Bone Densitometry

The purpose of the examination requirement is to assess whether individuals have obtained the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required in bone densitometry for practice at entry level.

ARRT determined ~~T~~the tasks that entry-level bone density technologists typically perform~~ed were determined~~ by administering a comprehensive practice analysis survey to a nationwide sample of bone ~~densitometrists~~density technologists.[1] The *Task Inventory for Bone Densitometry* ~~may be found~~ is on the ARRT's website (www.arrt.org).

The *Examination Content Specifications for Bone Densitometry* and attached content outline identify the knowledge areas underlying performance of the tasks on the *Task Inventory for Bone Densitometry.* Every content category can be linked to one or more tasks on the task inventory.

This document is not intended to serve as a curriculum guide. Although ARRT programs for certification and registration and educational programs may have related purposes, their functions are clearly different. Educational programs are generally broader in scope and address the subject matter that is included in the content outline, but do not limit themselves to only this content.

The table below presents the ~~major~~ content categories ~~covered on~~ the examination covers~~.~~, and t~~T~~he number of test questions in each category ~~are listed in bold~~. ~~and number of test questions in each subcategory in parentheses.~~ Specific topics within each category are addressed in the content outline, which makes up the remaining pages of this document.

Content Category	Number of Scored Questions[2]
Patient Care	**17**
Patient Bone Health, Care, and Radiation Principles ~~(17)~~	
Image Production	**20**
Equipment Operation and Quality Control ~~(20)~~	
Procedures	**38**
DXA Scanning ~~(38)~~	
Total	**75**

1. A special debt of gratitude is due to the hundreds of professionals participating in this project as committee members, survey respondents, and reviewers.
2. The exam includes an additional 30 unscored (pilot) questions.

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/diagnosis
      b. guidelines
   5. prevention and treatment
      a. lifestyle factors
         1. nutrition
         2. exercise
         3. smoking cessation
      b. fall prevention
      c. drug therapies (e.g., FDA approved)
         1. antiresorptive
         2. formation
         3. hormonal and others (e.g., SERMS)

B. Patient Preparation and Safety
   1. patient preparation
      a. special needs
         1. fall prevention and mobility assistance
         2. disabilities (e.g., mental impairment or disorientation)
      b. technologist ergonomics
         1. alignment, movement
         2. patient transfer techniques
      c. patient instructions
         1. explanation of ~~procedure~~ examination
         2. explanation of radiation dose and effects
         3~~2~~.number and duration of scans
         4~~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. enter~~y of~~ patient data (e.g., EMR)
         2. remove~~al of~~ artifact-producing ~~clothing and jewelry~~objects (e.g., clothing, medical devices)
      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~~ absorbed dose (~~mSv~~mGy)
         2. effective dose ~~equivalent~~ (mSv)
         3. relationship to other types of imaging studies

e.g., is used to indicate examples of the topics covered, but not a complete list~~ 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 (QC)

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 (SD)
      c. coefficient of variation (%CV)
   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. Trabecular bone score (TBS)
   7. ~~6~~.pediatric/adolescent scanning

F. Whole body DXA
   (e.g., body composition, bone density)

G~~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 (e.g., least significant change [LSC])
   4. follow-up scanning
      a. reproduce baseline study (e.g., acquisition parameters, positioning, ROI placement)
      b. changes affecting scan validity

~~G~~H. 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~~ interpret ~~of~~ QC results
      a. pass/fail criteria
      b. need for repeat QC tests
      c. need for service
   5. record results (e.g., binder, chart, electronic database)

I~~H~~. Maintenance, Repair, and Upgrade
   1. relocation
      a. recalibration
      b. re-establish baseline data
   2. equipment safety
      a. electrical
      b. emergency stop button
   ~~3. cross-calibration~~
   ~~a. equipment replacement~~
   ~~b. change in manufacturer~~
   3~~4~~.software errors and upgrades/updates
   4. reconfigure report settings (e.g., disable/enable auto analysis)

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

J. Informatics
1. backup, archive, and import/retrieve data/scan
   a. PACS/MIMPS
   b. DICOM
   c. external hard drive/DVD
   d. network
2. medical information systems/ patient records (e.g., HIS, RIS, EMR)

Procedures

1. DXA Scanning

A. Lumbar Spine
1. anatomy ~~related to scanning~~
   a. vertebral anatomy
   b. region~~s~~ of interest ~~in DXA~~ (ROI)
   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. special considerations ~~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. pathology~~ical processes~~ (e.g., scoliosis, arthritis, osteophytes)
      4. aortic and other calcifications
      5. surgery (e.g., biomechanical devices, laminectomy, fusion)
4. ~~lumbar spine~~scan analysis
   a. ROI placement
   b. reported values (e.g., BMC, T-score, Z-score, percent of mean)
   c. vertebral exclusions
   d. graphical displays
   e. window level
5. follow-up scans
   a. rate of change
      1. BMD
      2. T-score, Z-score
   b. reproduce baseline study

B. Proximal Femur
1. anatomy ~~related to scanning~~
   a. ~~femoral neck~~ proximal femur anatomy
   b. region~~s~~ of interest ~~in DXA~~ (ROI)
   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. special considerations ~~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. pathology~~ical 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, Z-score, percent of mean)
   c. graphical displays
   d. window level
5. follow-up scans
   a. rate of change
      1. BMD
      2. T-score, Z-score
   b. reproduce baseline study

~~(Procedures continues on the following page.)~~

Procedures (continued)

C. Forearm
1. anatomy ~~related to scanning~~
   a. distal forearm anatomy
   b. region~~s~~ of interest ~~in DXA~~(ROI)
   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~~ special considerations 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. pathology~~ical processes~~ (e.g., arthritis, joint disease)
4. scan analysis
   a. ROI placement
   b. reported values (e.g., BMC, T-score, Z-score, percent of mean)
   c. graphical displays
   d. window level
5. follow-up scans
   a. rate of change
      1. BMD
      2. T-score, Z-score
   b. reproduce baseline study