Magnetic Resonance Imaging

The purpose of continuing qualifications requirements (CQR) is to assist technologists in documenting their continued qualifications in the disciplines of certification and registration held. To accomplish this purpose the continuing qualifications requirements are presented in three parts: the professional profile, the structured self assessment (SSA) and continuing education (CE).

The Structured Self Assessment Content Specifications for Magnetic Resonance Imaging is provided to assist technologists during their CQR compliance period. Its purpose is to prepare technologists for the SSA and to help education providers develop coursework for the technologists who need to address specified areas with targeted continuing education. Targeted CE is assigned only if a standard is not met in a category on the SSA.

The SSA is composed of sets of questions that are designed to evaluate an individual’s knowledge in topics related to current practice. Participants are allowed a maximum of two hours and 30 minutes to complete the SSA for Magnetic Resonance Imaging.

The table below presents the major categories and subcategories covered on the SSA. The number of questions in each category are listed in bold and number of questions in each subcategory in parentheses. The potential number of targeted CE credits that would be prescribed if the standard is not met, are across from each subcategory, with the maximum amount listed at the bottom. Specific topics within each category are addressed in the content outline, which makes up the remaining pages of this document.

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Total 80  Maximum CE 36

¹ The SSA includes an additional 40 unscored (pilot) questions.
Patient Care

1. Patient Interactions and Management
   A. Legal and Ethical Principles
      1. confirmation of exam requisition
         a. verification of patient identification
         b. comparison of request to clinical indications
      2. legal issues
         a. common terminology
            (*e.g., negligence, malpractice)
         b. legal doctrines (e.g., respondeat superior, res ipsa loquitur)
      3. patient's rights
         a. informed consent (written, oral, implied)
         b. confidentiality (HIPAA)
         c. American Hospital Association (AHA) Patient Care Partnership
            (Patient’s Bill of Rights) (e.g., privacy, access to information,
            health care proxy, research participation)
   4. ARRT Standards of Ethics
   B. Infection Control
      1. terminology and basic concepts
         a. types of asepsis
         b. sterile technique
         c. pathogens
            (e.g., fomites, vehicles, vectors)
         d. hospital acquired infections
      2. cycle of infection
         a. pathogen
         b. source or reservoir of infection
         c. susceptible host
         d. method of transmission (contact, droplet, airborne, common vehicle, vector-borne)
      3. CDC Standard Precautions (general patient contact)
         a. handwashing
         b. gloves, gowns
         c. masks
         d. medical asepsis/disinfection
      4. additional or transmission-based precautions (e.g., hepatitis B, HIV, tuberculosis)
         a. airborne (e.g., negative ventilation)
         b. droplet (e.g., mask)
         c. contact (e.g., gloves, gown)
      5. safe cleaning of equipment and disposal of contaminated materials
         a. linens
         b. needles
         c. patient supplies
         d. scanner, bore, coils, ancillary equipment

* The abbreviation “e.g.,” is used to indicate that examples are listed in parentheses, but that it is not a complete list of all possibilities.

(Patient Care continues on the following page.)
Patient Care (continued)

C. Interpersonal Communications
1. modes of communication
   a. verbal, written
   b. nonverbal
      (e.g., eye contact, touching)
2. challenges in communication
   a. patient characteristics
      (e.g., cultural factors, physical or emotional status)
   b. strategies to improve understanding
3. patient education
   a. explanation of procedure
      (e.g., risks, benefits)
   b. communication with patient during procedure
   c. follow-up instructions
   d. referral to other services
4. medical terminology

D. Patient Assessment, Monitoring and Management
1. routine monitoring
   a. vital signs
   b. physical signs and symptoms
   c. sedated patients
   d. claustrophobic patients
2. emergency response
   a. reactions to contrast
   b. other allergic reactions (e.g., latex)
   c. cardiac/respiratory arrest (CPR)
   d. physical injury, trauma or RF burn
   e. other medical disorders
      (e.g., seizures, diabetic reactions)
   f. life-threatening situations
      (e.g., quench, projectiles)
3. patient transfer and body mechanics
4. assisting patients with medical equipment
   a. implantable devices (e.g., infusion catheters, pumps, pacemakers)
   b. oxygen delivery systems
   c. other (e.g., nasogastric tubes, urinary catheters)

E. Pharmacology
1. contrast media types (FDA approved)
2. contraindications
3. laboratory values
   (e.g., BUN, creatinine, eGFR)
4. dose calculation
5. administration route
Safety

1. MRI Screening and Safety
   A. Screening and Education (patients, personnel, non-personnel)
      1. biomedical implants
         a. identify and document device, year, make, model
         b. research and verify device labeling (MRI safe, MRI conditional, MRI unsafe)
         c. identify device specific parameters
      2. ferrous foreign bodies
      3. medical conditions (e.g., renal function, pregnancy)
      4. prior diagnostic or surgical procedures
      5. topical or externally applied items (e.g., tattoos, medication patches, body piercing jewelry, monitoring devices)
      6. level 1 and level 2 MRI personnel

B. Equipment Safety
   1. placement of conductors (e.g., ECG leads, coils, cables)
   2. cryogen safety
   3. ancillary equipment in proximity (MRI safe, conditional, unsafe)
   4. emergency procedures (e.g., quench, fire)

C. Environment
   1. climate control (temperature, humidity)
   2. designated safety zones
   3. gauss lines
   4. magnetic shielding
   5. RF shielding

D. Biological Considerations
   1. RF field
      a. specific absorption rate (SAR)
      b. biological effects
      c. FDA guidelines
   2. static and gradient magnetic fields
      a. biological effects
      b. FDA guidelines
   3. acoustic noise
Image Production

1. Physical Principles of Image Formation

A. Instrumentation
   1. electromagnetism
      a. Faraday's law
      b. types of magnets
         (superconductive, permanent, resistive)
      c. magnetic field strength
   2. radiofrequency system
      a. coil configuration
      b. transmit and receive coils
      c. transmit and receive bandwidth
      d. pulse profile
      e. phased array
   3. gradient system
      a. coil configuration
      b. slew rate
      c. rise time
      d. duty cycle

B. Fundamentals
   1. nuclear magnetism
      a. Larmor equation
      b. precession
      c. gyromagnetic ratio
      d. resonance
      e. RF pulse
      f. equilibrium magnetization
      g. energy state transitions
      h. phase coherence
      i. free induction decay (FID)
   2. tissue characteristics
      a. T1 relaxation
      b. T2 relaxation
      c. T2* (susceptibility)
      d. proton (spin) density
      e. flow
      f. diffusion
      g. perfusion

3. spatial localization
   a. vectors
   b. X, Y, Z coordinate system
   c. physical gradient
   d. slice select gradient
   e. phase-encoding gradient
   f. frequency (readout) gradient
   g. k-space (raw data)

C. Artifacts
   1. cause and appearance of artifacts
      a. aliasing
      b. Gibbs, truncation
      c. chemical shift
      d. magnetic susceptibility
      e. radiofrequency, zipper
      f. motion and flow
      g. partial volume averaging
      h. crosstalk
      i. cross excitation
      j. Moiré pattern
      k. parallel imaging artifacts
   2. compensation for artifacts

D. Quality Control
   1. slice thickness
   2. spatial resolution
   3. contrast resolution
   4. signal to noise
   5. center frequency
   6. transmit gain
   7. geometric accuracy
   8. equipment handling and inspection
      (e.g., coils, cables, door seals)

(Image Production continues on the following page.)
Image Production (continued)

2. Sequence Parameters and Options

A. Imaging Parameters
   1. TR
   2. TE
   3. TI
   4. number of signal averages (NSA)
   5. flip angle (Ernst angle)
   6. FOV
   7. matrix
   8. number of slices
   9. slice thickness and gap
   10. phase and frequency
   11. echo train length
   12. effective TE
   13. bandwidth (transmit, receive)
   14. concatenations
      (number of acquisitions per TR)

B. Imaging Options
   1. 2D/3D
   2. slice order
      (sequential, interleaving)
   3. spatial saturation pulse
   4. gradient moment nulling
   5. suppression techniques
      (e.g., fat, water)
   6. physiologic gating and triggering
   7. in-phase/out-of-phase
   8. rectangular FOV
   9. anti-aliasing
   10. parallel imaging
   11. motion correction imaging technique
   12. filtering

FOCUS OF QUESTIONS

Questions will address the interdependence of the imaging parameters and options listed on the left, and how those parameters and options affect image quality and image contrast.

1. Image Quality
   • contrast to noise (C/N)
   • signal to noise (S/N)
   • spatial resolution
   • acquisition time

2. Image Contrast
   • T1 weighted
   • T2 weighted
   • proton (spin) density
   • T2* weighted

(Image Production continues on the following page.)
Image Production (continued)

3. Data Acquisition and Processing

A. Pulse Sequences
   1. spin echo
      a. conventional spin echo
      b. fast spin echo (FSE)
   2. inversion recovery
      a. STIR
      b. FLAIR
   3. gradient recall echo (GRE)
      a. conventional gradient echo
      b. spoiled gradient echo
      c. coherent gradient echo
      d. steady state free precession
      e. fast gradient echo
   4. echo planar imaging (EPI)

B. Data Manipulation
   1. k-space mapping and filling
      (e.g., centric, spiral, keyhole)
   2. fast fourier transformation (FFT)
   3. post processing
      a. maximum intensity projection (MIP)
      b. multiplanar reconstruction (MPR)
      c. subtraction
      d. apparent diffusion coefficient (ADC) mapping

C. Special Procedures
   1. MRA/MRV
      a. flow dynamics
      b. time-of-flight
      c. phase contrast
      d. contrast enhanced
   2. functional techniques
      a. diffusion
      b. perfusion
      c. spectroscopy
   3. dynamic imaging
   4. contrast bolus detection
      a. fluoro-triggering
      b. timing bolus
      c. automatic bolus detection
Procedures

1. Neuro
   A. Head and Neck
      1. brain
      2. head trauma
      3. brain for stroke
      4. brain for MS
      5. brain for seizure
      6. brain for CSF Flow
      7. pediatric brain
      8. IAC
      9. pituitary
     10. orbit
     11. soft tissue neck (e.g., parotids, thyroid)
     12. angiography
     13. spectroscopy
   B. Spine
      1. cervical
      2. thoracic
      3. lumbar
      4. sacrum/coccyx
      5. brachial plexus

2. Body
   A. Thorax
      1. chest
      2. breast
      3. angiography
   B. Abdomen
      1. liver, spleen
      2. pancreas
      3. kidneys
      4. adrenals
      5. MRCP
      6. angiography
      7. enterography
   C. Pelvis
      1. soft tissue pelvis (bladder, rectum, anus)
      2. female pelvis (uterus/cervix, ovaries, vagina)
      3. male pelvis (prostate, testes)
      4. angiography (iliac and run-off)

FOCUS OF QUESTIONS

Questions about each of the studies listed on the left may focus on any of the following factors:

1. Anatomy and Physiology
   • imaging planes
   • pathological considerations
   • protocol considerations
   • patient considerations (e.g., pediatric, geriatric, bariatric)

2. Patient Set-Up
   • patient data input
   • coil selection and position
   • patient orientation
   • landmarking
   • physiologic gating and triggering

3. Contrast Media
   • effect on images

(Procedures continue on the following page.)
Procedures (continued)

3. Musculoskeletal
   A. Temporomandibular Joint
   B. Shoulder
   C. Elbow
   D. Wrist
   E. Hand/Fingers
   F. Thumb
   G. Hip
   H. Ankle
   I. Knee
   J. Fore Foot and Hind Foot
   K. Long Bones (humerus, forearm, femur, lower leg)
   L. Arthrography
   M. Angiography
   N. SI Joints
   O. SC Joints
   P. Sternum
   Q. Bony Pelvis

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