Bone Densitometry

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 Bone Densitometry* is provided to assist candidates with these requirements.

Candidates for bone densitometry 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 Bone Health, Care, and Radiation Principles	
Image Production (includes)	1
Equipment Operation and Quality Control	
Procedures (includes)	1
DXA Scanning	
Total	**16**

Acceptable Examples:

Example 1	Example 2	Example 3
Patient Care – 3 hours Image Production – 6 hours Procedures – 7 hours	Patient Care – 1 hour Image Production – 1 hour Procedures – 14 hours	Patient Care – 1 hour Image Production – 10 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 Bone Health, Care, and Radiation Principles

A. Osteoporosis
   1. definitions and types
      a. definition according to World Health Organization (WHO)
      b. primary
      c. secondary
   2. bone physiology
      a. functions of bone
      b. structural anatomy
      c. types of bone
         1. cortical bone
         2. trabecular bone
      d. cellular structure
         1. osteoclasts
         2. osteoblasts
      e. bone remodeling
         1. remodeling cycle
         2. factors affecting remodeling (*e.g., age, hormones, pathology)
   3. risk factors
      a. genetic
      b. endocrine
      c. nutritional
      d. lifestyle
      e. medications (e.g., steroids, thyroid, hormones, anticoagulants)
   4. Bone Mass Measurement Act (CMS billing and coding)
      a. clinical indications
      b. guidelines
   5. prevention and treatment
      a. lifestyle factors
         1. nutrition
         2. exercise
         3. smoking cessation
      b. fall prevention
      c. drug therapies
         1. antiresorptive
         2. formation
         3. hormonal and others

B. Patient Preparation and Safety
   1. patient preparation
      a. special needs
         1. fall prevention and mobility assistance
         2. mental impairment or disorientation
      b. technologist ergonomics
         1. alignment, movement
         2. patient transfer techniques
      c. patient instructions
         1. explanation of procedure
         2. number and duration of scans
         3. motion and breathing requirements
      d. patient history relevant to scan
         1. medical history (e.g., bone disorder, prosthesis, peak height)
         2. current height and weight
         3. laboratory tests (e.g., biochemical markers)
         4. contraindications (e.g., recent contrast agents, radiopharmaceuticals, calcium supplements)
         5. possible pregnancy
      e. scan preparation
         1. entry of patient data
         2. removal of artifact-producing clothing and jewelry
      f. infection control (e.g., disinfect work area and equipment)
   2. radiation safety
      a. basic principles
         1. ALARA
         2. workstation – scanner distance
      b. levels of radiation in DXA
         1. entrance dose (mSv)
         2. dose equivalent (mSv)
         3. relationship to other types of imaging studies

* 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.

Image Production

1. Equipment Operation and Quality Control

A. Dual Photon Energies
   1. typical energy levels
   2. advantages and limitations

B. DXA Components
   1. x-ray production
      a. k-edge filtration
      b. energy switching
   2. radiation detector system

C. Fan Beam
   1. mechanics of fan beam
      a. beam collimation
      b. detector system
      c. scan arm motion
   2. geometry of fan beam
      a. source-object-detector distances
      b. magnification and distortion
      c. object centering
      d. estimated BMC and area

D. Scan Analysis Algorithm
   1. computation of soft tissue density
   2. bone edge detection
   3. definition and calculation of BMC, area, and BMD

E. Measuring BMD
   1. basic statistical concepts
      a. mean
      b. standard deviation
      c. coefficient of variation
   2. standard scores
      a. Z-scores
      b. T-scores
   3. WHO Diagnostic Criteria
   4. FRAX® (WHO Fracture Risk Assessment Tool)
   5. Vertebral Fracture Assessment (VFA)
   6. pediatric/adolescent scanning

F. Factors Affecting Accuracy and Precision
   1. quality of bone density measurements
      a. precision
      b. sources of precision error
      c. accuracy
   2. equipment characteristics
      a. scanner speed/mode
      b. scanner calibration/stability
   3. operator and patient characteristics
      a. positioning
      b. geometry (e.g., centering, ROI size)
      c. body habitus, variant anatomy
      d. pathology
      e. in vivo precision studies
   4. follow-up scanning
      a. reproduce baseline study (acquisition parameters, positioning, ROI placement)
      b. changes affecting scan validity

G. Equipment QC
   1. purposes of quality control
      a. scanner function and calibration
      b. timely repairs and recalibration
      c. shift/drift
   2. types of QC
      a. internal versus external calibration
      b. baseline versus longitudinal phantom
   3. types of phantoms
      a. aluminum
      b. anthropomorphic
   4. analysis of QC results
      a. pass/fail criteria
      b. need for repeat QC tests
      c. need for service

H. Maintenance, Repair, and Upgrade
   1. relocation
      a. recalibration
      b. reestablish baseline data
   2. equipment safety
      a. electrical
      b. emergency stop button
   3. cross-calibration
      a. equipment replacement
      b. change in manufacturer
   4. software errors and upgrades

I. File and Database Management
   1. storage and retrieval of data
   2. back-up and archiving

Procedures

1. DXA Scanning

A. Lumbar Spine
   1. anatomy related to scanning
      a. vertebral anatomy
      b. regions of interest in DXA
      c. bony landmarks
      d. radiographic appearance
      e. significant adjacent structures (e.g., pelvis, ribs, T12)
   2. scan acquisition
      a. scan parameters
         1. standard technique
         2. compensation for variation in anatomy, body habitus, pathology, or low bone density
      b. patient positioning
         1. positioning aids (e.g., leg block)
         2. common challenges (e.g., scoliosis)
   3. problems related to positioning, ROI placement, and analysis
      a. types of problems
         1. poor bone edge detection
         2. intervertebral spaces obscured
         3. nonremovable artifacts
         4. inaccurate BMC or BMD values
      b. potential causes
         1. variant anatomy
         2. fractures
         3. pathological processes (e.g., scoliosis, arthritis, osteophytes)
         4. aortic and other calcifications
         5. surgery (e.g., biomechanical devices, laminectomy, fusion)
   4. lumbar spine analysis
      a. ROI placement
      b. reported values (e.g., BMC, T-score, percent of mean)
      c. vertebral exclusions
      d. graphical displays

B. Proximal Femur
   1. anatomy related to scanning
      a. femoral neck anatomy
      b. regions of interest in DXA
      c. bony landmarks
      d. radiographic appearance
      e. significant adjacent structures (e.g., pelvis)
   2. scan acquisition
      a. femur selection (right versus left, or dual)
      b. scan parameters
         1. standard technique
         2. compensation for variation in anatomy, body habitus, pathology, or low bone density
      c. patient positioning
         1. femoral neck rotation
         2. femoral shaft placement
         3. positioning aids
         4. common challenges (e.g., arthritis)
   3. problems related to positioning, ROI placement, and analysis
      a. types of problems
         1. poor bone edge detection
         2. nonremovable artifacts
         3. ischium underlying neck
         4. inaccurate BMC or BMD values
      b. potential causes
         1. variant anatomy (e.g., short femoral neck, inadequate space between ischium and femur)
         2. fractures
         3. pathological processes (e.g., arthritis, joint disease)
         4. surgery (e.g., biomechanical devices)
   4. scan analysis
      a. ROI placement
      b. reported values (e.g., BMC, T-score, percent of mean)
      c. graphical displays

(Procedures continues on the following page.)

Procedures (continued)

C. Forearm
   1. anatomy related to scanning
      a. forearm anatomy
      b. regions of interest in DXA
      c. bony landmarks
      d. radiographic appearance
      e. significant adjacent structures (e.g., carpal bones, soft tissue)
   2. scan acquisition
      a. selection (right versus left)
      b. forearm length
      c. scan parameters
         1. standard technique
         2. compensation for variations in anatomy, body habitus, pathology, or low bone density
      d. patient positioning
         1. radius – ulna orientation
         2. positioning aids
         3. common challenges (e.g., kyphosis, contracture)
   3. problems related to positioning, ROI placement, and analysis
      a. types of problems
         1. poor bone edge detection
         2. nonremovable artifacts
         3. inaccurate BMC or BMD values
      b. potential causes
         1. low bone density
         2. pathological processes (e.g., arthritis, joint disease)
   4. scan analysis
      a. ROI placement
      b. reported values (e.g., BMC, T-score, percent of mean)
      c. graphical displays