Computed Tomography

The purpose of structured education is to provide the opportunity for individuals to develop mastery of discipline-specific knowledge that, when coupled with selected clinical experiences, helps to document qualifications. The *Structured Education Requirements for Computed Tomography* is provided to assist candidates with these requirements.

Candidates for computed tomography certification and registration must document at least 16 hours of structured education[1]. The activities must be earned within the 24-month period immediately prior to submission of an application for certification and registration. Structured education activities may be academic courses from an institution accredited by a mechanism recognized by the ARRT[2], CE opportunities approved by a RCEEM or RCEEM+, or a combination of the two.

Structured education documentation must include at least one CE credit or its equivalent in each content category listed below (i.e., Patient Care, Safety, Image Production, and Procedures). The remaining hours may be earned from any one or more of the content areas. Specific topics within each category are addressed in the content outline, which makes up the remaining pages of this document.

Content Category	**Minimum Credit Hours**
Patient Care (includes)	1
Patient Interactions and Management	
Safety (includes)	1
Radiation Safety and Dose	
Image Production (includes)	1
Image Formation	
Image Evaluation and Archiving	
Procedures (includes)	1
Head, Spine, and Musculoskeletal	
Neck and Chest	
Abdomen and Pelvis	
Total	**16**

Acceptable Examples:

Example 1	Example 2	Example 3
Patient Care – 3 hours Safety – 2 hours Image Production – 4 hours Procedures – 7 hours	Patient Care – 1 hour Safety – 1 hour Image Production – 1 hour Procedures – 13 hours	Patient Care – 1 hour Safety – 5 hours Image Production – 5 hours Procedures – 5 hours
TOTAL – 16 hours	TOTAL – 16 hours	TOTAL – 16 hours

1. If there is a structured education requirement document with a newer effective date, you may either use the new document or continue to use this document if you have completed at least one educational activity prior to the effective date of the new version. For more information access the online clinical experience tool, where structured education is also reported.

2. Activities meeting the definition of an approved academic course will be awarded credit at the rate of 12 CE credits for each academic **quarter** credit or 16 CE credits for each academic **semester** credit. See the ARRT *Continuing Education Requirements* document for additional information.

Patient Care

1. Patient Interactions and Management

A. Patient Assessment and Preparation
   1. patient history
   2. interpersonal communication (e.g., patient care team, physician)
   3. scheduling and screening
   4. patient education
   5. consent (e.g., informed, oral, implied)
   6. positioning aids to eliminate motion artifacts and for patient safety (e.g., velcro straps, padding)
   7. patient monitoring
      a. level of consciousness
      b. fall prevention
      c. vital signs
      d. heart rhythm and cardiac cycle
      e. oximetry
      f. medical emergency
   8. ergonomics and patient transfer techniques
   9. management of accessory medical devices
      a. oxygen delivery systems
      b. chest tubes
      c. in-dwelling catheters
   10. lab values
      a. renal function (*e.g., eGFR, creatinine, BUN)
      b. other (e.g., d-dimer, LFT, INR)
   11. medications and dosage
      a. current
      b. pre-procedure medications (e.g., steroid, anti-anxiety)
      c. post-procedure instructions (e.g., diabetic patient)

B. Contrast and Medication
   1. contrast media types and properties
      a. ionic, nonionic
      b. osmolarity
      c. barium sulfate
      d. water soluble (iodinated)
      e. air
      f. water
      g. other
   2. special contrast considerations
      a. contraindications
      b. indications
      c. pregnancy
      d. lactation
      e. dialysis patients
   3. noncontrast medications (e.g., lidocaine, nitroglycerin)
   4. administration routes and dose calculations
      a. IV
      b. oral
      c. rectal
      d. intrathecal
      e. catheters (e.g., central line, PICC line, Foley)
      f. other (e.g., stoma, intra-articular)
   5. venipuncture
      a. site selection
      b. medical aseptic and sterile technique
      c. documentation (e.g., site, amount, gauge, concentration, rate, and number of attempts)
   6. injection techniques
      a. safety
      b. manual
      c. power injector options
         1. single or dual head
         2. single phase
         3. multi-phase
         4. flow rate
         5. timing bolus
         6. bolus tracking
   7. post-procedure care
      a. complications (e.g., extravasation/infiltration)
      b. documentation
   8. adverse reactions
      a. recognition and assessment
      b. treatment
      c. documentation
   9. infection control

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

Safety

1. Radiation Safety and Dose

A. Radiation Physics
   1. x-ray production
   2. target interactions
      a. bremsstrahlung
      b. characteristic
   3. x-ray beam
      a. frequency and wavelength
      b. beam characteristics
         1. quality
         2. quantity
         3. primary versus remnant (exit)
      c. inverse square law
      d. fundamental properties of x ray
      e. acquisition (geometry)
   4. photon interactions with matter
      a. photoelectric
      b. Compton
      c. coherent (classical)
      d. attenuation by various tissues

B. Radiation Protection
   1. minimizing patient exposure
      a. kVp
      b. mAs
      c. pitch
      d. collimation/beam width
      e. filtration
      f. gating
      g. image reconstruction (e.g., iterative, retrospective, artifact suppression software)
      h. detector efficiency
      i. overranging
      j. dose modulation techniques (e.g., SMART mA, auto mA, CARE dose, SURE Exposure)
      k. dose notification/dose alert
   2. shielding (e.g., lead apron)
   3. patient considerations
      a. positioning
      b. removal of radiopaque materials and radiosensitive devices
      c. communication (e.g., breathing instructions)
      d. pediatric
      e. adult (e.g., BMI)
      f. pregnancy
   4. dose measurements
      a. absorbed dose (mGy)
      b. effective dose (mSv)
      c. CT dose index (CTDI) [mGy]
      d. dose length product (DLP) [mGy-cm]
      e. documentation
   5. personnel protection
      a. controlled access
      b. education

Image Production

1. Image Formation

A. Components of a CT Unit
   1. gantry
      a. tube
         1. x-ray production
         2. warm-up procedures
      b. generator
      c. detectors
         1. detector configuration
         2. detector collimation
      d. data acquisition system (DAS)
      e. slip rings
   2. array processor and host computer

B. Imaging Parameters
   1. kVp
   2. mAs
   3. pitch
   4. collimation/beam width
   5. acquisition slice thickness
   6. x, y, z planes
   7. scan field of view (SFOV)

C. Methods of Data Acquisition
   1. axial/sequential
   2. helical
   3. volumetric
   4. shuttle/continuous/cine
   5. dual energy/dual source

D. Image Reconstruction
   1. filtered backprojection reconstruction
   2. iterative reconstruction
   3. prospective/retrospective reconstruction
   4. raw data versus image data
   5. reconstruction algorithm
   6. reconstruction slice thickness
   7. reconstruction interval
   8. interpolation

E. Post Processing
   1. multi-planar reformation (MPR)
   2. 3D rendering (e.g., MIP, SSD, VR)
   3. quantitative analysis (e.g., distance, diameter, calcium scoring, ejection fraction)

2. Image Evaluation and Archiving

A. Image Display
   1. pixel, voxel
   2. matrix
   3. image magnification
   4. display field of view (DFOV)
   5. window level (W/L), window width (W/W)
   6. cine loop/matrix
   7. geometric distance or region of interest (ROI) (e.g., mean, standard deviation [SD])

B. Image Quality
   1. spatial resolution
   2. contrast resolution
   3. temporal resolution
   4. noise and uniformity
   5. quality assurance and accreditation
   6. CT number (Hounsfield units [HU])
   7. linearity

C. Artifact Recognition and Reduction
   1. beam hardening or cupping
   2. partial volume averaging
   3. motion
   4. metallic
   5. edge gradient
   6. patient positioning (out-of-field)
   7. equipment artifacts
      a. rings
      b. streaks
      c. tube arcing
      d. cone beam

D. Informatics
   1. hard/electronic copy (e.g., DICOM file format)
   2. archive
   3. PACS/MIMPS and electronic medical record (EMR)
   4. networking

Procedures

TYPE OF STUDY

1. Head, Spine, and Musculoskeletal

A. Head
   1. temporal bones/internal auditory canal (IACs)
   2. orbits
   3. sinuses
   4. maxillofacial and/or mandible
   5. temporomandibular joints (TMJs)
   6. brain/cranium
   7. brain perfusion

B. Spine
   1. cervical
   2. thoracic
   3. lumbar
   4. sacrum/coccyx
   5. post myelography

C. Musculoskeletal
   1. upper extremity
   2. lower extremity
   3. bony pelvis and/or hips
   4. shoulder and/or scapula
   5. arthrography

FOCUS OF QUESTIONS

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

Anatomy and Physiology

- cross sectional anatomy
- pathological considerations/recognition
- landmarks
- vasculature

Factors

- imaging planes
- protocol considerations
- patient considerations (e.g., pediatric, geriatric, bariatric)
- post-processing presentations

Contrast Media

- indications
- scan/prep delay
- effect on images

Additional Procedures

- vascular (CTA, CTV) (e.g., PE, dissection, runoff, venogram)
- biopsies
- drainages
- aspirations
- trauma

(Procedures continue on the following page.)

Procedures (continued)

TYPE OF STUDY

2. Neck and Chest
- A. Neck
  1. larynx/airway
  2. soft tissue neck
- B. Chest
  1. mediastinum
  2. lung
  3. heart
  4. airway
  5. chest wall
  6. low dose lung screening

3. Abdomen and Pelvis
- A. Abdomen
  1. liver
  2. biliary
  3. spleen
  4. pancreas
  5. adrenals
  6. kidneys and/or ureters
  7. GI tract
- B. Pelvis
  1. bladder
  2. colorectal
  3. reproductive organs

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