of the gallbladder in the first 0.5 h if morphine is injected at the beginning of the scan
    (c) Absence of the appearance of the gallbladder up to 3 h after radiotracer injection
    (d) Absence of the appearance of the gallbladder at 0.5 h after morphine injection if morphine is injected in the 60th min of the scan

18. Hepatobiliary scintigraphy is performed on a patient with suspected acute cholecystitis. The gallbladder does NOT appear 1 h after radiotracer injection, although activity is detected in the intestines. Therefore, morphine is injected. Which statement is correct?
    (a) Acute cholecystitis is confirmed if the gallbladder does NOT appear in 30 min after morphine injection.
    (b) Chronic cholecystitis is confirmed if the gallbladder does NOT appear in 30 min after morphine injection.
    (c) Acute cholecystitis is most probably confirmed if the gallbladder appears in 30 min after morphine injection.
    (d) Imaging must be continued until 3 h after morphine injection to rule out chronic cholecystitis.
19. ^{99m}Tc-HIDA scan is performed on a patient with suspected acute acalculous cholecystitis. The gallbladder appears in the 45th min of the scan. Which of the following interventions is recommended if the goal is to increase the accuracy for the diagnosis of acute cholecystitis?
    (a) Morphine administration in the 60th min
    (b) Repeat of scan after intravenous CCK injection
    (c) Acquisition of 4 h delayed images
    (d) In-WBC scan
20. What is the preferred method for shortening the scan procedure in the diagnosis of acute cholecystitis?
    (a) Recommendation for 12 h fasting before the test
    (b) Termination of scan after 1 h
    (c) CCK injection 30 min before radiotracer injection
    (d) Injection of morphine if the gallbladder does NOT appear in 60 min
21. On hepatobiliary scintigraphy:
    (a) A patient with a marked reduction of gallbladder ejection fraction benefits from cholecystectomy.
    (b) The scan is abnormal in all cases with acute cholecystitis.
    (c) CCK is more commonly used than morphine for shortening the scan procedure.
    (d) Morphine decreases the incidence of false-negative findings of acute cholecystitis.
22. Which of the following conditions can cause false-negative results in the diagnosis of acute cholecystitis with gallbladder scintigraphy?
    (a) Acute acalculous cholecystitis
    (b) Prolonged fasting
    (c) Total parenteral nutrition
    (d) Non-fasting
23. Gallbladder ejection fraction is evaluated for a patient with chronic acalculous cholecystitis. Which of the following items is NOT considered an advantage of the slow infusion of CCK (30–60 min) over rapid infusion (1–2 min)?
    (a) More physiologic
    (b) No side effect
    (c) Lesser incidences of false-negative results
    (d) Better emptying

24. Which of the following situations is indicated in preferential gallbladder filling?
    (a) Decreased intra-CBD pressure
    (b) Increased gallbladder pressure
    (c) Biliary hypokinesia due to opium
    (d) Functional obstruction of the CBD
25. Which of the following conditions is associated with postcholecystectomy syndrome?
    (a) Common bile duct stimulation
    (b) Stimulation of the operated gallbladder
    (c) Sphincter of Oddi dysfunction
    (d) Choleductal stimulation
26. Which of the following statements about the rim sign is NOT correct?
    (a) The rim sign can be observed in biliary stasis.
    (b) The rim sign can be observed in hyperemia-induced radiotracer accumulation.
    (c) The sensitivity of the rim sign for acute gangrenous cholecystitis is high.
    (d) The rim sign is NOT sufficiently specific for acute cholecystitis to dismiss the requirement of a delayed scan or morphine injection.
27. On cholecystography for the diagnosis of acute cholecystitis:
    (a) A low dose of morphine (0.1 mg/kg) 60 min after radiotracer injection is the best method for the diagnosis of acute cholecystitis in patients with severe intermittent illness.
    (b) Morphine infusion is allowed in patients with symptoms of obstruction.
    (c) Morphine can help to evaluate suspected acute calculous/acalculous cholecystitis in patients with signs of a cystic duct.
    (d) The indication of morphine for patients with hyperamylasemia is agreed upon.
28. A patient with a history of cholecystectomy complains about pain in the RUQ after a fatty meal. Liver tests are abnormal, but the dilatation of the common bile duct is reported. What is the recommended method for a more accurate evaluation?
    (a) MRCP
    (b) ERCP
    (c) Cholescintigraphy
    (d) Sphincter of Oddi manometry
29. Which of the following statements about cholescintigraphy is NOT correct?
    (a) If the goal is to evaluate the Sphincter of Oddi dysfunction, then cholecystokinin is injected before the radiotracer.
    (b) Multiple injections of sincalide are possible in one study.
    (c) The delayed appearance of the intestines is NOT a specific finding for chronic cholecystitis.
    (d) If the rim sign is observed in the 1 h images, delayed imaging will NOT be required.

30. In the evaluation of gallbladder ejection fraction (GBEF) with fatty meal stimulation:
    (a) 5 g of fatty meal is required.
    (b) Calculation of GBEF should be performed 60 min after the fatty meal.
    (c) Maximum GBEF is 30 min after the fatty meal.
    (d) Fasting for 4 h before the scan is NOT required.
31. What is the best diagnostic method for chronic cholecystitis?
    (a) Hepatobiliary scan
    (b) Sonography
    (c) Oral cholecystography
    (d) Intravenous cholangiography
32. In which of the following studies is the Sostre score used?
    (a) Gastric emptying test
    (b) Evaluation of esophageal kinesis
    (c) Gastrointestinal bleeding
    (d) Hepatobiliary scan
33. A 49-year-old woman with severe abdominal pain is presented to the emergency department. On her physical examination, tenderness in the RUQ is observed. The probability of having gallstones is high. What should be the next modality in this patient's management?
    (a) Ultrasonography
    (b) Cholescintigraphy
    (c) OCG
    (d) ERCP
34. What is the most sensitive modality in the assessment of a cystic duct?
    (a) CT scan
    (b) MRI
    (c) Doppler ultrasonography
    (d) Cholescintigraphy
35. Which of the following findings properly describes Mirizzi syndrome?
    (a) Irregular mucous with an asymmetric increase in thickening of the gallbladder
    (b) Biliary obstruction, cholelithiasis, and cystic duct stone
    (c) Gallbladder dilatation and thickening without stone
    (d) Presence of echogenic foci in the dilated gallbladder wall
36. If the goal is to differentiate a choledochal cyst from other abdominal cysts, what is the most appropriate method for identifying the connection of the choledochal cyst with the bile ducts?
    (a) Transabdominal ultrasonography
    (b) MR cholangiopancreatography
    (c) Hepatobiliary scintigraphy
    (d) Endosonography

37. If the goal is to diagnose acute cholecystitis, when should morphine be injected on HIDA scintigraphy?
    (a) Concurrent with the HIDA injection for a quick procedure
    (b) When the gallbladder does NOT appear in 1 h despite the appearance of the intestines
    (c) Evident hepatic uptake without detectable secretion after 0.5 h
    (d) All of the above

5.6.1 Answer

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5.7 Neonatal Hyperbilirubinemia

1. Neonatal hyperbilirubinemia:
   (a) Estimated to occur in 1 out of 500,000 live births.
   (b) Males are more commonly affected than females.
   (c) There appears to be a genetic predilection.
   (d) There does not appear to be a genetic predilection.
2. In the diagnosis of neonatal hyperbilirubinemia:
   (a) The giant-cell transformation in histology can be present only in extrahepatic biliary atresia (EHBA).
   (b) The absent gallbladder is seen only in extrahepatic biliary atresia (EHBA).
   (c) The ultrasound is the diagnostic method for extrahepatic biliary atresia (EHBA).
   (d) A gallbladder larger than 1.5 cm is considered to indicate neonatal hepatitis.
3. The biliary tract is not seen even in the delayed views of the ^{99m}Tc-HIDA scan of a 3-month-old infant with hyperbilirubinemia. Otherwise, the infant is healthy. Which diagnosis is the least probable?
   (a) Cystic fibrosis
   (b) Alpha-1 antitrypsin deficiency
   (c) Alagille syndrome
   (d) Severe hepatitis
4. Biliary scintigraphy is performed on a 1-month-old infant with cholestatic icterus. The biliary tree is absent in the images. Which item is NOT probable?
   (a) Cystic fibrosis
   (b) Biliary atresia
   (c) Alagille syndrome
   (d) Alpha-1 antitrypsin deficiency
5. On a neonatal hepatobiliary scan:
   (a) No relationship exists between the amount of injected radiopharmaceutical and serum bilirubin.
   (b) The lateral view of the scan is NOT required for the observation of activity in the rectum.
   (c) Phenobarbital increases the specificity of ^{99m}Tc-IDA on biliary scintigraphy.
   (d) For infants younger than 2 months with biliary atresia, the liver–heart ratio 5 min after injection is similar to that of patients with neonatal hepatitis syndrome.
6. Which of the following findings is the most indicative of biliary atresia on hepatobiliary scintigraphy?
   (a) Decreased hepatic uptake, decreased serum clearance of the radiotracer, increased activity in the heart
   (b) Absence of the gallbladder and the common bile duct
   (c) Lack of activity in intestines up to 24 h after the administration of the radiotracer
   (d) Decreased hepatic uptake and increased renal clearance of the radiotracer

7. What is the first imaging step for a neonate with an increased level of serum bilirubin?
   (a) Hepatobiliary scintigraphy
   (b) Liver sonography
   (c) Abdominal CT scan
   (d) Hepatic scintigraphy with sulfur colloid
8. HIDA scan is indicated for neonates with suspected biliary atresia. Which statement is correct?
   (a) Intra- and extrahepatic bile ducts must be observed on a normal scan.
   (b) The administration of phenobarbital 2 days before scan increases the sensitivity of the test.
   (c) Diagnosis and treatment of the disease must be performed in the first 4 weeks after birth.
   (d) Biliary atresia and cystic fibrosis are always differentiable.
9. Which of the following statements about neonatal hepatobiliary scan and hyperbilirubinemia is NOT correct?
   (a) Retroviruses are the possible cause of biliary atresia and neonatal hepatitis.
   (b) The liver biopsy patterns of biliary atresia and neonatal hepatitis are similar.
   (c) Sonography is the first diagnostic method for neonatal conjugated hyperbilirubinemia.
   (d) Bile ducts usually appear on the scan, but the gallbladder is hardly observed.

5.7.1 Answer

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5.8 Nuclear Medicine in the Acute Care of Neurological Patients

1. The brain regions with rCBF of 12–22 ml/100 g/min are considered:
   (a) Misery perfusion
   (b) Penumbra regions
   (c) Luxury perfusion
   (d) Infarcted regions
2. Which MRI technique has become the method of choice for differentiating between irreversible damage and hypoperfused tissue?
   (a) Diffusion MRI
   (b) T2 MRI
   (c) T1 MRI
   (d) FLAIR MRI
3. What is the method of choice for the diagnosis of herpes simplex encephalitis (HSE)?
   (a) CT
   (b) PET/CT
   (c) MRI
   (d) ^{99m}Tc-HMPAO scintigraphy
4. Which scintigraphic agent is not recommended for the diagnosis of herpes simplex encephalitis (HSE)?
   (a) ^{99m}Tc-ECD
   (b) ^{99m}Tc-HMPAO
   (c) ^{99m}Tc-glucoheptonate
   (d) ^{99m}Tc-IMP
5. Which of the following findings does NOT appear on the brain scan of a patient with cerebrovascular accident?
   (a) Increased uptake in the same cerebellar hemisphere
   (b) Increased perfusion around the infarcted zone
   (c) Delayed parenchymal uptake and clearance of the involved hemisphere in the angiography phase
   (d) Shift of blood flow to the external carotid system
6. Evaluation of rCBF with SPECT is performed a few hours after stroke. In which of the following conditions is thrombolytic therapy indicated?
   (a) Acute complete absence of rCBF
   (b) No change in rCBF
   (c) Acute decrease in rCBF
   (d) Increase in rCBF
7. Brain MRI shows a focal lesion for an AIDS patient. Radiotracer accumulation in the same region is also reported on the ^{201}Tl SPECT scan. What is the most probable diagnosis?
   (a) Toxoplasmosis
   (b) Lymphoma
   (c) Tuberculosis
   (d) Fungal granuloma

8. Stroke penumbra after stroke:
   (a) It is observed before ischemic penumbra.
   (b) It is due to differentiation or disconnection.
   (c) It may be observed in subacute or chronic stroke.
   (d) This stage is before cell death and is reversible after reperfusion.
9. Oligemic zone after stroke:
   (a) It is observed before ischemic penumbra.
   (b) It is due to differentiation or disconnection.
   (c) It may be observed in subacute or chronic stroke.
   (d) This stage is before cell death and is reversible after reperfusion.
10. Diaschisis after stroke:
   (a) It is observed before ischemic penumbra.
   (b) It is due to differentiation or disconnection.
   (c) It may be observed in subacute or chronic stroke.
   (d) This stage is before cell death and is reversible after reperfusion.
11. Extended stroke penumbra after stroke:
   (a) It is observed before ischemic penumbra.
   (b) It is due to differentiation or disconnection.
   (c) It may be observed in subacute or chronic stroke.
   (d) This stage is before cell death and is reversible after reperfusion.
12. If the goal is to diagnose acute cerebral perfusion defects, how long after the event is the sensitivity of SPECT becomes higher than that of anatomical methods (CT and MRI)?
   (a) 72 h
   (b) 24 h
   (c) 48 h
   (d) 96 h
13. In which of the following conditions does FDG-PET overestimate the size of defect in brain trauma?
   (a) Cortical contusion
   (b) Intracerebral hematoma
   (c) Encephalomalacia due to trauma
   (d) Epidural hematoma
14. Which of the following statements regarding the application of PET in neurologic and psychiatric diseases is NOT correct?
   (a) Focal cerebral hypometabolism is observed in most subdural and epidural hematomas.
   (b) A relationship exists between the severity of hypometabolism and the Glasgow Coma Scale (GCS).
   (c) Hypometabolism and hypoperfusion of the thalamus on the dominant side are reported in patients with chronic refractory pain.
   (d) PET canNOT discriminate structural and functional defects in the brain.

15. Which of the following items about herpes simplex virus 1 (HSV-1) and 2 (HSV-2) is NOT correct?
    (a) HSV1 is common in adult and older children.
    (b) HSV1 causes a focal uptake in the temporal lobe.
    (c) The blood–brain barrier scan is commonly abnormal in viral infections of the brain.
    (d) HSV2 typically involves the frontal lobe.
16. What is the pattern of FDG and Tl uptake in AIDS-associated lymphoma and toxoplasmosis?
    (a) In contrast to toxoplasmosis, FDG and Tl uptake are NOT observed in lymphoma.
    (b) Both lymphoma and toxoplasmosis do NOT show FDG and Tl uptake.
    (c) Both lymphoma and toxoplasmosis show FDG and Tl uptake.
    (d) In contrast to toxoplasmosis, FDG and Tl uptake is observed in lymphoma.
17. Which scan is valuable for the evaluation of brain abscess?
    (a) Gallium scan
    (b) BBB imaging
    (c) CT scan
    (d) rCBF scan
18. In which of the following phases of cerebral infraction does the temporary loss of visibility of an infarct occur on the CT scan (fogging phenomenon)?
    (a) Acute (after hours)
    (b) Early subacute (after 1 week)
    (c) Late subacute (after 2 weeks)
    (d) Chronic (after 1 month)
19. Lesions causing acute stroke that are overlooked on a brain perfusion scan are commonly reported in:
    (a) Brain stem
    (b) Cerebellum
    (c) Cortex
    (d) Subcortical
20. A 48-year-old man is suspected to have brain death based on clinical symptoms and apnea test. Which of the following modalities has the highest diagnostic sensitivity and specificity?
    (a) ^{99m}Tc-HMPAO brain SPECT
    (b) ^{99m}Tc-pertechnetate cerebral perfusion
    (c) Electroencephalogram
    (d) ^{99m}Tc-DTPA cerebral perfusion

21. A patient with suspected herpes encephalitis is subjected to the ^{99m}Tc-HMPAO scan. What are the scan findings 1 day and 40 days after onset of the disease, respectively?
    (a) Mild increase in uptake, normal uptake
    (b) Severe increase in uptake, decrease in uptake
    (c) Severe increase in uptake on both scans
    (d) Decrease in uptake, increase in uptake
22. Which statement is NOT correct regarding the diagnosis of herpes simplex encephalitis with the ^{99m}Tc-HMPAO brain perfusion scan?
    (a) Increased uptake in the involved brain regions in the acute phase of the disease.
    (b) Increased uptake mainly in the temporal lobe.
    (c) The ^{99m}Tc-HMPAO scan is effective when the MRI is unremarkable.
    (d) Uptake in the involved brain regions increases over time.
23. What is the pattern of brain death in SPECT?
    (a) Diffuse cerebral distribution of Tc-HMPAO
    (b) Diffuse cerebral distribution of Tc-ECD
    (c) Empty skull
    (d) Observation of the sagittal sinus
24. In brain death:
    (a) Brain scintigraphy has NO role in the identification of brain death.
    (b) Hot nose sign is indicative of brain death.
    (c) Delayed cerebral activity after Tc-HMPAO injection is suggestive of brain death.
    (d) Barbiturates do NOT affect the scan pattern in brain death.
25. What is the preferred radiopharmaceutical for the confirmation of brain death in a patient in deep coma?
    (a) ^{99m}Tc-DTAP
    (b) ^{99m}Tc-ECD
    (c) ^{99m}TcO4−
    (d) ^{133}Xe
26. In acute viral encephalitis, the findings of which scan is NOT an increased uptake?
    (a) ^{99m}Tc-DTPA
    (b) ^{99m}Tc-HMPAO
    (c) ^{99m}Tc-IMP
    (d) ^{99m}Tc-ECD
27. About the evaluation of brain death in nuclear medicine:
    (a) An important sign in brain death is the lack of tracer activity in the superior sagittal sinus during the venous phase of the flow study.
    (b) In brain death, blood flow superior to the circle of Willis circulation may exist.
    (c) SPECT is necessary in all cases with suspected brain death.
    (d) Reduced flow in the scalp is also observed in brain death aside from reduced flow of ACA and MCA.

5.8.1 Answer

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5.9 Radiolabeled Agents for the Localization of Infection and Inflammation

1. What is the gold standard scintigraphic technique for determining infection and inflammation?
   (a) ^{99m}Tc-MDP
   (b) ^{67}Ga
   (c) ^{99m}Tc-colloid
   (d) Radiolabeled leukocytes
2. What is the best scintigraphic technique for the diagnosis of spondylodiscitis?
   (a) ^{67}Ga
   (b) ^{99m}-Tc leukocytes
   (c) ^{111}In-leukocytes
   (d) ^{99m}Tc-colloid
3. ^{111}-In-WBC is performed on a 57-year-old man with fever of unknown origin (FUO). In the primary images, both lungs show radiotracer uptake. In the delayed images, lung activity is reduced, but hepatic uptake is increased. What is the best diagnosis?
   (a) Diffuse pulmonary vasculitis probably due to Wegener's granulomatosis
   (b) WBC damage during preparation
   (c) Drug-induced cholangitis
   (d) Normal view
4. In which of the following radiotracers does vascular permeability play the least important role in its accumulation in the infection site?
   (a) ^{67}Ga-citrate
   (b) ^{99m}Tc-HMPAO-WBC
   (c) Radiolabeled monoclonal antigranulocyte antibody
   (d) ^{111}In-IgG
5. Which method is the most effective in evaluating cerebral abscess?
   (a) ^{99m}Tc-MIBI scan
   (b) Thallium scan
   (c) MRT
   (d) CT scan
6. Which of the following regions does NOT show a radiotracer uptake on normal In-leucocyte scintigraphy?
   (a) Liver
   (b) Spleen
   (c) Breast
   (d) Bone scan
7. Radiotracer accumulation is found along the lateral and the diaphragmatic side of the liver and paracolic region on the gallium scan. Liver shows a marked decrease in uptake. What is the most probable diagnosis?
   (a) Hepatic failure
   (b) Peritonitis
   (c) Diffuse ascites
   (d) Infection of the supramesanteric space

8. If the goal is to evaluate infections, which one is NOT considered an advantage of In-leucocyte scan over gallium scan?
   (a) Higher specificity
   (b) Simple interpretation of the scan
   (c) High sensitivity for the detection of chronic infections
   (d) Better differentiation of abscess from tumor
9. In which of the following conditions is ^{99m}Tc- HMPAO-WBC preferred over ^{111}In-WBC?
   (a) A patient suspected to have an inflammatory bowel disease and quantitative calculation.
   (b) A patient with chronic fever but with no confirmed diagnosis.
   (c) A patient suspected to have urinary tract infection.
   (d) Precise localization of infection in a patient suspected to have abdominal abscess.
10. What is the mechanism of radiotracer accumulation at the infection site after ^{67}Ga-citrate injection?
   (a) Binding to lactoferrin, extravasal leakage, and binding to bacterial receptors and WBC at the infection site
   (b) Binding to leucocytes in blood circulation and accumulation at the infection site
   (c) Binding to transferrin, extravasal leakage, and binding to lactoferrin and siderophore at the infection site
   (d) Antigen–antibody bound between gallium and lactoferrin and binding to WBC receptors at the infection site
11. The In-WBC scan shows an increased uptake around the right shoulder joint, but the sulfur colloid scan is normal. What is the most probable diagnosis?
   (a) Loose prosthesis
   (b) Decreased bone marrow activity
   (c) Infection around the prosthesis
   (d) Tumoral infiltrations
12. Which organ is highly exposed to radiation after ^{111}In-WBC administration?
   (a) Spleen
   (b) Bone marrow
   (c) Gonads
   (d) Lungs
13. Which item is NOT the mechanism of ^{67}Ga uptake at the infection site?
   (a) Lymphocyte cell surface binding
   (b) Increase in vascular permeability
   (c) Bacterial siderophore binding
   (d) Macrophage uptake through iron binding
14. In which of the following conditions is gallium scan is preferred over ^{111}In-WBC?
   (a) Tissue encapsulation
   (b) Abdominal abscess
   (c) Inflammatory bowel disease (IBD)
   (d) Orthopedic infections

15. Which of the following complexes is used for WBC labeling in plasma and increases its viability and function?
    (a) ^{111}In complex with transferrin
    (b) ^{111}In complex with mercaptopyridine N-oxide and tropolone
    (c) ^{111}In-tropolone
    (d) ^{111}In-acetylacetone and tropolone
16. Which of the following patterns on the gallium scan is indicative of peritonitis in a child?
    (a) Haziness of the abdomen and pelvis, reduced uptake in the liver
    (b) Sporadic focal increase in activity in the abdomen and pelvis, increased activity in the liver
    (c) Accumulation of activity on the lateral and diaphragmatic sides of the liver, diffuse activity in the pelvis and abdomen, decreased liver uptake
    (d) Observation of a region without activity in the abdomen and pelvis, increased uptake in the liver
17. Gallium scan is performed on a patient. Diffuse abdominal uptake particularly in the liver and progression of liver uptake from the lateral border to the right subdiaphragmatic space are reported. What is the most probable diagnosis?
    (a) Hepatitis
    (b) Subdiaphragmatic abscess
    (c) Cellulitis
    (d) Peritonitis
18. For the labeling of leucocytes with technetium or indium:
    (a) In-labeled and ^{99m}Tc-labeled leucocytes have different normal distributions of activity.
    (b) The physiologic activity of ^{111}In-leukocyte in the kidneys and bladder sometimes interferes with the detection of renal defect.
    (c) High purity of the radionuclide is one of the advantages of ^{99m}Tc-labeling over indium.
    (d) No intestinal activity is observed 3 h after the intravenous administration of ^{99m}Tc-leucocyte.
19. A patient with severe and sudden spinal pain is presented. Laboratory tests show WBC of 18,000 and ESR of 56. What should be the first diagnostic procedure to be conducted?
    (a) X-ray and bone scan
    (b) X-ray and gallium scan
    (c) Gallium scan and bone scan
    (d) X-ray and sulfur colloid scan
20. A 45-year-old woman with history of L4–L5 disk surgery 20 months ago is referred with pain and intermittent fever. Bone scan shows an increased uptake in L4–L5, but the ^{111}In-WBC scan demonstrates a decreased activity. What is the most probable cause of this finding?
    (a) Acute infection
    (b) Metastasis in the region
    (c) Antibiotic administration for chronic infection
    (d) Low resolution of ^{111}In-WBC images

21. The ^{111}In-WBC scan is performed on a patient with suspected abdominal abscess. The appearance of which organ on the scan is considered normal?
    (a) Lung
    (b) Kidney
    (c) Small intestine
    (d) Colon
22. A 67-year-old woman with discopathy underwent surgical therapy 6 weeks ago. She is currently complaining about back pain. Blood test is normal, destructive changes are found on the radiography of the vertebral column, and an increased activity is detected in the delayed phase of the three-phase bone scan. Therefore, osteomyelitis is suspected. Which of the following diagnostic methods has the highest sensitivity and specificity?
    (a) ^{67}Ga SPECT
    (b) MRI
    (c) ^{111}In-labeled leukocyte scan
    (d) CT scan
23. A 32-year-old man is subjected to antibiotic therapy because of chronic osteomyelitis in the right medial tibia. What is the method of choice for therapeutic monitoring?
    (a) ^{67}Ga scan
    (b) ^{111}In-WBC scan
    (c) ^{99m}Tc-HMPAO-WBC scan
    (d) ^{201}Tl scan
24. A neonate with edema of the right ankle is referred for ^{111}In-WBC scan. What is the required blood volume for labeling?
    (a) 10 cc
    (b) 30 cc
    (c) 50 cc
    (d) 80 cc
25. Which item is the rarest cause of a false-positive result on the ^{99m}Tc-HMPAO-WBC scan?
    (a) Malignant bone tumors
    (b) Pulmonary emboli
    (c) Accessory spleen
    (d) Intermittent colon enema
26. Which of the following radiopharmaceuticals for a bone marrow scan demonstrates the least uptake in the liver and spleen?
    (a) ^{99m}Tc-nanocolloid
    (b) ^{99m}Tc-sulfur colloid
    (c) ^{99m}Tc-NS-Ab
    (d) ^{111}In-chloride

27. A 7-year-old child diagnosed with non-Hodgkin's lymphoma is subjected to chemotherapy. He suffers from granulocytopenia and is currently experiencing fever of unknown origin. A focal increase in uptake in the RLQ region is observed on the gallium scan and is present in the 24, 48, and 72 h images. What is the most probable diagnosis?
    (a) Infected appendicitis.
    (b) Typhlitis.
    (c) Delayed scan is also required for diagnosis.
    (d) Necrotizing proctitis.
28. In which of the following conditions is the discrepancy of reticuloendothelial and erythroblastic activity in the bone marrow the most common?
    (a) Metastatic lesions
    (b) Bone marrow infarction
    (c) Aplastic anemia due to chemotherapy
    (d) Radiation
29. About the application of bone marrow scan:
    (a) Radiography is more sensitive than bone marrow scan if the goal is the early detection of bone metastasis.
    (b) An increased activity in the involved region is observed in the primary stages of acute bone marrow infarction.
    (c) Bone marrow returns to its normal condition a few weeks after bone radiation.
    (d) Long bones are completely observed on the bone marrow scan of patients with sickle cell anemia.
30. What is the advantage of ^{99m}Tc-HMPAO over ^{111}-In for the labeling of WBC?
    (a) The scan can be completed in 2 h.
    (b) WBC must be separated.
    (c) It is more appropriate for the detection of chronic infection.
    (d) It is more appropriate for the detection of gastrointestinal and urinary infections.
31. In which of the following conditions is the In-leukocyte scan more effective than the gallium scan?
    (a) Evaluation of patients with fever of unknown origin without a history of surgery
    (b) Identification of the cause of fever in neutropenic patients
    (c) Diagnosis of chronic pulmonary granulomatosis defects
    (d) Evaluation of bone infection lesions
32. The uptake of ^{111}In-WBC is observed in all of the following conditions *except*:
    (a) Bacterial endocarditis
    (b) Active inflammatory bowel disease
    (c) Acute myocardial infarction
    (d) Transplanted kidney

33. In which of the following condition is the ^{111}In-labeled WBC scan has the least sensitivity?
    (a) A patient with fever and abdominal pain after hip surgery
    (b) A patient with ulcerative colitis and poor general condition for whom colonoscopy is NOT possible
    (c) A diabetic patient with suspected osteomyelitis of the metatarsal
    (d) A young man with fever and back pain after disk surgery
34. In the comparison between the gallium and ^{111}In-WBC scans:
    (a) The accumulation of ^{111}In-WBC in abscesses is greater than that of gallium.
    (b) Interpretation of the gallium scan is easier.
    (c) Gallium scan is more specific than ^{111}In-WBC scan in detecting infection.
    (d) ^{111}In-WBC shows a better uptake in chronic infections.
35. For the diagnosis of osteomyelitis with ^{111}In-leukocyte scan:
    (a) False-negative findings are observed in traumas and diabetes.
    (b) If this scan is conducted, bone scan with ^{99m}Tc-MDP is NOT required.
    (c) This scan is NOT useful for the diagnosis of vertebral osteomyelitis.
    (d) ^{111}In is more appropriate than ^{99m}Tc-HMPAO in children.
36. ^{111}In-IgG is the least valuable for the diagnosis of which type of infection?
    (a) Intrahepatic infections
    (b) Articular prosthesis infections
    (c) Pneumocystis carinii pneumonia
    (d) Early diagnosis of infection in patients with a compromised immune system
37. Bone marrow scan:
    (a) This scan is capable of differentiating between infarction and infection.
    (b) A radionuclide peripheral expansion is observed in most cases of multiple myeloma.
    (c) The scan is abnormal in the primary stages of polycythemia vera in most cases.
    (d) If the goal is to diagnose avascular necrosis of the femoral head in adults, accuracy of the radionuclide bone marrow scan is similar to that of bone scan.
38. Gallium scan:
    (a) CT scan and sonography are conducted prior to gallium scan for the diagnosis of phlegmon.
    (b) Gallium scan is NOT conducted prior to CT scan and sonography for the diagnosis of peritonitis.
    (c) Labeled-WBC scan is conducted prior to gallium scan for the detection of abdominal infection.
    (d) Gallium scan is currently NOT indicated for abdominal infections.

39. All of the following statements about the evaluation of infection with labeled leukocytes are correct *except*:
    (a) Imaging must be performed at least 4 h after injection if ^{99m}Tc-HMPAO is used for abdominal evaluation.
    (b) ^{111}In-WBC must be used for the evaluation of infection in the urinary tract.
    (c) ^{111}In-WBC is preferred for the quantitative evaluation of gastrointestinal inflammatory lesions.
    (d) ^{111}In-WBC is preferred for the concurrent evaluation of peripheral osteomyelitis with bone scan.
40. What is the recommended method for the therapeutic monitoring of a patient with malignant otitis externa?
    (a) Bone scintigraphy
    (b) Gallium scan
    (c) Nanocolloid scan
    (d) CT scan
41. Which of the following statements about WBC labeling with ^{111}In and ^{99m}Tc-HMPAO is NOT correct?
    (a) The labeling efficiency of ^{111}In-tropolon is less than that of ^{99m}Tc-HMPAO.
    (b) Complete plasma separation is required for ^{111}In-oxine.
    (c) ^{99m}Tc-HMPAO has greater affinity in the labeling of granulocytes.
    (d) ^{99m}Tc-HMPAO labeling is possible with a small amount of plasma.
42. Which of the following statements is correct?
    (a) CT scan can be used to detect phlegmon because it is a focal inflammatory defect.
    (b) When the clinical origin of sepsis is NOT clear, the labeled leukocyte scan can be used as the first diagnostic method.
    (c) Liver abscess can be diagnosed with gallium scan only.
    (d) Gallium scan can be used for differentiating between focal pancreatic abscess and pancreatitis.
43. Colloidal bone marrow scan:
    (a) The hepatosplenic uptake of nanocolloid is greater than that of sulfur colloid.
    (b) Sulfur colloid is recommended for the evaluation of bone marrow distant from the liver and spleen areas.
    (c) The background of sulfur colloid images are greater than that of nanocolloid.
    (d) The covering of the hepatosplenic region and dynamic imaging on a bone marrow scan are NOT beneficial.
44. In which of the following organs is the radiotracer uptake unremarkable 18–24 h after the injection of ^{111}In-leukocyte?
    (a) Bone marrow
    (b) Lungs
    (c) Spleen
    (d) Liver

45. Which of the following characteristics is considered an advantage of ^{67}Ga over ^{111}In-leukocyte?
    (a) Easier interpretation
    (b) More specific
    (c) Lack of accumulation in the colon and sterile wounds
    (d) Greater efficacy in chronic infections
46. In abdominal wall cellulitis:
    (a) Sonography is an efficient method for diagnosis.
    (b) CT scan is a suitable method for diagnosis.
    (c) The accuracy of the ^{67}Ga scan for diagnosis is high.
    (d) The anatomical features of cellulitis are clear.
47. In differentiating between subdiaphragmatic abscess and empyema, which modality is recommended?
    (a) CT scan
    (b) Ultrasonography
    (c) Radionuclide scintigraphy
    (d) All of the above
48. Which of the following statements about radioactive iron is NOT correct?
    (a) The quantitative evaluation of erythropoiesis can be performed by ^{52}Fe.
    (b) ^{52}Fe is more valuable than ^{99m}Tc-SC for the evaluation of bone marrow disorders in the thoracic and lumbar regions.
    (c) ^{52}Fe is indicated for the evaluation of suspected extramedullary hematopoiesis.
    (d) ^{57}Fe is a suitable alternative to ^{52}Fe because of its excellent photopeak.
49. Which of the following statements about In-chloride scan is NOT correct?
    (a) It binds to serum transferrin immediately after intravenous administration, and its half-life in plasma is 5 h.
    (b) Compared with ^{52}Fe scintigraphy, the higher dose of In-chloride is required for bone marrow evaluation.
    (c) The hepatosplenic uptake of In-chloride indicates erythropoiesis in these organs.
    (d) Five hundred rad of bone marrow radiation causes the absence of ^{52}Fe uptake but NOT In-chloride uptake.
50. Which type of cell is the least probable to react with NCA-95?
    (a) Promyelocytes
    (b) Myelocytes
    (c) Metamyelocytes
    (d) a and b
51. For the labeling of white blood cells:
    (a) Evaluation of sterility and apyrogenicity is critical after labeling.
    (b) Evaluation of leucocyte function is critical after labeling.
    (c) Imaging is performed 18–24 h after the injection of In-oxine WBC.
    (d) The presence of plasma does not interfere with the In-oxine labeling of blood cells.

52. Which of the following imaging methods earlier shows the positive findings of acute infection (e.g., osteomyelitis)?
    (a) ^{99m}Tc-MDP scan
    (b) ^{111}In-WBC scan
    (c) ^{68}Gallium scan
    (d) CT scan
53. The ^{111}In-labeled leukocyte scan is conducted prior to the ^{99m}Tc-labeled leukocyte scan in all of the following situations *except*:
    (a) Chronic infections (e.g., fever of unknown origin)
    (b) Suspected infection of the urinary tract
    (c) Quantification of the GI inflammatory process
    (d) Exact localization of the GI process
54. A 4-year-old boy is referred to the emergency ward with fever, lymphadenopathy, erythema, and edema of the cervical lymph nodes that began 5–6 days ago. Oral cephalexin was prescribed 3 days ago, but fever and edema have NOT yet diminished. The child is hospitalized and subjected to intravenous antibiotic therapy, but fever and edema continue for more than 48 h. Which of the following studies is recommended?
    (a) Gallium scan
    (b) Neck sonography
    (c) Thoracic CT scan
    (d) Neck and thorax MRI

5.9.1 Answer

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5.10 Undiagnosed Fever

1. What is the most common tumor causing pyrexia of unknown origin (PUO)?
   (a) Colorectal cancer
   (b) Hodgkin's lymphoma
   (c) Non-Hodgkin's lymphoma
   (d) Hepatoma
2. Occult infection and pyrexia of unknown origin (PUO):
   (a) PUO is more likely to be associated with a neutrophilic infiltration.
   (b) Differentiating between PUO and occult infection is useful.
   (c) Patients categorized to have occult infection should be investigated with ^{67}Ga.
   (d) Patients categorized to have PUO should be investigated with labeled leukocytes
3. Infection is the name of
   (a) ^{99m}Tc-sulesomab
   (b) ^{99m}Tc-ciprofloxacin
   (c) ^{99m}Tc-anti-E-selectin
   (d) ^{99m}Tc-liposomes
4. Undiagnosed fever in pediatrics:
   (a) The interpretation of leukocyte scintigraphy in children is similar to that in adults.
   (b) ^{111}In-labeled cells are preferred over ^{99m}Tc-HMPAO for children.
   (c) ^{99m}Tc-HMPAO is preferred over ^{111}In-labeled cells for chronic sepsis in children.
   (d) The performance of leukocyte scintigraphy in children is different from that in adults.
5. A normal ^{67}Ga scan in the presence of obvious respiratory deterioration in an HIV patient indicates:
   (a) Very good prognosis.
   (b) Very poor prognosis.
   (c) It cannot determine the prognosis and needs further tests.
   (d) Good prognosis.
6. Fever of unknown origin (FUO) is observed in a patient after surgery. Abdominal graphy, sonography, and CT scan results are negative. What is the next step?
   (a) Scan with labeled leucocyte
   (b) Scan with labeled antibody
   (c) Gallium scan
   (d) Scan with ciprofloxacin
7. For the evaluation of a patient with fever of unknown origin:
   (a) Gallium scan is the first step.
   (b) ^{111}In-WBC scan is the first step.
   (c) Gallium scan should be considered as an imaging method for evaluating the patient.
   (d) ^{18}F-FDG is indicated when other methods canNOT provide a specific finding.

8. In the comparison between gallium and In-WBC scans for the evaluation of infectious and inflammatory processes:
   (a) In-WBC scan is more sensitive for the evaluation of sarcoidosis.
   (b) Gallium scan is preferred for the evaluation of abdominal abscess.
   (c) Gallium scan in the peripheral bones is more successful in detecting bone infection.
   (d) In-WBC scan is less sensitive for the detection of chronic osteomyelitis than that of the acute form.
9. A 64-year-old man with a history of fever for 4 weeks is evaluated. Laboratory tests are unremarkable. What is the recommended radiopharmaceutical for the diagnosis?
   (a) ^{67}Ga citrate
   (b) ^{99m}Tc-HMPAO-WBC
   (c) ^{111}In-WBC
   (d) NeutroSpec
10. What is the best radiopharmaceutical for the diagnosis of fever of unknown origin (FUO)?
   (a) Tc-HMPAO
   (b) ^{111}In-leukocyte
   (c) ^{67}Ga
   (d) ^{99m}Tc-IgG

5.10.1 Answer

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5.11 Inflammatory Bowel Disease

1. All of the following are the principal indications for leukocyte imaging in inflammatory bowel disease (IBD) *except*:
   (a) Diagnosis of IBD especially ulcerative colitis (UC)
   (b) Ruling out of IBD in a patient with symptoms suggestive of IBD but without a diagnosis
   (c) Determination of disease distribution
   (d) Confirmation of disease relapse
2. ^{99m}Tc-HMPAO-labeled leucocyte scintigraphy reveals accumulated radioactivity in the rectum and descending colon. Which of the following items can cause such an accumulation?
   (a) Constipation
   (b) Ulcerative colitis
   (c) Pancolitis
   (d) Irritable bowel syndrome
3. A 44-year-old man with a history of IBD is experiencing fever. He has recently used antibiotics especially clindamycin. ^{111}In-WBC scan is performed to investigate the reason for the fever, and it shows generalized activity throughout the large bowel. What is the most probable diagnosis?
   (a) Scan is normal.
   (b) Pseudomembranous colitis should be considered.
   (c) Delayed scan is required for diagnosis.
   (d) b and c.
4. In-WBC scan is routinely performed 16–24 h after radiotracer injection. In which of the following conditions is a scan 2–4 h after injection also required?
   (a) Bone prosthesis
   (b) Diabetic foot
   (c) Vascular graft
   (d) Inflammatory bowel disease
5. Which of the following statements about imaging of patients with ulcerative colitis or Crohn's disease is NOT correct?
   (a) If the goal is to evaluate the whole colon in severe ulcerative colitis, scintigraphy with labeled leucocyte is preferred over colonoscopy.
   (b) If the goal is to evaluate patients with Crohn's disease suspected to have obstruction, CT scan and barium evaluation are more effective than scintigraphy.
   (c) ^{111}In-lukocyte scintigraphy is the gold standard for the diagnosis of ulcerative colitis.
   (d) Scintigraphy with labeled leukocyte is sometimes indicated for the differentiation between ulcerative colitis and Crohn's disease.
6. Which scan provides the best diagnostic findings in a patient with suspected inflammatory bowel disease?
   (a) ^{111}In-WBC
   (b) ^{99m}Tc polyclonal antibodies
   (c) ^{99m}Tc-HAMPAO WBC
   (d) ^{111}In-interleukin

7. A 47-year-old patient with a history of Crohn's is presented with diarrhea and bloody mucus that began in the previous week. What is the recommended method of evaluation?
   (a) Colonography with CT
   (b) ^{99m}Tc-HMPAO-WBC
   (c) ^{111}In-WBC
   (d) Small intestine transit with barium
8. Which of the following findings in the ^{99m}Tc-HMPAO-WBC scan of intestines has a positive predictive value of more than 90% for the diagnosis of inflammatory bowel disease?
   (a) No uptake in the 1 h scan, increased uptake in the 12 h scan
   (b) Increased uptake in the 1 h scan, decreased uptake in the 12 h scan
   (c) Increased uptake in the 1 h scan, increased intensity of initial uptake in the 3 h scan
   (d) No uptake in the 1 h scan, increased uptake in the 3 h scan
9. About ^{111}In-WBC scan:
   (a) The sensitivity of scan is NOT influenced by antibiotic therapy in chronic infections.
   (b) It is more sensitive for the detection of acute osteomyelitis than that of the chronic form.
   (c) The spleen receives most of the radiation during scan.
   (d) All of the above.
10. ^{111}In-labeled granulocyte is NOT indicated for the diagnosis of:
   (a) Ulcerative colitis
   (b) Paracolic abscess
   (c) Crohn's disease
   (d) Gastritis

5.11.1 Answer

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5.12 Nuclear Imaging in Cardiovascular Infection and Cardiac Transplant Rejection

1. What is the frontline imaging method used for the diagnosis of prosthetic vascular graft infection during the late postoperative period?
   (a) MRI
   (b) CT
   (c) ^{67}Ga scintigraphy
   (d) ^{111}In-labeld leukocyte
2. What are the best modalities for the diagnosis of subacute endocarditis?
   (a) PET, MRI
   (b) Radionuclide angiogram, MRI
   (c) Echocardiography, Doppler ultrasonography
   (d) Echocardiography, MRI

5.12.1 Answer

	A	B	C	D
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5.13 The Immunocompromised Patient

1. ^{67}Ga scanning in immunocompromised patients is NOT recommended in:
   (a) Intra-abdominal infections
   (b) Lymphocytic interstitial pneumonitis
   (c) Mycobacterial lung involvement
   (d) Cytomegalovirus pneumonitis
2. A mild uptake around the hilum of the lung and an increased uptake in both orbits and adrenal glands are found on the gallium scan of a patient with AIDS. What is the most probable diagnosis?
   (a) Lymphocytic interstitial pneumonitis
   (b) Diffuse infiltrative lymphocytosis syndrome
   (c) Cytomegalovirus infection
   (d) Lymphoma with associated reaction
3. In which of the following conditions does ^{111}In-WBC have higher sensitivity than gallium scan?
   (a) Adult respiratory distress
   (b) Active pulmonary sarcoidosis
   (c) Pneumocystis carinii
   (d) None
4. What is the radiotracer of choice for the diagnosis of pneumocystis carinii in a patient with AIDS?
   (a) ^{111}In-IgG
   (b) ^{67}Ga-citrate
   (c) ^{111}In-WBC
   (d) ^{99m}Tc-anti-CD15
5. Diffused uptake of ^{67}Ga is observed in the lungs of a child with HIV. Swelling of the salivary glands, clubbing of fingers, and generalized lymphadenopathy are observed upon clinical examination. What is the most probable diagnosis?
   (a) Pneumocystis carinii pneumonia
   (b) Lymphocytic interstitial pneumonitis
   (c) Cytomegalovirus infection
   (d) Tuberculosis
6. Which of the following items is indicated by a normal gallium scan in a symptomatic patient with advanced AIDS?
   (a) Poor prognosis
   (b) Response to treatment
   (c) Saturated iron band capacity
   (d) Good prognosis
7. In which of the following conditions does ^{111}In-WBC have higher sensitivity than gallium scan?
   (a) Pulmonary active sarcoidosis
   (b) Adult respiratory distress syndrome
   (c) Pneumocystis carinii
   (d) Pneumonia in patients with AIDS

8. Gallium scan is performed on an HIV-positive patient with pulmonary symptoms. A radiopharmaceutical uptake is observed only in the lymph nodes. What is the most probable diagnosis?
   (a) Cytomegalovirus infection
   (b) Lymphoma
   (c) Bacterial pneumonia
   (d) Pneumocystis carinii
9. Which of the following diagnostic methods is the least valuable for a patient with herpes encephalitis?
   (a) Blood–brain barrier scan
   (b) ^{99m}Tc-HMPAO scan
   (c) ^{18}F-FDG-PET
   (d) CT scan
10. In cerebral HIV infection:
   (a) Multifocal reduced activity in brain ^{18}F-FDG-PET.
   (b) Multifocal increased activity in brain SPECT.
   (c) Thallium scan is NOT effective in differentiating between lymphoma and toxoplasmosis.
   (d) Increased uptake in ^{18}F-FDG-PET of patients with toxoplasmosis.
11. Which of the following methods provides high specificity and sensitivity for the diagnosis of problematic cases of brain abscess?
   (a) Blood–brain barrier scan
   (b) Labeled WBC scan
   (c) CT scan
   (d) MRI
12. In patients with brain lesions due to AIDS:
   (a) Ring sign in brain MRI is very specific for the diagnosis of the type of lesion.
   (b) Margin of the ring sign shows weak or no uptake on ^{201}Tl-SPECT in tuberculous lesions.
   (c) Margin of the ring sign shows a similar uptake in the scalp on ^{201}Tl-SPECT in toxoplasmosis.
   (d) The shape of the tuberculous lesions in MRI is completely different from that of toxoplasmosis.
13. Some ring lesions are observed in the brain MRI of a patient with AIDS. What is the method of choice for differentiating between toxoplasmosis and lymphoma?
   (a) Brain SPECT with ^{99}mTc-HMPAO
   (b) Brain SPECT with ^{201}Tl
   (c) Brain SPECT with ^{99}mTc-ECD
   (d) Brain SPECT with ^{68}Ga

14. Gallium scan is requested for an HIV+ patient with a history of PCP. An increased uptake is detected only in the upper segments of the lung. Which item is indicated by this finding?
    (a) Superimposed cytomegalovirus infection with necrosis in the medial segments
    (b) TB granuloma
    (c) Antimicrobial treatment
    (d) Superimposed Kaposi's sarcoma in the inferior segments
15. CT scan is performed on an HIV+ patient with focal neurologic symptoms. A large lesion is found in the frontal lobe. What is the recommended scan for differentiating between metastasis (lymphoma) and infection (toxoplasmosis)?
    (a) ^{67}Ga SPECT
    (b) ^{201}Tl SPECT
    (c) ^{18}F-FDG-PET
    (d) ^{99m}Tc-ECD SPECT
16. An increased uptake in the salivary glands is reported on the gallium scan of an AIDS patient. What is the most probable diagnosis?
    (a) Salivary gland malignancy
    (b) A normal finding for AIDS patients
    (c) Diffuse infiltrative lymphocytosis syndrome (DILS)
    (d) Opportunistic infection
17. A patient with chronic coronary artery disease and left ventricular dysfunction underwent heart transplantation. After surgery, he experiences fever, and multiple pulmonary nodules are found on radiography. What is the most probable diagnosis?
    (a) Nocardiosis
    (b) Pneumocystis carinii
    (c) Pneumococcus pneumonia
    (d) Aspergillus
18. What is the main finding of the pulmonary gallium scan for pneumocystis carinii pneumonia in a patient suffering from AIDS?
    (a) Negative gallium scan + abnormal radiography
    (b) Abnormal diffuse pulmonary uptake + normal radiography
    (c) Multifocal gallium uptake
    (d) Focal or regional gallium uptake
19. What is the main finding of the pulmonary gallium scan for actinomycosis in a patient suffering from AIDS?
    (a) Negative gallium scan + abnormal radiography
    (b) Abnormal diffuse pulmonary uptake + normal radiography
    (c) Multifocal gallium uptake
    (d) Focal or regional gallium uptake

20. What is the main finding of the pulmonary gallium scan for Kaposi's sarcoma in a patient suffering from AIDS?
    (a) Negative gallium scan + abnormal radiography
    (b) Abnormal diffuse pulmonary uptake + normal radiography
    (c) Multifocal gallium uptake
    (d) Focal or regional gallium uptake

5.13.1 Answer

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Suggested Readings

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