Part A

Patient Care in MRI

Bioeffects, Safety, and Patient Care

Introduction

To date, there are no known long-term biological effects associated with magnetic resonance imaging (MRI). However, there are some aspects of MRI that could potentially result in irreversible and devastating outcomes for the patients and operators. These aspects include the static magnetic fields (potential projectiles and torque), the time-varying magnetic fields associated with the magnetic field gradients (peripheral nerve stimulation and acoustic noise), and the radiofrequency field (thermal injuries, heating, and burns). Part A will provide "practice" questions to prepare for the safety component of the MRI Boards.

MR image acquisition is very different from radiographic imaging, nuclear medicine, and sonography. The instrumentation used and the physical principles of image formation are "unique" for MR imaging. For these reasons, safety considerations for patients and personnel in MRI are also "unique" to the modality. For example, the strength of the magnetic field in the majority of MR imagers is so high (1.5 Tesla or 10 000 Gauss) that terminal velocity of a "paperclip" is up to 40 miles per hour. A simple paperclip would hit the side of the MR scanner at 40 mph! Furthermore, the velocity with which a metallic object (such as the paperclip) flies toward the scanner is determined by the mass of the object and the distance from the scanner (in addition to the type of metal and strength of the magnetic field). One can only imagine the damage that could be done if an oxygen

Review Questions for MRI, Second Edition. Carolyn Kaut Roth and William H. Faulkner.

tank was inadvertently brought into the MR scan room. MR safety can be a "life-or-death" scenario. Part A will provide practice questions about projectiles (flying metallic objects) as well as other "life-threatening" safety considerations in MRI.

The safety component of the MRI Boards (post primary examination and/or primary examination)

Beginning in 1995, the advanced-level examination in MRI was available as a "post primary examination". At that time, the post primary examination was only available for the registered technologist in radiography (RT (R)). To qualify for the MRI (post primary) examination, the technologist had to have a "primary certification". The primary examination could include: the radiography examination (RT (R)), the nuclear medicine examination (RT (N)), and the radiation therapy examination (RT (T)) or the sonography examination RT (S)). The assumption was that the technologist had already learned (and had been tested on) subjects such as "general patient care" during their primary examination. Therefore, when the MRI Boards were only available as a post primary examination, the safety category of the MRI boards included *only* MRI safety considerations.

Toward the fall of 2005 the ARRT announced that "the technologist need not be an *RT* to qualify for the advanced level examination in MRI". In January 2006, the ARRT defined the statement whereby one could qualify for the exam as a primary examination or a post primary examination. To qualify for the post primary examination, the technologist must have a primary certification (explained above). To qualify for the "primary examination", the "student" must attend an accredited MRI educational program. This program "can" resemble a radiography program, whereby the radiation physics is replaced by MR physics; radiation technique is replaced by MRI scan parameters; and patient care and radiation safety is replaced by patient care and MR safety. Today the MRI Boards are available as a "post primary examination" (for the RT) and also as a "primary examination" (for the non-RT). For this reason, the safety category within the advanced-level examination in MRI includes not only MRI safety but also general patient care.

There are several types of examination for the MRI technologist in North America, including the ARRT examination, the ARMRIT examination, and the CAMRT examination. Each examination has safety questions and these make up roughly 15–20% of the examination.

Part A offers review questions and answers that relate to general patient care and MRI safety considerations. Even though the questions are set with the guidelines from the content specifications from North American Boards in mind, MRI safety is critical for healthcare workers in the MR environment worldwide!

General patient care

1. Legal and ethical principles
   a. Confirmation of exam requisition
   b. Legal issues

c. Patient's rights
d. ARRT standard of ethics

2. Patient assessment, monitoring, and management
a. Routine monitoring
b. Emergency response
c. Patient transfer and body mechanics
d. Assisting patients with medical equipment

3. Interpersonal communications
a. Modes of communication
b. Challenges in communication
c. Patient education
d. Medical terminology

4. Infection control
a. Terminology and basic concepts
b. Cycle of infection
c. Standard precautions (general patient contact)
d. Additional or transmission-based precautions (e.g. hepatitis B, HIV, tuberculosis)
e. Disposal of contaminated materials

Legal and ethical principles

It is important for the MRI technologist to understand legal and ethical issues associated with MR imaging. This information is critical as deviation from these standards can lead to unsafe patient practices, lawsuits, and/or termination of employment. Questions on legal and ethical principles are drawn from the following subject areas:

a. Confirmation of exam requisition
i. Verification of patient identification
ii. Comparison of request to clinical indications

b. Legal issues
i. Common terminology (e.g. negligence, malpractice)
ii. Legal doctrines (e.g. *respondeat superior*, *res ipsa loquitur*)

c. Patient's rights
i. Informed consent (written, oral, implied)
ii. Confidentiality (HIPAA)
iii. Patient's Bill of Rights (e.g. privacy, access to information, healthcare proxy, research participation)

d. Standard of ethics
i. ARRT
ii. CAMRT
iii. ARMRIT

Questions 1–29 concern legal and ethical principles.

Patient assessment, monitoring, and management

This category has been modified from the original content specifications and includes patient management information. Questions on patient assessment, monitoring, and assessment are drawn from the following subject areas:

a. Routine monitoring
- **i.** Vital signs
- **ii.** Physical signs and symptoms
- **iii.** Sedated patients
- **iv.** Claustrophobic patients

b. Emergency response
- **i.** Reactions to contrast
- **ii.** Other allergic reactions (e.g. latex)
- **iii.** Cardiac/respiratory arrest (CPR)
- **iv.** Physical injury, trauma, or RF burn
- **v.** Other medical disorders (e.g. seizures, diabetic reactions)
- **vi.** Life-threatening situations (e.g. quench, projectiles)

c. Patient transfer and body mechanics

d. Assisting patients with medical equipment
- **i.** Implantable devices (e.g. infusion catheters, pumps, pacemakers, others)
- **ii.** Oxygen delivery systems
- **iii.** Other (e.g. nasogastric tubes, urinary catheters)

Questions 30–104 concern patient assessment, monitoring, and management.

Interpersonal communications

Since the advanced-level examination offered by the ARRT is now available as a primary examination (for the person who attended an accredited MRI school) or a post primary examination [for the technologist who first studied a primary modality such as radiography RT (R), or nuclear medicine RT (N), or radiation therapy RT (T)], new patient care information has been added to the content specifications. Questions on communication are drawn from the following subject areas:

a. Modes of communication
- **i.** Verbal, written
- **ii.** Nonverbal (e.g. eye contact, touching)

b. Challenges in communication
- **i.** Patient characteristics (e.g. cultural factors, physical or emotional status)
- **ii.** Strategies to improve understanding

c. Patient education
- **i.** Explanation of procedure (e.g. risks, benefits)
- **ii.** Follow-up instructions
- **iii.** Referral to other services

d. Medical terminology

Questions 105–114 concern interpersonal communications.

Infection control

Since the advanced-level examination offered by the ARRT is now available as a primary examination (for the person who attended an accredited MRI school) or a post primary examination [for the technologist who first studied a primary modality such as radiography RT (R), or nuclear medicine RT (N), or radiation therapy RT (T)], new patient care information has been added to the content specifications. Questions on infection control are drawn from the following subject areas:

a. Terminology and basic concepts
- **i.** Types of asepsis
- **ii.** Sterile technique
- **iii.** Pathogens (e.g. fomites, vehicles, vectors)
- **iv.** Nosocomial infections

b. Cycle of infection
- **i.** Pathogen
- **ii.** Source or reservoir of infection
- **iii.** Susceptible host
- **iv.** Method of transmission (contact, droplet, airborne, common vehicle, vector borne)

c. Standard precautions (general patient contact)
- **i.** Handwashing
- **ii.** Gloves, gowns
- **iii.** Masks
- **iv.** Medical asepsis/disinfection

d. Additional or transmission-based precautions (e.g. hepatitis B, HIV, tuberculosis)
- **i.** Airborne (e.g. negative ventilation)
- **ii.** Droplet (e.g. particulate mask)
- **iii.** Contact (e.g. gloves, gown)

e. Disposal of contaminated materials
- **i.** Linens
- **ii.** Needles
- **iii.** Patient supplies

Questions 115–138 concern infection control.

MRI screening and safety

This category is from the original (ARRT post primary) examination. Questions on MRI screening and safety are drawn from the following subject areas. (The ARMRIT and the CAMRT also have MRI screening and safety categories within their examinations.)

1. Biological effects and MRI safety considerations
- **a.** RF field
  - **i.** Specific absorption rate (SAR)
  - **ii.** Biological effects
  - **iii.** FDA guidelines
- **b.** Static and gradient magnetic fields
  - **i.** Biological effects
  - **ii.** FDA guidelines
- **c.** Acoustic noise

2. MRI screening, monitoring, and assessment
- **a.** Screening
  - **i.** Biomedical implants (e.g. pacemakers, clips)
  - **ii.** Ferrous foreign bodies
  - **iii.** Medical conditions
  - **iv.** Prior diagnostic or surgical procedures
- **b.** Equipment safety
  - **i.** Placement of conductors (e.g. ECG leads, coils, cables)
  - **ii.** Cryogen safety
  - **iii.** Ancillary equipment in proximity
  - **iv.** Emergency procedures (e.g. quench, fire)
- **c.** Environment
  - **i.** Climate control (temperature, humidity)
  - **ii.** Gauss lines
  - **iii.** Magnetic shielding
  - **iv.** RF shielding
  - **v.** American Registry for Radiologic technologists Warning signs

Questions 139–202 concern MRI screening and safety.

Part A: Questions

Legal and ethical principles

1. What is the first duty the technologist should perform when beginning an MR examination?

a. Check the physician's orders in the chart ☐
b. Verify the patient's identity ☐
c. Place the film in the Bucky tray ☐
d. Obtain an accurate medical history on the patient ☐

2. In a medical malpractice suit, the _____ must prove medical malpractice.

a. Physician charged ☐
b. Risk manager ☐
c. Patient plaintiff ☐
d. Technologist performing the scan ☐

3. Healthcare workers generally practice _____, which states the "goal is to do no harm".

a. Beneficence ☐
b. Confidentiality ☐
c. Nonmaleficence ☐
d. The prudent professional standard ☐

4. A patient on the MRI table is left unattended and rolls off onto the floor, causing an injury to the head. The technologist in attendance can be sued for:

a. Slander ☐
b. Negligence ☐
c. Battery ☐
d. False imprisonment ☐

5. A patient, deemed competent, becomes claustrophobic during an MRI procedure and refuses to continue with the study. The technologist should first:

a. Call for security and force the patient to continue ☐
b. Stop the study and inform the supervisor ☐
c. Coerce the patient to be more cooperative ☐
d. Reassure the patient and attempt to talk him or her through the procedure ☐

6. A malpractice case based on an obvious negligent act, e.g. a radiograph (or MR image) of the abdomen demonstrates that a surgical sponge was inadvertently left in the surgical site (within the peritoneum) after surgery, will likely be considered under the doctrine of:

- **a.** *Respondeat superior* ☐
- **b.** *Res ipsa loquitor* ☐
- **c.** *Stare decisis* ☐
- **d.** Breach of confidentiality ☐

7. When entering data on a patient's chart, the technologist must be sure to:

- **a.** Sign and date the entry ☐
- **b.** Date the entry, record the time, and sign using name and credentials ☐
- **c.** Date the entry, record the time, and indicate your department ☐
- **d.** Date the entry and sign using name and credentials ☐

8. Unintentional misconduct is also known as:

- **a.** Libel ☐
- **b.** Battery ☐
- **c.** False imprisonment ☐
- **d.** Negligence ☐

9. Which of the following describes assault of the patient?

- **a.** Hitting the patient ☐
- **b.** Restraining the patient ☐
- **c.** Causing the patient to feel threatened ☐
- **d.** Performing an MRI study against the patient's will ☐

10. Which of the following statements is incorrect regarding the principle of the double effect?

- **a.** The action must be morally neutral or good ☐
- **b.** The good effect is not the only intention ☐
- **c.** The good effect must be equal to or greater in importance than the bad effect ☐
- **d.** The bad effect must not be the means by which the good effect is accomplished ☐

11. An ambulatory, outpatient lying down on the MRI table as requested by the technologist has given:

- **a.** Implied consent ☐
- **b.** Informed consent ☐
- **c.** Emergency consent ☐
- **d.** Vicarious liability ☐

12. Which of the following is an example of battery?

- **a.** Threatening the patient ☐
- **b.** Sharing patient information with another technologist in the work area ☐
- **c.** Imaging the incorrect body part ☐
- **d.** Using an immobilization device ☐

13. Which is the most likely type of law under which a suit is brought against a technologist for performing unintentional acts that fall below the standard of care and result in patient injury?

- **a.** Felonious ☐
- **b.** Tort ☐
- **c.** Criminal ☐
- **d.** Administrative ☐

14. *Respondeat superior* is a Latin term meaning:

- **a.** The thing speaks for itself ☐
- **b.** The reasonable technologist should make the decision ☐
- **c.** There is no need for the MRI technologist to carry their own liability insurance ☐
- **d.** Let the master answer ☐

15. Which of the following is NOT a true statement regarding informed consent?

- **a.** Consent must be given under no duress ☐
- **b.** The patient must understand all aspects of the procedure being performed ☐
- **c.** The patient must be of legal age ☐
- **d.** The procedure must be explained in terms that the patient can understand, to include risks and benefits ☐

16. Destroying or altering medical records without legitimate authorization or reason is called:

- **a.** Medical negligence ☐
- **b.** Failure to follow standard of care ☐
- **c.** Spoliation ☐
- **d.** Vicarious liability ☐

17. Which of the following means "to stand by things decided"?

- **a.** Consequentialism ☐
- **b.** *Res ipsa loquitor* ☐
- **c.** *Respondeat superior* ☐
- **d.** *Stare decisis* ☐

18. A technologist who touches a patient without permission (with the exception of emergency consent) could be found guilty of:

- **a.** Negligence ☐
- **b.** Breach of confidentiality ☐
- **c.** Battery ☐
- **d.** Assault ☐

19. Discussing a patient's confidential medical information with a person who does not have a need to know is called:

- **a.** Vicarious liability ☐
- **b.** Invasion of privacy ☐
- **c.** Libel ☐
- **d.** *Stare decisis* ☐

20. If the supervising radiologist instructs you to scan a patient with a known cardiac pacemaker and the patient goes into cardiac arrest due to pacemaker failure, you MAY be protected from a lawsuit under the doctrine of *respondeat superior*, which means:

- **a.** Let the master answer ☐
- **b.** The thing speaks for itself ☐
- **c.** Radiologists (like all supervising physicians) are always liable ☐
- **d.** Hospital administration decides who is liable in each situation ☐

21. Patient rights would include all of the following EXCEPT:

- **a.** Right to privacy ☐
- **b.** Right to a diagnosis by the MRI technologist ☐
- **c.** Right to refuse the MRI study ☐
- **d.** Right to know potential risks of the MRI study ☐

22. Which of the following is the term used to describe written malicious spreading of information?

- **a.** Breach of confidentiality ☐
- **b.** Libel ☐
- **c.** Slander ☐
- **d.** Qualified privilege ☐

23. The burden of proof for medical negligence rests with the:

- **a.** Physician ☐
- **b.** Patient ☐
- **c.** Radiographer ☐
- **d.** Risk manager ☐

24. All of the following may be considered an example of battery EXCEPT:

- **a.** Touching the patient without consent ☐
- **b.** Sharing patient information with another technologist in the work area ☐
- **c.** Imaging the wrong body part ☐
- **d.** Restraining the patient ☐

25. Which of the following describes assault of the patient?

- **a.** Striking the patient ☐
- **b.** Touching the patient without consent ☐
- **c.** Threatening the patient or causing the patient to feel threatened ☐
- **d.** Performing a radiographic procedure against the patient's will ☐

26. The concept of the reasonable prudent person is interpreted as:

- **a.** How a reasonable jury member would perform the act ☐
- **b.** How a professional with similar education, training, and experience would perform the act ☐
- **c.** How a prudent attorney would interpret the act ☐
- **d.** How a reasonable and prudent judge will rule on the act ☐

27. According to the ARRT standard of ethics, the radiologic technologist acts to advance the principal objective of the profession to provide services to humanity _____.

- **a.** With full respect for the dignity of mankind ☐
- **b.** With discrimination on the basis of sex, race, creed, religion, or socio-economic status ☐
- **c.** Understanding interpretation and diagnosis are within the scope of practice for the profession ☐
- **d.** Providing full disclosure for all patient information among colleagues and other patients ☐

28. According to the ARRT standard of ethics (specifically within the Code of Ethics), the radiologic technologist acts to advance the principal objective of the profession to provide services to humanity and includes all of the following EXCEPT:

- **a.** The radiologic technologist conducts herself or himself in a professional manner, responds to patient needs, and supports colleagues and associates in providing quality patient care ☐
- **b.** The radiologic technologist acts to advance the principal objective of the profession to provide services to humanity with full respect for the dignity of mankind ☐
- **c.** Delivers patient care and service unrestricted by the concerns of personal attributes or the nature of the disease or illness, and without discrimination on the basis of sex, race, creed, religion, or socio-economic status ☐
- **d.** Practices technology founded upon theoretical knowledge and concepts, uses equipment and accessories inconsistent with the purposes for which they were designed, and employs procedures and techniques inappropriately ☐

29. Which of the following circumstances would NOT be an ARRT ethical violation?

- **a.** Contacting a referring doctor when he or she has ordered the wrong procedure on a patient ☐
- **b.** Discussing with your colleagues whether or not you should do the procedure if the order is incorrect ☐
- **c.** Performing the procedure on the patient if the order is not correct ☐
- **d.** Performing a procedure on a patient without any order ☐

Patient assessment, monitoring, and management

30. Which of the following may cause a patient to experience a syncopal episode?

1. Anxiety
2. Hunger
3. Hypertension

a. 1 only ☐
b. 3 only ☐
c. 1 and 2 only ☐
d. 2 and 3 only ☐

31. All claustrophobic patients who are scheduled for MRI examinations should be:

a. Sedated ☐
b. Forced to overcome their fear to complete the examination ☐
c. Rescheduled for another day ☐
d. Handled delicately so as not to compound their anxiety ☐

32. Patients who should be monitored (with pulse oximetry) during MRI procedures are:

1. Unresponsive and uncommunicative patients
2. Sedated, psychiatric and pediatric patients
3. Patients who have weak voices and/or impaired hearing

a. 1 only ☐
b. 1 and 2 only ☐
c. 1 and 3 only ☐
d. 1, 2, and 3 ☐

33. Patients who have been sedated with diazepam should be monitored with:

a. Pulse oximetry ☐
b. ECG gating ☐
c. Peripheral gating ☐
d. Verbal communication ☐

34. It is good practice for all patients who undergo MRI to be monitored:

a. Visually and/or verbally ☐
b. By ECG ☐
c. By respiratory monitors ☐
d. Not at all ☐

35. BEFORE the publication of the "Contrast Media Update" by the ACR in 2010, contraindications for using gadolinium included:
1. Sickle cell crisis and hypertension
2. Pregnancy and breast-feeding mothers
3. High BUN and creatinine
4. Low GFR
5. Renal insufficiency and/or acute renal injury
6. None known

a. 6 only ☐
b. 1, 2, and 3 only ☐
c. 4 and 5 only ☐
d. 1, 2, 3, 4, and 5 only ☐

36. AFTER the publication of the first edition of the "Contrast Media Update" by the ACR in 2010, contraindications for using gadolinium included:
1. Sickle cell crisis and hypertension
2. Pregnancy and breast-feeding mothers
3. High BUN and creatinine
4. Low GFR
5. Renal insufficiency and/or acute renal injury
6. None known

a. 6 only ☐
b. 1, 2, and 3 only ☐
c. 4 and 5 only ☐
d. 1, 2, 3, 4, and 5 only ☐

37. Precautions for the use of gadolinium include:
1. Sickle cell crisis and hypertension
2. Pregnancy
3. Low GFR
4. Hemolytic anomalies and lactating mothers
5. Prior contrast reactions and patients with a history of asthma or allergies

a. 3 only ☐
b. 1, 2, and 3 only ☐
c. 2, 3, 4, and 5 only ☐
d. 1, 2, 3, 4, and 5 ☐

38. The approved gadolinium contrast agents are currently indicated for:
1. Intravenous injection for pediatric imaging
2. Intravenous injection for abdominal imaging
3. Intravenous injection for central nervous system (CNS) imaging
4. Intra-articular injection for musculoskeletal imaging

a. 3 only ☐
b. 2 and 3 only ☐
c. 1, 2, and 3 only ☐
d. 1, 2, 3, and 4 ☐

39. The patient who has too much insulin in their body is experiencing:

a. Diabetic coma ☐
b. Hyperglycemia ☐
c. Hypoglycemia ☐
d. Hypovolemia ☐

40. What is the correct order for administering basic life support?

a. Airway, breathing, circulation ☐
b. Circulation, breathing, airway ☐
c. Breathing, circulation, airway ☐
d. Airway, circulation, breathing ☐

41. If a patient, while recumbent on the MR couch, says that he or she feels "faint", what action should the technologist take?

a. Sit the patient upright slowly ☐
b. Contact the referring physician ☐
c. Place the patient in the Fowler's position ☐
d. Place the patient in the Trendelenberg position ☐

42. The proper method of treating contrast media extravasation is to:

a. Place a warm compress over the site and complete the contrast administration ☐
b. Remove the needle, place a bandage over the injection site to stop bleeding, and choose another location to complete the contrast administration ☐
c. Remove the needle, hold pressure on the vein until bleeding stops, then apply ice ☐
d. Stop the injection and wait for the fluid collection to disperse, then resume contrast administration ☐

43. Which of the following may cause a loss of patency in an IV line?

a. Using the incorrect IV solution ☐
b. Improper height of the IV solution ☐
c. Poor circulation ☐
d. Improper needle selection ☐

44. Deep veins are not used in venipuncture because:

- **a.** They are too difficult to locate ☐
- **b.** Their tunica intima is much thicker ☐
- **c.** They are close to major arteries and nerves ☐
- **d.** There would be possible interference with the lymphatic system ☐

45. Which of the following can be used for multiple doses of the same drug?

- **a.** Ampule ☐
- **b.** Vial ☐

46. Reducing viscosity of contrast media can be accomplished by:

- **a.** Warming the contrast prior to administration ☐
- **b.** Cooling the contrast prior to administration ☐
- **c.** Shaking the container vigorously prior to administration ☐
- **d.** Storing the container in an area with low humidity ☐

47. The stated gauge of the IV needle or catheter refers to its:

- **a.** Length ☐
- **b.** Bevel angle ☐
- **c.** Diameter ☐
- **d.** Circumference ☐

48. Which blood test for renal function is used in the calculation of eGFR (estimated glomerular filtration rate)?

- **a.** Blood urea nitrogen (BUN) ☐
- **b.** Hematocrit ☐
- **c.** Partial thromboplastin time ☐
- **d.** Serum creatinine ☐

49. Which of the following blood tests would NOT be used to assess the patient's risk of hemorrhaging during an invasive procedure (such as a biopsy)?

- **a.** Prothrombin time (PT) ☐
- **b.** Hematocrit ☐
- **c.** International normalized ratio (INR) ☐
- **d.** Platelet count ☐

50. Which blood vessel has the thickest tunica media?

- **a.** Artery ☐
- **b.** Vein ☐
- **c.** Capillary ☐
- **d.** Lymphatic ☐

51. A normal serum creatinine range is:

- **a.** 0.2–1.0 mg/dL ☐
- **b.** 0.6–1.5 mg/dL ☐
- **c.** 0.8–2.5 mg/dL ☐
- **d.** 1.2–3.0 mg/dL ☐

52. An eGFR of below 15 is indicative of:

- **a.** Normal kidney function ☐
- **b.** A kidney infection ☐
- **c.** Polycystic kidney ☐
- **d.** A patient in need of dialysis ☐

53. Although ALL patients must be evaluated on a case by case basis, the ACR recommends that gadolinium should not be administered in patients with an eGFR of:

- **a.** 50 and above ☐
- **b.** 30 and above ☐
- **c.** 30 and below ☐
- **d.** There is no relationship between eGFR and the administration of gadolinium contrast media ☐

54. Which type of circulation is responsible for reoxygenation of the blood?

- **a.** Pulmonary ☐
- **b.** Systemic ☐
- **c.** Nonsystemic ☐
- **d.** Portal ☐

55. Which of the layers of a blood vessel is made of fibrous, connective tissue?

- **a.** Tunica adventitia ☐
- **b.** Tunica media ☐
- **c.** Tunica intima ☐
- **d.** Capillaries ☐

56. A normal range for blood urea nitrogen (BUN) is:

- **a.** 0.6–1.5 mg/100 dL ☐
- **b.** 2.0–15.0 mg/100 dL ☐
- **c.** 8.0–20.0 mg/100 dL ☐
- **d.** 25.0–50.0 mg/100 dL ☐

57. Which type of blood cell carries oxygenated hemoglobin?

- **a.** Platelet ☐
- **b.** Erythrocyte ☐
- **c.** Thrombocyte ☐
- **d.** Leukocyte ☐

58. Which of the following lab tests can be used as an indicator of dehydration?

- **a.** BUN ☐
- **b.** PTT (partial thromboplastin time) ☐
- **c.** Serum potassium ☐
- **d.** Hematocrit ☐

59. A _____ can be used to administer nutrition or long-term chemotherapy.

- **a.** Peg tube ☐
- **b.** Chest tube ☐
- **c.** Venous catheter ☐
- **d.** J-tube ☐

60. The administration of IV (intravenous) injection gadolinium (Gd) contrast media is indicated for MRI during:

- **a.** Pediatric imaging ☐
- **b.** Abdominal imaging ☐
- **c.** Brain & Spine imaging ☐
- **d.** a, b, and c ☐

61. The percent (%) of patients who have been "reported" to have had reactions to contrast agents (gadolinium) in MRI is:

- **a.** Less than 2% ☐
- **b.** 5% ☐
- **c.** 15% ☐
- **d.** 20% ☐

62. Patients who are at an "increased risk" of reactions to gadolinium include:
1. A history of asthma and/or allergies
2. Prior contrast reactions
3. Hemolytic anomalies
4. All patients

a. 1 only ☐
b. 1 and 2 only ☐
c. 1, 2, and 3 only ☐
d. 1, 2, 3, and 4 ☐

63. Patients who "have been reported" to have had reactions to gadolinium include:
1. A history of asthma and/or allergies
2. Prior contrast reactions
3. Hemolytic anomalies
4. All patients

a. 1 only ☐
b. 1 and 2 only ☐
c. 1, 2, and 3 only ☐
d. 1, 2, 3, and 4 ☐

64. Contrast agent reactions, such as flushing, hives, and nausea, are called:

a. Psychosomatic ☐
b. Cardiovascular ☐
c. Anaphylactic ☐
d. Nonsystemic ☐

65. If you determine that an adult patient needs CPR, what should be your first response?

a. Call for help ☐
b. Begin cardiac compressions ☐
c. Begin mouth to mouth ☐
d. Begin the Heimlich maneuver ☐

66. When performing one-rescuer CPR on an adult, the rate of compressions to ventilations should be:

a. 5:2 ☐
b. 15:2 ☐
c. 15:1 ☐
d. 30:2 ☐

67. What is the most severe form of convulsive seizures?

- **a.** Grand mal ☐
- **b.** Petit mal ☐
- **c.** Epileptic ☐
- **d.** Partial ☐

68. If CPR is not started within _____ of cardiac arrest, there will be brain damage due to lack of oxygen.

- **a.** 1–3 minutes ☐
- **b.** 4–6 minutes ☐
- **c.** 7–10 minutes ☐
- **d.** 15 minutes ☐

69. Which type of shock is caused by failure of the heart to pump enough blood to the vital organs?

- **a.** Hypovolemic shock ☐
- **b.** Septic shock ☐
- **c.** Anaphylactic shock ☐
- **d.** Cardiogenic shock ☐

70. When lifting a patient, what must one remember?

1. Keep your back straight
2. Keep your arms straight
3. Keep your knees slightly bent

- **a.** 1 only ☐
- **b.** 2 only ☐
- **c.** 1 and 3 only ☐
- **d.** 1, 2, and 3 ☐

71. Log rolling is a method of moving patients with a suspected:

- **a.** Head injury ☐
- **b.** Vertebral column injury ☐
- **c.** Extremity fracture ☐
- **d.** Bowel obstruction ☐

72. The most common site(s) injured by technologists while caring for patients is(are) the:

- **a.** Head ☐
- **b.** Arms and shoulders ☐
- **c.** Lumbosacral spine ☐
- **d.** Lower leg ☐

73. During the movement and transfer of patients, urinary catheter bags should be placed:

- **a.** Below the level of the MR couch ☐
- **b.** At the foot end of the MR couch ☐
- **c.** Below the level of the urinary bladder ☐
- **d.** On the stretcher on the sheet with the patient ☐

74. When venipuncture is performed:

- **a.** The technologist is not responsible for obtaining patient history because the exam was ordered by a physician. ☐
- **b.** The contrast agent should NEVER be flushed through the syringe, any tubing used, and the needle before injection ☐
- **c.** The contrast agent must be cooled to make it easier to inject ☐
- **d.** The contrast agent must ALWAYS be flushed through the syringe, any tubing used, and needle before injection to avoid the administration of air into the vein ☐

75. Which of the following may cause a patient to experience a syncopal episode?

1. Hypertension
2. Anxiety
3. Infection
4. Hunger

- **a.** 1 and 2 only ☐
- **b.** 1 and 3 only ☐
- **c.** 2 and 3 only ☐
- **d.** 2 and 4 only ☐

76. The diabetic patient who has excessive insulin in their body is said to have:

- **a.** Hypotension ☐
- **b.** Hyperglycemia ☐
- **c.** Hypoglycemia ☐
- **d.** Hyperkalemia ☐

77. If a patient has a cardiac arrest during MR imaging, the technologist should:

- **a.** Call a code and direct them to the scan room ☐
- **b.** Quench the magnet ☐
- **c.** Begin CPR while the patient remains within the MR scan room ☐
- **d.** Begin CPR while transferring the patient out of the scan room ☐

78. During any emergency that occurs during MR imaging, the technologist should:

- **a.** Call a code and direct the team to the scan room ☐
- **b.** Quench the magnet ☐
- **c.** Continue imaging and call the radiologist ☐
- **d.** Remove the patient from the MR scan room ☐

79. A patient experiencing tachycardia will have a:

- **a.** Slow respiratory rate ☐
- **b.** Rapid pulse rate ☐
- **c.** Low oxygen saturation reading ☐
- **d.** High blood pressure reading ☐

80. What is the average pulse rate for an infant?

- **a.** 40–60 beats per minute ☐
- **b.** 70–80 beats per minute ☐
- **c.** 80–100 beats per minute ☐
- **d.** 115–130 beats per minute ☐

81. A normal blood pressure for an adult is:

- **a.** 80/120 mmHg ☐
- **b.** 120/80 mmHg ☐
- **c.** 250/120 mmHg ☐
- **d.** 120/250 mmHg ☐

82. Which of the following blood pressure readings would indicate shock?

- **a.** Diastolic pressure of 40 mmHg ☐
- **b.** Diastolic pressure of 90 mmHg ☐
- **c.** Systolic pressure of 100 mmHg ☐
- **d.** Systolic pressure of 160 mmHg ☐

83. A patient receiving oxygen should NOT have temperature measured via the _____ route.

- **a.** Axillary ☐
- **b.** Rectal ☐
- **c.** Oral ☐
- **d.** Tympanic ☐

84. A patient with epistaxis has a(n):

- **a.** Nose bleed ☐
- **b.** Ear infection ☐
- **c.** Slow pulse rate ☐
- **d.** Abscess ☐

85. Shock resulting from large loss of body fluid or blood is called:

- **a.** Cardiogenic ☐
- **b.** Septic ☐
- **c.** Hypovolemic ☐
- **d.** Neurogenic ☐

86. For an unconscious patient who has sustained a head injury, the main concern is:

- **a.** Preventing additional hemorrhage ☐
- **b.** Keeping a patent airway ☐
- **c.** Maintaining a normal pulse rate ☐
- **d.** Maintaining adequate oxygenation ☐

87. Geriatric patients likely exhibit all EXCEPT which of the following?

- **a.** Changes in anatomic landmarks ☐
- **b.** Fragile skin ☐
- **c.** Decrease in intelligence ☐
- **d.** Difficulty with balance ☐

88. A technologist may administer oxygen in an emergency situation. The most frequent rate used is:

- **a.** 2 L/min ☐
- **b.** 5 L/min ☐
- **c.** 10 L/min ☐
- **d.** 15 L/min ☐

89. The artery that is typically used to check an adult's pulse rate is the:

- **a.** Apical ☐
- **b.** Carotid ☐
- **c.** Femoral ☐
- **d.** Radial ☐

90. The pulse used to check for circulation during CPR in an adult is the:

- **a.** Apical ☐
- **b.** Carotid ☐
- **c.** Femoral ☐
- **d.** Radial ☐

91. Which of the following conditions is common in a patient with COPD?

- **a.** Bradycardia ☐
- **b.** Orthopnea ☐
- **c.** Dysphagia ☐
- **d.** Epistaxis ☐

92. In order to reduce the possibility of orthostatic hypotension, the technologist should:

- **a.** Sit the patient up slowly from the recumbent position and allow sufficient time sitting before proceeding to standing up ☐
- **b.** Provide the patient with something sweet to eat or drink to counteract excess insulin in the system ☐
- **c.** Elevate the patient's legs 60 degrees above the heart ☐
- **d.** Place the patient in the Trendelenberg position and call for help ☐

93. Where would a "central line" catheter be located?

- **a.** Subclavian vein ☐
- **b.** Brachiocephalic artery ☐
- **c.** Median cubital vein ☐
- **d.** Superior vena cava ☐

94. A patient with apraxia will have difficulty with:

- **a.** Speaking ☐
- **b.** Balance ☐
- **c.** Dressing ☐
- **d.** Swallowing ☐

95. A patient with aphasia will have difficulty with all of the following EXCEPT:

- **a.** Speaking ☐
- **b.** Reading ☐
- **c.** Dressing ☐
- **d.** Swallowing ☐

96. Severe hypoxia has a pulse oximetry reading of:

- **a.** 95–100% ☐
- **b.** 91–94% ☐
- **c.** 86–90% ☐
- **d.** 85% and below ☐

97. An adverse reaction or event caused by treatment by a healthcare professional is called:

- **a.** Idiopathic ☐
- **b.** Nosocomial ☐
- **c.** Iatrogenic ☐
- **d.** Anaphylactic ☐

98. A normal pulse rate range for an adult is:

- **a.** 40–60 bpm ☐
- **b.** 60–90 bpm ☐
- **c.** 80–100 bpm ☐
- **d.** 100–130 bpm ☐

99. Another term used for "fever" is:

- **a.** Hyperglycemia ☐
- **b.** Hypothermia ☐
- **c.** Febrile ☐
- **d.** Dyspnea ☐

100. A patient recovering from a seizure should be:

- **a.** Placed in the recovery position (Sim's) ☐
- **b.** Instructed to lie on their back ☐
- **c.** Administered emergency oxygen ☐
- **d.** Helped to move to a more comfortable area ☐

Interpersonal communications

101. The first stage of the grieving process is:

- **a.** Anger ☐
- **b.** Denial ☐
- **c.** Depression ☐
- **d.** Bargaining ☐

102. According to Maslow's hierarchy of needs, which of the following is NOT considered to be a physiologic need?

- **a.** Food and water ☐
- **b.** Sexual fulfilment ☐
- **c.** Sleep ☐
- **d.** Morality ☐

103. The best way to validate that the patient understands correctly information presented by the technologist is to:

- **a.** Ask the patient if they understood what was said ☐
- **b.** Observe the patient nodding their head "yes" or "no" ☐
- **c.** Have the patient restate the information back to the technologist ☐
- **d.** Have the patient write down what was said ☐

104. The technologist should remain standing when explaining a procedure to a child.

- **a.** True ☐
- **b.** False ☐

105. For patients with hearing loss, each of the following would be helpful for effective communication EXCEPT:

- **a.** Avoid noisy backgrounds ☐
- **b.** Speak loudly in a high pitch ☐
- **c.** Face the patient as you speak to him/her ☐
- **d.** Rephrase what you said as necessary ☐

106. Patients with mental impairment (mental retardation/mental health issues) will better understand directions stated clearly, one at a time and in simple language. All patients with mental impairment should be presented with instructions in this manner.

- **a.** True ☐
- **b.** False ☐

107. All of the following are examples of behaviors that are likely to vary with cultural beliefs EXCEPT:

- **a.** Direct eye contact is preferred ☐
- **b.** Language spoken may differ ☐
- **c.** Ability to feel pain ☐
- **d.** Giving someone a hug to comfort them ☐

108. Which of the following is NOT a true statement regarding patients with an altered state of consciousness?

- **a.** They may not remember verbal instructions ☐
- **b.** They will not remember conversations or statements made while in an altered state ☐
- **c.** It is important to continue communicating with unconscious patients ☐
- **d.** They may provide answers to questions that are incorrect or not pertaining to the actual question ☐

109. It is important for children, in particular, to be given choices ONLY when a choice exists.

- **a.** True ☐
- **b.** False ☐

110. We all have what is referred to as a safe "personal space" distance. We also have a distance at which we feel safe when interacting with healthcare providers, e.g. when a procedure is being explained. The distance at which a patient will feel "safe" during such an encounter is:

- **a.** 1 foot ☐
- **b.** 3 feet ☐
- **c.** 5 feet ☐
- **d.** This distance varies for each patient ☐

Infection control

111. In which direction should the top flap of a wrapped sterile package or tray be opened?

- **a.** Toward the individual ☐
- **b.** Away from the individual ☐
- **c.** Toward the dominant hand ☐
- **d.** Away from the dominant hand ☐

112. When sterile fields are prepared, damp packages:

- **a.** Are always considered contaminated ☐
- **b.** Are always considered sterile because the dampness confirms they were cleaned ☐
- **c.** Should be unwrapped first and placed in the center of the sterile field ☐
- **d.** Are always considered sterile; the dampness is only a remnant of the gassing process ☐

113. A common device used for high-pressure steam sterilization is called the:

- **a.** Thermal ventilator ☐
- **b.** Vector chamber ☐
- **c.** Autoclave ☐
- **d.** Inhalator ☐

114. When the body is invaded by pathogens, what is the response in the bloodstream?

- **a.** Red blood cell count increases ☐
- **b.** White blood cell count increases ☐
- **c.** Serum count increases ☐
- **d.** Platelet count increases ☐

115. Isolation that is used for patients who have a depressed immune system is known as:

- **a.** Enteric isolation ☐
- **b.** Protective isolation ☐
- **c.** Respiratory isolation ☐
- **d.** Contact isolation ☐

116. How should linen be handled in cases of suspected salmonella contamination?

- **a.** It should be placed in a red contamination bag ☐
- **b.** It should be placed in the dirty linen as usual ☐
- **c.** It should be stored in a separate dirty linen compartment for 24 hours ☐
- **d.** It should be placed in a bag and sent to the incinerator immediately ☐

117. According to the Centers for Disease Control and Prevention (CDC), what type of isolation precautions should be used for HIV-positive patients?

- **a.** Strict ☐
- **b.** Respiratory ☐
- **c.** Enteric ☐
- **d.** Standard (universal) ☐

118. Under which of the following conditions would a sterile package NOT be considered contaminated (i.e. safe to use)?

- **a.** Package has a tear in it ☐
- **b.** Tape used to indicate sterility is intact ☐
- **c.** Package is damp ☐
- **d.** Package expiration date has been exceeded ☐

119. A sterile tray that has been set up on a table or cart will have a border of ____ that must be considered NOT sterile.

- **a.** ½ inch ☐
- **b.** 1 inch ☐
- **c.** 4 inches ☐
- **d.** 12 inches ☐

120. The process of reducing the number of possible pathogenic microorganisms by using chemical disinfectants is called:

- **a.** Sterilization ☐
- **b.** Surgical asepsis ☐
- **c.** Medical asepsis ☐
- **d.** Infection control ☐

121. An infection that is acquired in a hospital or healthcare facility is called a(n):

- **a.** Iatrogenic infection ☐
- **b.** Nosocomial infection ☐
- **c.** Idiopathic infection ☐
- **d.** Fomite infection ☐

122. Diseases, such as malaria, in which microorganisms are transferred via an insect come under the classification of _____ infections.

- **a.** Nosocomial ☐
- **b.** Indirect contact ☐
- **c.** Common vehicle ☐
- **d.** Vector borne ☐

123. Which type of blood cell is responsible for phagocytosis?

- **a.** Leukocyte ☐
- **b.** Erythrocyte ☐
- **c.** Platelet ☐
- **d.** Lymphocyte ☐

124. The source of infection where pathogens thrive in numbers sufficient to cause a threat is known as a:

- **a.** Carrier ☐
- **b.** Droplet ☐
- **c.** Reservoir ☐
- **d.** Fomite ☐

125. Which portion of a sterile surgical gown is NOT considered to be sterile?

- **a.** Arms ☐
- **b.** Chest area ☐
- **c.** Waist area ☐
- **d.** Back ☐

126. Which of the following items would NOT be a type of fomite in MRI?

- **a.** Head coil ☐
- **b.** MRI table ☐
- **c.** Syringe for injection ☐
- **d.** Mouse at the control panel ☐

127. Airborne contamination can be prevented by using special types of ventilation systems.

- **a.** True ☐
- **b.** False ☐

128. Droplet contamination frequently occurs via:

- **a.** Sneezing ☐
- **b.** Shaking hands ☐
- **c.** Normal breathing ☐
- **d.** Sharing the operator console mouse ☐

129. The best method to prevent the spread of microorganisms is:

- **a.** Handwashing ☐
- **b.** Disinfecting counters and other workspaces ☐
- **c.** Sterilizing as many materials as possible ☐
- **d.** The inflammatory response ☐

130. When removing personal protective apparel, which item should be removed first?

- **a.** Mask ☐
- **b.** Gown ☐
- **c.** Gloves ☐
- **d.** It does not matter in which order apparel is removed ☐

131. For droplet precautions, healthcare workers as well as visitors must wear:

- **a.** A gown only ☐
- **b.** A mask only ☐
- **c.** Gown and mask ☐
- **d.** Gown, mask, and gloves ☐

132. When cleaning, clean from:

- **a.** Bottom to top ☐
- **b.** Most contaminated area to least contaminated area ☐
- **c.** Least contaminated area to most contaminated area ☐
- **d.** The least dusty area to the most dusty area ☐

133. Disinfectants will provide a method for:

- **a.** Sterilization ☐
- **b.** Surgical asepsis ☐
- **c.** Medical asepsis ☐
- **d.** Improved body hygiene ☐

MRI screening and safety

134. Family members and ancillary personnel accompanying the patient into the scan room:

- **a.** Need not be screened because they are not undergoing MRI ☐
- **b.** Can enter the scan room to check on the patient but cannot stay during scanning ☐
- **c.** Should be screened as if they are going through the procedure themselves ☐
- **d.** Must wear a lead apron during the procedure ☐

135. In preparation for the MRI examination, patients should be encouraged to:

- **a.** Wear their own clothing so as to feel "at home" with the study ☐
- **b.** Wear a wrist watch so they are aware of the length of the exam ☐
- **c.** Keep their hearing aid in so as to hear the commands and requests of the technologist ☐
- **d.** Change into a hospital gown or a scrub suit provided by the imaging center and known to be MR safe (containing no metallic components such as snaps and/or zippers) ☐

136. Mrs Jones has just been sent to the MRI department from the emergency room, following a severe motor vehicle accident. She has suffered a fracture of C3 and her physicians are concerned about a cervical spinal cord compression at that level. Select the best method for proceeding with this case.

- **a.** Rush her quickly into the scanner on her own stretcher so as not to aggravate the fracture ☐
- **b.** Ask her and her family about the possibility of her having metal fragments in her body ☐
- **c.** On finding out that she has had a total hip replacement, cancel the exam ☐
- **d.** Allow her to wear her favorite gold necklace during the procedure ☐

137. Persons that should be educated about the effects of the static magnetic field, especially in high field superconducting magnets, include:

1. The nursing staff and the code team
2. The housekeeping staff and members of the fire department
3. The anesthesiologists and respiratory therapists
4. The technologist and the radiologist

- **a.** 4 only ☐
- **b.** 1 and 4 only ☐
- **c.** 1,3, and 4 only ☐
- **d.** 1, 2, 3, and 4 ☐

138. According to the White Paper on MRI safety, persons are identified into "levels" whereby "Level 2" personnel include:

- **a.** Persons with no MRI safety training ☐
- **b.** Persons with limited MRI safety training ☐
- **c.** Persons with extensive training in MRI safety to include the broader aspects of MRI (such as the magnetic field, gradient and RF fields – to name a few) ☐
- **d.** There are no Level 2 personnel in the White Paper of MRI safety ☐

139. According to the White Paper on MRI safety, imaging centers should be separated into "Zones" including all of the following EXCEPT:

a. Zone 0 – the parking lot ☐
b. Zone 1 – freely accessible to any "Level" of MR personnel ☐
c. Zone 2 – the interface between Zone 1 and Zone 3 ☐
d. Zone 3 – the "warm" Zone, generally the console area and the last stop before the scan room ☐
e. Zone 4 – The "hot" Zone, the scan room itself ☐

140. A screening questionnaire for patients about to undergo MRI should include information about:

a. Prior injuries ☐
b. Prior surgery and implants ☐
c. Pregnancy ☐
d. All of the above ☐

141. The terminology for devices and implants in MRI was modified a few years ago, whereby the term MR compatible has been replaced with all of the following EXCEPT:

a. MR reliable ☐
b. MR safe ☐
c. MR unsafe ☐
d. MR conditional ☐

142. Absolute contraindications to MRI include:
1. Intracranial vascular clips, unless they are KNOWN to be safe
2. Cardiac pacemakers, unless they are KNOWN to be safe
3. Pregnancy
4. Intraocular, ferrous foreign bodies

a. 1 only ☐
b. 1 and 2 only ☐
c. 1, 2, and 3 only ☐
d. 1, 2, and 4 only ☐

143. The accepted standard of care for the detection of intraocular ferrous foreign bodies is:

- **a.** Computed tomography ☐
- **b.** MRI ☐
- **c.** Plain film ☐
- **d.** Visual examination ☐

144. A method that is more accurate in the detection of small intraocular ferrous foreign bodies is:

- **a.** Computed tomography (CT) ☐
- **b.** MRI ☐
- **c.** Plain film ☐
- **d.** Visual examination ☐

145. Before a patient enters the MRI environment they should be screened for:

- **a.** Prior injuries ☐
- **b.** Prior surgical implants ☐
- **c.** Pregnancy ☐
- **d.** All of the above ☐

146. Of the following implants, which would be considered acceptable to scan by MRI?

- **a.** Ferrous aneurysms clips ☐
- **b.** Neurostimulators ☐
- **c.** Cardiac pacemakers ☐
- **d.** Heart valves ☐

147. If monitoring is to be achieved by electrical and/or mechanical devices, it is important that compatibility with the MR system be demonstrated by:

- **a.** Clearance by the FDA (Food and Drug Administration) ☐
- **b.** Prior testing ☐
- **c.** Manufacturer declaration ☐
- **d.** All of the above ☐

148. The following items are usually allowed to enter the scan room in high magnetic field systems:

- **a.** Surgical stainless steel hemostats ☐
- **b.** Surgical stainless steel scissors ☐
- **c.** Copper tools ☐
- **d.** Laryngoscopes ☐

149. When used for MRI, cables from RF coils and ECG leads should be:

- **a.** Braided and placed straight through the imager ☐
- **b.** Laid along the patient's right arm, along the bore ☐
- **c.** Formed into loops within the imager ☐
- **d.** Neatly coiled and ready for use ☐

150. Surface coil cables can potentially cause damage to the patient when:

- **a.** They are not frayed and rest along the arm of the patient ☐
- **b.** They are slightly touching the patient and are frayed ☐
- **c.** They are looped and not touching the patient ☐
- **d.** All of the above ☐
- **e.** None of the above ☐

151. A quench can be used to:

- **a.** Improve image quality in MRI ☐
- **b.** Rapidly remove superconductivity and the magnetic field ☐
- **c.** Maintain magnetic field homogeneity ☐
- **d.** Satisfy the thirst of the technologist ☐
- **e.** Lubricate the magnet coils ☐

152. During a quench, patients and operators should be evacuated from the room to avoid:

- **a.** Asphyxiation and frostbite ☐
- **b.** Subarachnoid hemorrhage ☐
- **c.** Ruptured tympanic membranes ☐
- **d.** a and c ☐
- **e.** a, b, and c ☐

153. What is regulated by the FDA?

- **a.** Length of the bore ☐
- **b.** Diameter of the bore ☐
- **c.** Acoustic noise ☐
- **d.** Scan time ☐

154. For optimum operation of MRI systems, the ambient temperature and relative humidity should remain between:

- **a.** 30°F and 50°F/30% and 50% ☐
- **b.** 65°F and 75°F/50% and 70% ☐
- **c.** 70°F and 90°F/70% and 100% ☐
- **d.** No specific temperature or humidity range ☐

155. The acceptable safe level for exposure to magnetic fringe fields with respect to patients with cardiac pacemakers has been reported to be:

- **a.** Between 5 g and 15 g ☐
- **b.** Between 5 T and 15 T ☐
- **c.** Between 15 g and 30 g ☐
- **d.** Below 5 g ☐

156. Magnetic field shielding can be achieved either actively or passively. Passive shielding can be achieved by lining the MRI room with:

- **a.** Copper ☐
- **b.** Steel ☐
- **c.** Lead ☐
- **d.** None of the above ☐

157. RF shielding can be achieved by lining the MRI room with:

- **a.** Copper ☐
- **b.** Steel ☐
- **c.** Lead ☐
- **d.** None of the above ☐

158. It is acceptable for the general population to be exposed to a field strength of:

- **a.** 2.0 Tesla ☐
- **b.** 4.0 Tesla ☐
- **c.** 8.0 Tesla ☐
- **d.** 5.0 gauss ☐

159. The unit of measure of RF absorption is:

- **a.** Watts per pound ☐
- **b.** Volts per pound ☐
- **c.** Watts per kilogram ☐
- **d.** Volts per kilogram ☐

160. MR imagers are magnetic field shielded such that:

- **a.** Any metallic objects can enter the scan room ☐
- **b.** The fringe field is confined to / within the bore ☐
- **c.** The fringe field is confined to / within the scan room ☐
- **d.** There is no fringe field ☐

161. Fringe files are less of a concern for:

- **a.** Mid-field superconducting imagers ☐
- **b.** Low-field resistive imagers ☐
- **c.** High-field superconductive imagers that are shielded ☐
- **d.** Low field, vertical field permanent magnet imagers ☐

162. In July of 2003, The FDA's Center for Devices & Radiological Health (CDRH) modified the limit on RF absorption (dose) to _____ for the HEAD.

- **a.** 2.0 W/kg absorption for 5 minutes ☐
- **b.** 3.0 W/kg absorption for 10 minutes ☐
- **c.** 4.0 W/kg absorption for 15 minutes ☐
- **d.** 12.0 W/kg absorption for 5 minutes ☐

163. The Food and Drug Administration (FDA) limits the allowable RF absorption to:

- **a.** 0.2 W/kg averaged over the body ☐
- **b.** 0.4 W/kg averaged over the body ☐
- **c.** 2.0 W/kg averaged over the body ☐
- **d.** 4.0 W/kg averaged over the body ☐

164. The term used to describe RF absorption is:

- **a.** Sensitive acquisition range (SAR) ☐
- **b.** Specific absorption rate (SAR) ☐
- **c.** Susceptibility attack region (SAR) ☐
- **d.** None of the above ☐

165. The predominant biologic effect of RF fields is:

- **a.** Induced voltages ☐
- **b.** Tissue heating ☐
- **c.** Hypothermia ☐
- **d.** Magnetic hemodynamic effect ☐

166. RF antenna effects can cause:

- **a.** Better reception on your car radio ☐
- **b.** RF interference artifacts ☐
- **c.** Thermal injury and flames ☐
- **d.** b and c ☐

167. The FDA limits the effect of RF absorption to an increase in core body temperature of:

- **a.** 0.1 °C ☐
- **b.** 1° C ☐
- **c.** 10 °F ☐
- **d.** There is no limit ☐

168. The increase in body temperature as the result of RF absorption is:

- **a.** Barely detectable ☐
- **b.** Greatest on the outside, becoming less at the center ☐
- **c.** Greatest at the center, becoming less on the surface ☐
- **d.** Evenly distributed throughout the body ☐

169. RF energy used in MRI is classified as:

- **a.** High energy, ionizing radiation ☐
- **b.** High energy, nonionizing radiation ☐
- **c.** Low energy, nonionizing radiation ☐
- **d.** Low energy, ionizing radiation ☐

170. As the flip angle is doubled, RF deposition increases by a factor of:

- **a.** One ☐
- **b.** Two ☐
- **c.** Three ☐
- **d.** Four ☐

171. RF heating is more of a concern in imaging sequences such as:

- **a.** Gradient echo ☐
- **b.** Echo planar ☐
- **c.** Spin echo ☐
- **d.** Fast spin echo ☐

172. Areas of the body that are most sensitive to the heat (from SAR) are:

- **a.** Brain and spinal cord ☐
- **b.** Vertebral bodies ☐
- **c.** Globes of the eyes and testicles ☐
- **d.** Pancreas and liver ☐

173. For adult imaging in MRI, the FDA guidelines limit the field strength of clinical imagers to:

- **a.** 1.5 T and below ☐
- **b.** 2 T and below ☐
- **c.** 4.0 T ☐
- **d.** 8.0 T ☐

174. A magnetic field strength of 1 T is equal to:

- **a.** 1000 g ☐
- **b.** 10 000 g ☐
- **c.** 100 000 g ☐
- **d.** 10 g ☐

175. All of the following are regulated by the FDA EXCEPT:

- **a.** Field strength of the main magnet for clinical imaging ☐
- **b.** RF absorption (SAR) ☐
- **c.** Gradient length ☐
- **d.** Acoustic noise ☐

176. No biologic effects have been reported in humans as the result of exposure to:

- **a.** Static magnetic fields above 2T ☐
- **b.** Time-varying magnetic fields ☐
- **c.** RF fields ☐
- **d.** Static magnetic fields below 2T ☐

177. The field strength at isocenter is measured in units of:

- **a.** Gauss ☐
- **b.** Tesla ☐
- **c.** Watts ☐
- **d.** SAR ☐

178. Magnetic field strength outside the imager is usually measured in:

- **a.** Gauss ☐
- **b.** Tesla ☐
- **c.** Watts ☐
- **d.** SAR ☐

179. The attractive force that an object will experience at a distance of 6 feet from isocenter is dependent on:

- **a.** The ferromagnetic properties of the object ☐
- **b.** The mass of the object ☐
- **c.** The field strength of the system ☐
- **d.** All of the above ☐

180. As a conductive medium (e.g. blood) moves across a magnetic field, an effect known as the magnetic hemodynamic effect occurs, resulting in:

- **a.** Increased blood pressure ☐
- **b.** Increased temperature ☐
- **c.** Elevated T-wave ☐
- **d.** No noticeable effect ☐

181. It is _____ for all patients to be provided with hearing protection in the form of _____.

- **a.** Required/headphones or earplugs ☐
- **b.** Recommended/headphones or earplugs ☐
- **c.** Required/head coil ☐
- **d.** Recommended/helmet ☐

182. The gradient magnetic fields:

- **a.** Produce heat in the gradient coils during the scan ☐
- **b.** Can produce noise to cause temporary hearing loss ☐
- **c.** Change rapidly during the scanning process ☐
- **d.** All of the above ☐

183. When a patient is placed within the bore of a magnetic resonance imager, an effect can be noted on the ECG whereby there is an elevated "T" wave. This "effect" is known as all EXCEPT:

- **a.** Magnetohydrodynamic effect ☐
- **b.** Magnet-hydrodynamic effect ☐
- **c.** Magnet-hemodynamic effect ☐
- **d.** Magnetophosphenes ☐

184. The "effect" whereby the patient experiences a visual impression of seeing "stars in their eyes", is known as _____.

- **a.** Magnetohydrodynamic effect ☐
- **b.** Magnet-hydrodynamic effect ☐
- **c.** Magnet-hemodynamic effect ☐
- **d.** Magnetophosphenes ☐

185. The FDA limit on time-varying magnetic fields is _____.

- **a.** 10 G/cm ☐
- **b.** 6 T/s ☐
- **c.** 1 G/cm ☐
- **d.** Until the patient experiences peripheral nerve stimulation ☐

186. Time-varying magnetic field (TVMF) effects include all of the following EXCEPT:

- **a.** Heat and increased body temperature ☐
- **b.** Acoustic damage and hearing loss ☐
- **c.** Peripheral nerve stimulation and tingling ☐
- **d.** Magnetophosphenes and "stars in the eyes" ☐

187. TVMF effects are of greater concern for which scan sequences?

- **a.** FSE ☐
- **b.** EPI ☐
- **c.** GE ☐
- **d.** SE ☐

188. The strength of gradient magnetic fields is measured in:

- **a.** MilliTesla per meter ☐
- **b.** Watts per kilogram of body weight ☐
- **c.** Watts per time ☐
- **d.** Gauss per centimeter ☐
- **e.** a and d ☐

189. Gradient magnetic fields are a safety concern because they:

- **a.** Produce large amounts of RF energy ☐
- **b.** Induce currents in conductors ☐
- **c.** Cause short-term memory loss ☐
- **d.** All of the above ☐

190. Time-varying magnetic fields have been reported to have caused:

- **a.** Mild cutaneous sensations and images of flashing lights in patients ☐
- **b.** Involuntary muscle contractions and cardiac arrhythmias in patients ☐
- **c.** Neither of the above ☐
- **d.** a and b ☐

191. The FDA limit for the static magnetic field for clinical imaging for patients over 1 month of age is:

- **a.** 1.0T ☐
- **b.** 1.5T ☐
- **c.** 4.0T ☐
- **d.** 8.0T ☐

192. The FDA limit for the static magnetic field for clinical imaging (including any and all patients) is:

- **a.** 1.0T ☐
- **b.** 1.5T ☐
- **c.** 4.0T ☐
- **d.** 8.0T ☐

193. The imaging sequence that is of most concern for time-varying magnetic field effects is:

- **a.** Spin echo ☐
- **b.** Gradient echo ☐
- **c.** Fast spin echo ☐
- **d.** Echo planar ☐

194. Gradient rise time is:

- **a.** The time it takes for a gradient to get to full amplitude ☐
- **b.** The time it takes for the cake to rise ☐
- **c.** The time it takes for one TR to occur ☐
- **d.** The time it takes for one acquisition to be complete ☐

195. The duty cycle is:

- **a.** The time it takes for the gradient to reach its full amplitude ☐
- **b.** The time it takes for one TR to occur ☐
- **c.** The time the gradients are on during a TR period ☐
- **d.** How much the gradient changes the magnetic field over a specific distance ☐

196. To avoid auditory damage during MRI, all patients should be offered:

- **a.** Headphones ☐
- **b.** Earplugs ☐
- **c.** Antinoise devices ☐
- **d.** a and b ☐
- **e.** a, b, and c ☐

Part A: Answers

1. **b**

2. **c**
   The plaintiff is the person (patient) bringing suit and the defendant is the person (healthcare provider) being sued.
   To establish a claim of malpractice, four conditions must be proved true:
   1. The defendant had a duty to provide reasonable care to the patient
   2. The patient has sustained some type of loss or injury
   3. The defendant is the party responsible for the loss
   4. The loss is attributable to negligence or improper practice

3. **c**
   Beneficence and nonmaleficence are two ethical terms. Beneficence is to only do good and to prevent evil or harm. It is not always possible to practice beneficence. Case in point: a needle stick is somewhat painful, yet necessary to inject IV contrast media.

4. **b**
   There are two types of negligence: intentional and unintentional. This type of situation most likely falls under the category of unintentional negligence.

5. **d**

6. **b**
   Res ipsa loquitor is a Latin term meaning "the thing speaks for itself".

7. **b**

8. **d**

9. **c**
   Assault and battery are terms frequently linked together. Assault is threatening to cause physical harm. Battery is actually causing physical harm.

10. **b**
    The good effect must be the only intention. In other words, the healthcare worker is not purposely causing pain, anxiety or harm. The good effect is what is intended and the bad effect is unintended or an indirect consequence.

11. **a**

12. **c**

13. **b**
    Tort law encompasses recovery of damages for a civil wrong for which the law provides a remedy. Tort action is filed to recover damages for personal injury or property damage occurring from negligent conduct or intentional misconduct.

14. **d**

15. b
The patient must understand in laymen's terms (or terms that said patient can understand) what will happen during the procedure. The patient does not need to know every single little detail regarding the procedure.

16. c

17. d

18. c

19. b
Invasion of privacy is also a breach of confidentiality. Only those parties with a need to know should be privy to this type of confidential information.

20. a

21. b
It is not within the MRI technologist's scope of practice to provide the patient with a diagnosis. Questions regarding diagnosis and treatment must be referred to the physician.

22. b

23. b

24. b

25. c

26. b

27. a

28. d

ARRT Standard of Ethics 2011

Statement of purpose

The purpose of the ethics requirements is to identify individuals who have internalized a set of professional values that cause one to act in the best interests of patients. This internalization of professional values and the resulting behavior is one element of ARRT's definition of what it means to be qualified. Exhibiting certain behaviors as documented in the Standards of Ethics is evidence of the possible lack of appropriate professional values.

The Standards of Ethics provides proactive guidance on what it means to be qualified and to motivate and promote a culture of ethical behavior within the profession. The ethics requirements support the ARRT's mission of promoting high standards of patient care by removing or restricting the use of the credential by those who exhibit behavior inconsistent with the requirements. www.arrt.org

Code of Ethics

The Code of Ethics forms the first part of the Standards of Ethics. The Code of Ethics shall serve as a guide by which Certificate Holders and Candidates may evaluate their professional conduct as it relates to patients, healthcare consumers, employers, colleagues, and other members of the healthcare team. The Code of Ethics is intended to assist Certificate Holders and Candidates in maintaining a high level of ethical conduct and in providing for the protection, safety, and comfort of patients. The Code of Ethics is aspirational.

1. The radiologic technologist acts in a professional manner, responds to patient needs, and supports colleagues and associates in providing quality patient care.
2. The radiologic technologist acts to advance the principal objective of the profession to provide services to humanity with full respect for the dignity of mankind.
3. The radiologic technologist delivers patient care and service unrestricted by the concerns of personal attributes or the nature of the disease or illness, and without discrimination on the basis of sex, race, creed, religion, or socioeconomic status.
4. The radiologic technologist practices technology founded upon theoretical knowledge and concepts, uses equipment and accessories consistent with the purposes for which they were designed, and employs procedures and techniques appropriately.
5. The radiologic technologist assesses situations; exercises care, discretion, and judgment; assumes responsibility for professional decisions; and acts in the best interest of the patient.
6. The radiologic technologist acts as an agent through observation and communication to obtain pertinent information for the physician to aid in the diagnosis and treatment of the patient and recognizes that interpretation and diagnosis are outside the scope of practice for the profession.
7. The radiologic technologist uses equipment and accessories, employs techniques and procedures, performs services in accordance with an accepted standard of practice, and demonstrates expertise in minimizing radiation exposure to the patient, self, and other members of the healthcare team.
8. The radiologic technologist practices ethical conduct appropriate to the profession and protects the patient's right to quality radiologic technology care.
9. The radiologic technologist respects confidences entrusted in the course of professional practice, respects the patient's right to privacy, and reveals confidential information only as required by law or to protect the welfare of the individual or the community.
10. The radiologic technologist continually strives to improve knowledge and skills by participating in continuing education and professional activities, sharing knowledge with colleagues, and investigating new aspects of professional practice.

Rules of Ethics

The Rules of Ethics form the second part of the Standards of Ethics. They are mandatory standards of minimally acceptable professional conduct for all Certificate Holders and Candidates. Certification and Registration are methods of assuring the medical community and the public that an individual is qualified to practice within the profession. Because the public relies on certificates and registrations issued by ARRT, it is essential that Certificate Holders and Candidates act consistently with these Rules of Ethics. These Rules of Ethics are intended to promote the protection, safety, and comfort of patients. The Rules of Ethics are enforceable. Certificate Holders and Candidates engaging in any of the following conduct or activities, or who permit the occurrence of the following conduct or activities with respect to them, have violated the Rules of Ethics and are subject to sanctions as described hereunder. www.arrt.org

It is always recommended to review the most current version of this, or any document "quoted" within this book.

29. a

Although there are times when colleagues need to discuss the clinical situation, this particular scenario requires no discussion among colleagues. When a request is clearly incorrect (e.g. the patient injures the knee, but imaging of the shoulder is ordered), the technologists needs to contact the referring physician to correct the order. In this case, no further discussion is required.

30. c

A syncopal episode means that the patient has fainted. Patients who are nervous (anxiety) and/or hungry (possibly hypoglycemic) are more likely to faint.

31. d

There are patients who do require medication (sedation) to enable them to complete the MR examination. If medication has not been ordered prior to the MR examination, the study may need to be rescheduled. However, most patients can endure the procedure when handled "delicately".

32. d

All such patients should be monitored in MRI because verbal communication with them can be difficult. This has been recommended by the Safety Committee for the ISMRM (International Society for Magnetic Resonance in Medicine) and also the ACR (American College of Radiology). White Paper on MRI Safety www.acr.org

33. a

Diazepam (brand name Valium) is a respiratory depressant, so respiratory monitoring should be considered with such patients.

34. a

The Safety Committee for the SMR states in its guidelines and recommendations for monitoring of patients in MRI that: "It is good practice for all patients that undergo MRI to be visually and/or verbally monitored."

35. a

BEFORE 2010, package inserts for all FDA-approved gadolinium chelates listed "No Known" contraindications. As of 2010, the ACR produced a MRI Safety Manual for Contrast Media, known as the Contrast Media Update. It was observed in 2007, that the administration of gadolinium to patients with renal insufficiency (or acute renal injury) can cause a deadly condition known as NSF (nephrogenic systemic fibrosis). For this reason as of 2010, contrast media is contraindicated in patients with known renal impairment, acute renal injury or renal function of below 30. The glomerular filtration rate (GFR) is calculated from the patient's creatinine, age, race, and sex.

36. c

37. d

38. c

At this time, only one agent has been approved for pediatric and abdominal imaging. All have been approved for central nervous system imaging. Technically, gadolinium is NOT FDA approved for intra-articular injection. However, since gadolinium is commonly injected intra-articularly, it has become the "accepted standard of care".

39. c

Hypoglycemia is a condition whereby the diabetic patient does not have enough sugar in the system for the insulin delivered to metabolize. A diabetic patient who does not have enough insulin and has too much sugar in the body would experience hyperglycemia.

40. a

41. d

Since the MRI table (or couch) is not capable of "tilting" into the Trendelenberg position, the legs can be elevated 60' (degrees) to achieve the same result.

42. c

Ice is preferred to heat for contrast extravasation. The ice localizes the area of fluid collection, keeping it from spreading to more tissue and causing damage to those tissues. Extravasation must ALWAYS be documented. In moderate to severe extravasation, the referring physician must be notified. Check and follow institutional policies for extravasation.

43. b

IV solution should be kept at a height of 18 –20 inches above the vein. Solution higher than this will run too fast, possibly causing extravasation. Solution lower than this height can lead to the back flow of blood.

44. c

Superficial veins are used for contrast media injections. Common veins to use are often found in the antecubital area of the arm: cephalic, accessory cephalic, antecubital and basilic. Remember to avoid using the arm on the same side as a mastectomy site or the affected side for a stroke patient. Also avoid areas of scarring, burns, and bruising.

45. b
Although it can be used for multiple doses, the multidose vial should ONLY be used for one patient.

46. a

47. c

48. d
Routine blood tests performed to assess renal function (prior to contrast administration for imaging studies) are: serum creatinine and blood urea nitrogen (BUN)

49. b
Hematocrit is a blood test that can be used to detect dehydration. When administration of contrast media is anticipated, it is best that the patient be well hydrated in order to more efficiently excrete the contrast media via the kidneys.

50. a
The tunica media is the middle layer of an artery or vein. It is the elastic, muscular layer. It is thicker in an artery due to the increased pressure of blood flow versus venous return.

51. b
Lab results should be reported for each patient along with a normal range for that particular facility. Normal ranges may vary somewhat between facilities. Creatinine is an indicator of renal function. Creatinine is a by-product of creatine. Creatine is related to muscle function. Therefore, creatinine (and creatine) varies with the amount of muscle within the body. So, for example, a young male body builder could have a creatinine of 2.0 within the bloodstream; this could be "normal" for this particular patient. However, the same creatinine level in an older female patient (who is light in weight with little muscle mass) would be high. Therefore, the creatinine is only an *indicator* of renal function. For this reason, the GFR (glomerular filtration rate) or eGFR (estimated glomerular filtration rate) should be calculated to evaluate renal function prior to the administration of gadolinium.

52. d

53. c

54. a
The pulmonary arteries carry deoxygenated blood from the right ventricle to the lungs for oxygenation. The oxygenated blood then returns to the left atrium via the pulmonary veins.

55. a
The outer layer of the artery or vein can be called either the tunica adventitia or tunica externa.

56. c

57. b
An erythrocyte is a red blood cell.

58. d

59. c

60. d

61. a

62. b

63. d
Although any patient can react to gadolinium (or any medication including saline), patients with allergies and asthma (and/or those who have previous history of reactions) do have a higher risk of reacting. Bear in mind that any (or all) patient(s) can have serious anaphylactic reactions (and death) from the administration of contrast.

64. d
Systemic refers to the entire body (being affected). Nonsystemic refers to only a portion of the body (being affected). Flushing and hives occur only in a particular portion of the body at one time; therefore they are nonsystemic responses.

65. a
An adult requiring CPR most likely needs to be defibrillated; a physician or qualified nurse trained in the use of the defibrillator, which should be on the crash cart, is required. This situation refers to a healthcare setting where crash carts with defibrillators are routinely found. (Not to a defibrillator that can be used by the general public.)

66. d

67. a

68. a

69. d

70. c

71. b

72. c
Proper body mechanics for moving patients should always be observed. Use the legs (slightly apart for balance) with knees slightly bent, instead of the back. It is also better to push than to pull with the arms.

73. c
Urinary catheters are often a cause of nosocomial urinary tract infections. One reason for this is due to the backflow of urine into the bladder associated with NOT keeping the urine collection bag below the level of the bladder.

74. d

75. d
A syncopal episode means that the patient has fainted. Patients who are nervous (anxiety) and/or hungry (possibly hypoglycemic) are more likely to faint.

76. c

Hypoglycemia is a condition whereby the diabetic patient does not have enough sugar in the system for the insulin delivered to metabolize. A diabetic patient who does not have enough insulin and has too much sugar in the body would experience hyperglycemia.

77. d

The White Paper on MRI Safety, published by the blue ribbon panel of MRI experts, recommends that the patient be removed from the scan room and, if possible, resuscitation procedures begun. For more information about MRI safety, visit the ACR website www.acr.org to obtain the most current version of the Safety documents. Also, information can be found on the MRI safety website www.mrisafety.com

78. d

Regardless of the nature of the emergency, it is always prudent to remove the patient out of the magnetic field, such that intervention can be safely administered.

79. b

80. d

81. b

Blood pressure measurements indicate the "pressure" of blood flow during systole (while the heart is in contraction) and diastole (while the heart is in relaxation). In a normal adult, a systolic pressure of 120 and a diastolic pressure of 80 are considered to be normal values. Although both systolic and diastolic pressures are important factors, when the diastolic pressure increases (even up to 90), this is considered mild hypertension (or high blood pressure) since the heart should be in its relaxation phase.

82. a

83. c

The oral route should also not be used for patients who are mouth breathers (and who have just had a warm or cold drink or meal). Taking a rectal temperature may cause stimulation of the vagus nerve, which may cause additional problems for patients with certain cardiac conditions. Rectal temperature is considered to be the most accurate and axillary the least accurate.

84. a

85. c

86. b

A "patent" airway refers to an open airway.

87. c

88. a

Oxygen is considered a medication and as such must be prescribed by a physician. In an emergency, the technologist may administer oxygen. The rate of 1–4 L/minute

is considered a safe amount to administer via nasal cannula or a regular face mask. Rates of 5 L/minute or higher must be administered using a type of humidification system to avoid excessive drying out of mucosal membranes.

89. d

90. b
The carotid pulse is found over the carotid artery toward the anterolateral aspect of the neck. The carotid bifurcation is located at the level of C-3 (at the angle of the mandible). The radial pulse, found in the wrist over the radial artery at the base of the thumb, is the pulse used in "routine" circumstances. To remember the location of the radial artery and ulnar artery (in the wrist) the radial is on the thumb side; "R-T".

91. b
Orthopnea means that the patient has difficulty breathing when lying down. This is a common problem in patients with COPD (emphysema).

92. a
Orthostatic hypotension is abnormally low blood pressure resulting from standing up too fast after lying down. This happens most often in elderly patients and can result in the patient fainting. The technologist should allow ample time for the patient to sit, allowing blood pressure to return to normal.

93. a

94. c
Apraxia can occur after a "brain injury" such as a stroke. Apraxia is the inability to perform "learned motor skills". These patients understand directions, but are unable to complete a task, such as getting dressed.

95. c
Aphasia can occur after a "brain injury" such as a stroke. Aphasia is the inability to complete language tasks such as speaking, reading and writing. These patients may have receptive aphasia (wherein they cannot understand what is being said to them) or expressive aphasia (wherein they can understand what is being said but cannot respond appropriately). In addition, aphasic patients can have difficulty swallowing.

96. d
At 85% oxygenation or less, body organs will not receive enough oxygen to support their needs and functions. They may experience ischemia and eventually infarction or necrosis if left untreated.

97. c
Iatrogenic, by definition means: "Of or relating to illness caused by medical examination or treatment." by dictionary.com.

98. b

99. c

Febrile is defined as pertaining to or marked by fever; feverish (dictionary.com). A febrile seizure (or convulsion) is a seizure caused by a high fever.

100. a

In the recovery position (Sim's), the patient is lying on their left side, semi-prone with the upper leg bent for support, so that the mouth is turned downward. This will prevent aspiration of any fluid (or vomitus) that may be draining from the mouth.

101. b

The five stages of grieving (in order), according to Elizabeth Kubler-Ross, are: denial, anger, bargaining, depression, and acceptance.

102. d

103. c

104. b

It is best to be on the same level with children to avoid intimidating them. This is true for all patients (such as a patient in a wheel chair).

105. b

Most hearing loss is in the higher pitch or range. For this reason, speaking in a low pitch and speaking very slowly will help the patient who is hearing impaired to understand your directions.

106. a

Patients with any type of mental impairment will significantly vary in their ability to understand and comply with directions. Each patient must be evaluated on an individual basis and treated accordingly with respect.

107. c

Many perceptions, behaviors, actions, and interpretations depend on cultural beliefs. This applies not only to patients and their families, but to our coworkers as well. It is important to keep in mind that variations also exist within each culture. It is beneficial to become familiar with cultural differences, while avoiding stereotyping.

108. b

109. a

Choose your words carefully in these situations. Example: Do NOT ask a young child if they "want to get up onto the table for you"; tell them that you need them to get up onto the table. Examples of a viable choice might be – which bandage do you want? or which sticker would you like? This same logic holds true for patients who are mentally impaired, but each patient needs to be assessed on an individual basis. Be careful when providing adults with choices as well.

110. d

Personal space is a very variable distance from one person to another. Cultural beliefs also play a huge role in perception of how close one person should come to another in any situation. It is our responsibility as technologists to determine what makes a patient feel comfortable. When touching a patient is necessary as

part of what we are doing, we need to take the time to explain what we are about to do and always to use a professional, firm, appropriate touch.

111. b

112. a

113. c
Items that have the potential to rust should not be sterilized in an autoclave.

114. b

115. b

116. a

117. d
Follow standard precautions for ALL patients at ALL times for safety and infection control.

118. b
Packaging or any sterile item that becomes damp prior to use is NOT considered sterile. The moisture invites microorganisms to collect in that area. Tape or labels that indicate sterility vary from one institution to another. This method of verifying sterility is often used when items are sterilized "in house". The technologist must be familiar with institutional procedures and protocols regarding sterilization.

119. b
The one-inch area border (or edges) of the sterile tray is NOT considered sterile since those edges are most likely to come in contact with a nonsterile item or person. When pouring a solution into a cup on a sterile tray, the bottle of solution may leak or drip toward the bottom of the bottle, causing an area of dampness.

120. c
Surgical asepsis is the process of sterilization, which will eliminate microorganisms and their spores.

121. b

122. d

123. a
A leukocyte is a white blood cell. Phagocytosis occurs when microorganisms enter the body and fluids carrying white blood cells travel to the site to destroy them.

124. c

125. d
The area under the arms (or the armpits) is not considered sterile due to dampness caused by perspiration.

126. c
A fomite is an object that carries microorganisms from one person to another via indirect contact.

127. a

Airborne contamination occurs via transmission of dust particles or droplets that have evaporated and contain infectious microorganisms. Special ventilation systems reduce the number of particles and droplets.

128. a

Droplets can be spread by sneezing, coughing, and speaking, and depositing the droplets into the mucous membranes of the face. Droplets travel short distances of 3 feet or less and do not remain suspended in air.

129. a

130. c

For a gown tied in the front, the ties should be unfastened first. Next, gloves are removed (using proper technique). Hands should then be washed. The mask is removed next using only the ties (the mask itself is considered contaminated). Remove the gown in the proper manner. Always wash your hands again.

131. b

132. c

133. c

134. c

135. d

136. b

137. d

In addition to patients, system operators, and hospital staff, the fire department and housekeeping personnel might also inadvertently enter the scan room with ferromagnetic materials. For this reason, such persons should be educated.

138. c

The White Paper on MRI safety states that there are levels of "expertise" associated with MRI safety whereby:

- Non-MR personnel have little or no training in MRI safety
- Level 1 personnel have limited training in MRI safety (education about the magnetic field)
- Level 2 personnel have extensive training in MRI safety, including training in not only the magnetic field but also the RF and gradient fields, and their safety considerations

139. a

The White Paper on MRI safety recommends that imaging centers are separated into "Zones" whereby:

- Zone 1 – freely accessible to any "Level" of MR personnel; can include the parking lot
- Zone 2 – the interface between Zone 1 and Zone 3; generally the reception area

- Zone 3 – the "warm" Zone, generally the console area and the last stop before the scan room. It is recommended that there is a lock between Zone 2 and Zone 3 to avoid someone inadvertently wandering into the scan room
- Zone 4 – the "hot" Zone; the scan room itself

140. d

In many cases information about prior injuries, surgery, and/or pregnancy can identify those patients who may require consideration for MRI imaging (What protocol should be performed? Should contrast be administered? Should the patient be scanned at all?).

141. a

The term MR compatible has been replaced with the following terms:

- MR safe – this device can ALWAYS be scanned (or brought into the scan room) at any time, in any field strength, with NO restrictions.
- MR unsafe – this device can NEVER be scanned (or brought into the scan room) at any time, in any field strength.
- MR conditional – this device MIGHT be scanned (or brought into the scan room) with specific restrictions (or under specific conditions).

142. d

Since the 1990s, intracranial vascular clips have been made of MR conditional metals (including titanium). These clips are MR conditional and can be scanned under certain "conditions". As of 2011, a new pacemaker was developed to be MR conditional. This "pacing system" can be imaged under particular "conditions".

143. c

Studies have shown that intraocular ferrous foreign bodies (IFFB; metallic fragments) that are smaller than can be detected by the resolution of plain film radiography are too small to cause ocular damage. For this reason, even though CT is more sensitive to the presence of metallic fragments, the standard of care for the detection of IFFB is plain film radiography – including two views (Waters view + lateral) and/or (Waters view with eyeballs looking upwards and again looking downwards).

144. a

145. d

146. d

147. d

The Safety Committee for the Society for Magnetic Resonance (SMR) has published a statement to this effect in its guidelines and recommendations for monitoring of patients in MRI.

148. c

Many surgical supplies are extremely magnetic and should not enter the scan room of high-field systems until they have been tested and proven safe.

149. a

150. d
Even though cables may look to be in excellent condition, any cable loops within the imager can potentially receive induced voltages. Therefore, cables that touch the patient are automatically looped, given that the human body is conductive and the patient completes the loop.

151. b

152. d
During a quench, asphyxiation can result from the loss of oxygen, frostbite from the low temperatures of cryogens, and ruptured tympanic membranes from the increased pressure in the scan room that occurs as the liquid cryogen (He) returns to gas.

153. c

154. b
Relatively low temperatures and humidities enable optimal use of MRI systems.

155. d

156. b

157. a

158. d
The FDA limit for clinical imaging, with respect to field strength, used to be 2.0T. As of July 2003, the regulations were changed whereby the FDA limit was increased to 4.0T for all patients and 8.0T for children aged 1 month and older. To answer this question, one must realize that the patients who are scheduled for MR imaging are screened prior to entering the scan room to avoid any contraindicated materials from entering with them, and hence the high magnetic field. When evaluating the "general population", one should assume that these persons have NOT been screened and could potentially possess contraindicated devices. For this reason, the "general population" should be restricted to within 5.0 Gauss.

159. c

160. c
There is a fringe field concern even for superconductive imagers that are magnetic field shielded. Shielding is used to confine the fringe field. The MR imager that is of "lesser" concern from the fringe field is the low field, vertical field, permanent magnet.

161. d
The FDA/CDRH modified the regulations in July of 2003 to absorption of RF (dose) averaged over the whole body and/or RF absorption that varies with anatomic location. In addition, the amount of RF is also measured by time of exposure. The regulations are:

Site	Dose	Time (min)	SAR > (W/kg)
• Whole body	Averaged over	15	4
• Head	Averaged over	10	3
• Head or torso	Per gram of tissue	5	8
• Extremities	Per gram of tissue	5	12

162. c

163. d

164. b

165. b
RF effects include increase in body temperature due to tissue heating. (Induced voltages come from gradients. Magnet hemodynamic effects come from the static magnetic field. Hypothermia results from exposure to cryogens during a quench.)

166. d
Voltages induced in RF coils can cause heat and, possibly, flames, and/or artifacts on MR images

167. b

168. b

169. c

170. d

171. d
Because fast spin echo uses a train (determined by the echo train length) of RF pulses to fill several lines of k-space per TR and acquire images faster, tissue heating increases with increased RF. As flip angle increases, RF power deposition increases. As flip angle doubles (from 90 degrees to 180 degrees) RF power increases by a factor of 4 (four).

172. c

173. d

174. b

175. c
The FDA (Food and Drug Administration) has regulations that monitor any, and all, devices for the safety and efficacy of that device. The components of the MR system that the FDA has specific guidelines include:

1. The static magnetic field
   - **a.** The FDA limit for clinical imaging is 4.0T (Tesla) for all patients
   - **b.** The FDA limit for clinical imaging is 8.0T (Tesla) for patients over one month of age.
2. The RF absorption

- **a.** Measured in SAR (Specific Absorption Rate)
- **b.** The FDA limit for SAR = 4.0 watts / kilogram
- **c.** The FDA also limits RF by anatomic location

3. Magnetic field gradients (also known as time-varing magnetic fields – TVMF)

- **a.** TVMF causes peripheral nerve stimulation
  - **i.** The FDA limit for TVMF, used to be 6 Tesla per second (T/s)
    1. T/s is expressed in units of dB/dt
    2. The equation… dB/dt = dV .defines Faraday's law of induction
       - **a.** dB – a change magnetic field
       - **b.** dt – a change in time
       - **c.** dV – a change in voltage
    3. When a magnet moves (dB) near a conductor (in this case, the human body), there is a voltage (dV) created within the conductor (manifesting as peripheral nerve stimulation, PNS).
    4. The amount of voltage (dV) or PNS is related to the strength of the magnet b and the rate at which it moves (dt).
  - **ii.** In July of 2003, The FDA's Center for Devices & Radiological Health (CDRH) modified the limit on gradients (TVMF)
  - **iii.** The FDA/CDRH limit for TVMF is "Until the patient feels painful nerve stimulation"
- **b.** Since the gradients produce acoustic noise, another TVMF affect is acoustic noise
  - **i.** The US FDA limit for sound is140 dB (decibels) or 99 dB with hearing protection in place [USFDA 2003]
- **c.** Gradient characteristics
  - **i.** Gradient strength is expressed in milliTesla per meter (mT/M) or Gauss per centimeter (g/cm).
  - **ii.** Gradient speed or rise time is expressed in microseconds (μs)
  - **iii.** The combination of rise time and strength is expressed as the Slew rate and is expressed in units of Tesla per meter per second (T/M/s)
  - **iv.** The length of the gradient is not a factor in TVMF effects, and therefore is NOT FDA regulated. www.acr.org

176. d

177. b

178. a

179. d

The more ferromagnetic, the greater the mass, and the stronger the magnetic field, the greater the attractive force.

180. c

This can be noticed in patients who are monitored with ECG leads and enter the bore of the imager.

181. b

182. d

183. d

Faraday's Law of induction states that if a conductor moves through a magnetic field, a voltage is induced within the conductor. In this case, as blood flows through the magnetic field (blood being a conductor) a voltage is induced and displayed onto the ECG monitor. This effect is known as the Magnet-hemodynamic effect and/or the Magnet-hydrodynamic effect and/or the Magnetohydrodynamic effect.

184. d

Faraday's law of induction states that if a conductor moves through a magnetic field, a voltage is induced within the conductor. In this case, as the gradient fields are switched on and off during image acquisition, a voltage is induced within the retinal phosphenes. The result is a phenomenon known as magnetophosphenes, whereby the patient experiences the sensation of "stars in their eyes".

185. d

186. a

187. b

188. e

Gradient strength is measured in field strength over distance (mT/m or G/cm) whereby 10 mT/m = 1 g/cm.

189. b

190. d

191. c

192. c

The FDA has changed the limit for field strength for clinical imaging from, up to 2.0 T, to 4.0 T for infants (up to 1 month of age) and 8.0 T for patients over one month of age.

193. d

Echo planar imaging uses gradients with very rapid rise times because all of the K space is filled in one TR time by changing the amplitude of the gradient as many as 128, 256 or 512 times per TR period.

194. a

195. c

196. e

Some companies do offer antinoise devices for MRI systems. However, earplugs can reduce noise by 10–20 dB and this is sufficient to reduce auditory effects in MRI.