



# Bone Densitometry Equipment Operator

The purpose of the ~~bone densitometry equipment operator~~ examination requirement, which is developed and administered by The American Registry of Radiologic Technologists (ARRT) on behalf of state licensing agencies, is to assess whether individuals have obtained the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of ~~operators of~~ bone densitometry equipment operators for practice at entry level into the profession. ARRT administers the examination to state approved candidates under contractual arrangement with the state and provides the results directly to the state. This examination is not associated with any type of certification and registration by the ARRT.

ARRT determined the tasks that entry-level bone density equipment operators typically perform. The knowledge and skills covered by the examination were determined by administering a comprehensive practice analysis survey to a nationwide sample of bone densitometrists-density technologists. From this survey, and adopting a list of tasks was adopted for bone densitometry equipment operators known as the task inventory. The task inventory appears in Attachment A of this document.<sup>1</sup>

The content specifications identify the knowledge areas underlying performance of the tasks on the bone densitometry equipment operator task inventory. Every content category can be linked to one or more activities on the task inventory.

The table below presents the major categories covered on the examination covers, along with and the number of test questions in each category. The remaining pages of this document list the specific topics addressed within each category. are addressed in the remaining pages of the content specifications.

| Section          | Number of Scored Questions <sup>2</sup> |
|------------------|---|
| Patient Care     | 12                                      |
| Safety           | 8                                       |
| Image Production | 165                                     |
| Procedures       | 245                                     |
| <b>Total</b>     | <b>60</b>                               |

<sup>1</sup> A special debt of gratitude is due to the hundreds of professionals participating in the project as committee members, survey respondents, and reviewers.

<sup>2</sup> The exam includes an additional 25 unscored (pilot) questions.



## Patient Care

### 1. Osteoporosis

- A. World Health Organization (WHO) Definition
- B. Primary
- C. Secondary

### 2. Bone Physiology

- A. Functions of Bone
  - 1. structural support and protection
  - 2. storage of essential minerals
- B. Structural Anatomy
- C. Types of Bone
  - 1. cortical bone
  - 2. trabecular bone
- D. Bone Remodeling Cycle
  - 1. resorption/formation
  - 2. osteoblasts/osteoclasts
  - 3. factors affecting remodeling (\*e.g., age, hormones, pathology)

### 3. Bone Health and Patient Education

- A. Prevention and Treatment
  - 1. exercise
  - 2. nutrition
  - 3. smoking cessation
  - 4. fall prevention
  - 5. drug therapies/supplements
- B. Risk Factors
  - 1. controllable (\*e.g., smoking, alcohol, calcium, vitamin D, hormone therapy, medications)
  - 2. uncontrollable (e.g., genetics, ~~face~~, gender, age, medical conditions)

\*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.

### 4. Patient Preparation

- A. Patient Instructions and Explanation of Procedure
- B. Patient History
  - 1. medical history (e.g., bone disorder, hyperparathyroidism, prosthesis, peak height)
  - 2. medications use (e.g., long term steroid use, hormone therapy, osteoporosis treatment)
  - 3. current height and weight
  - 4. contraindications (e.g., recent contrast agents, calcium supplements,)
  - 5. possible pregnancy
  - 6. clinical indications/diagnosis and guidelines (Bone Mass Measurement Act)
- C. Patient Factors
  - 1. limited mobility or mental impairment/disabilities
  - 2. unusual/variant anatomy, pathology, or body habitus
  - 3. removable artifacts
  - 4. pediatric patients
- D. Operator Ergonomics
  - 1. body mechanics (e.g., balance, alignment, movement)
  - 2. patient transfer techniques
- E. Infection Control (e.g., disinfect work area and equipment)

\*e.g., is used to indicate examples of the topics covered, but not a complete list

## Safety

### 1. Fundamental Principles

- A. ALARA
- B. Basic Methods of Protection
  - 1. time
  - 2. distance
  - 3. shielding

### 2. Biological Effects of Radiation

- A. Long-Term Effects
- B. Radiosensitive Tissues/Organs

### 3. Units of Measurement

- A. Absorbed Dose (e.g., mGy)
- B. Effective Dose Equivalent (e.g., mSv)

### 4. Radiation Protection

- A. General Protection Issues
  - 1. radiation signs posted
  - 2. door closed

- 3. limit unnecessary people in room
- B. Occupational Protection
  - 1. scanner-operator distance
  - 2. personnel monitoring
  - 3. exposure records
- C. Patient Protection
  - 1. comparison levels of radiation
    - a. peripheral DXA
    - b. axial DXA
    - c. natural background radiation
  - 2. strategies to minimize patient exposure
    - a. patient instructions
    - b. correct exam performance performed



## Image Production

### 1. Fundamentals of X-ray Production

- A. Properties of X-ray Beam (e.g., scatter, mass, wavelength, frequency)
- B. X-ray Energy Production

### 2. DXA Systems

- A. Dual Photon Energies
- 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~~
  - 2. geometry ~~of fan beam~~

### 3. Quality Control (QC)

- A. Equipment Safety (e.g., electrical, pinch points, emergency stop)
- B. Use of Phantoms
  - 1. frequency
  - 2. types
- C. ~~Re~~Ccalibration (e.g., relocation, ~~repair~~)
  - 1. ~~recalibration~~
  - 2. ~~cross-calibration (e.g., new scanner, software upgrade)~~
- D. Troubleshooting and Actions
  - 1. shift or drift
  - 2. pass/fail criteria
  - 3. need for service
- E. Record Maintenance

### 4. Measuring BMD

- A. Scan Analysis Algorithm
  - 1. bone edge detection
  - 2. definition and calculation of BMC, area, and BMD
- B. Basic Statistical Concepts
  - 1. mean
  - 2. standard deviation (SD)
  - 3. coefficient of variation (%CV)
- C. Reporting Patient Results
  - 1. Z-score
  - 2. T-score
  - 3. WHO diagnostic criteria
- D. Report Settings (e.g., disable/enable auto analysis)
- ~~E~~D. FRAX® (WHO Fracture Risk Assessment Tool)
- ~~F~~E. Vertebral Fracture Assessment (VFA)
- ~~G~~. Trabecular Bone Score (TBS)
- ~~H~~F. Pediatric/Adolescent Scanning (ages 5-19)
- I. Whole body DXA (e.g., body composition, bone density)

### 5. Determining Quality in BMD

- A. Precision
- B. Accuracy
- C. Factors Related to Accuracy and Precision
  - 1. scanner (e.g., speed/mode)
  - 2. operator
    - a. in vivo precision study (e.g., LSC)
    - b. positioning
  - 3. patient variables (e.g., body habitus, variant anatomy)

### ~~6. File and Database Management~~

#### ~~A. Storage and Retrieval of Data~~

#### ~~B. Back-up and Archiving~~

### 6. Informatics

- A. Backup, Archive, and Import Data
  - 1. PACS/MIMPS
  - 2. DICOM
  - 3. external hard drive/DVD
  - 4. network
- B. Medical Information Systems (e.g., HIS, RIS, EMR)



## Procedures

### 1. DXA Scanning of Lumbar Spine

- A. Anatomy
  - 1. regions of interest (ROI)
  - 2. bony landmarks
  - 3. radiographic appearance
  - 4. significant adjacent structures (e.g., pelvis, ribs, T12)
- B. Scan Acquisition
  - 1. patient instructions
  - 2. patient positioning
  - 3. compensation for variations in anatomy, body habitus, pathology, or low bone density
- C. ~~Common Problems~~ **Special Considerations and Potential Causes**
  - 1. poor bone edge detection
  - 2. nonremovable artifacts
  - 3. variant anatomy
  - 4. fractures or pathology
  - 5. aortic and other calcifications

- D. Scan Analysis
  - 1. accurate ROI placement
  - 2. BMC, area, and BMD
  - 3. T-score, Z-score
  - 4. graphical display
  - 5. ~~exclusion of vertebral~~ **exclusion**
  - 6. **window level**

- E. Follow-Up Scans
  - 1. ~~unit of comparison~~ **rate of change**
    - a. BMD
    - b. T-score, **Z-score**
  - 2. reproduce baseline study

### 2. DXA Scanning of Proximal Femur

- A. Anatomy
  - 1. regions of interest (ROI)
  - 2. bony landmarks
  - 3. radiographic appearance
  - 4. significant adjacent structures (e.g., pelvis)
- B. Scan Acquisition
  - 1. patient instructions
  - 2. femur selection (right versus left, or dual)
  - 3. patient positioning
    - a. femoral neck rotation
    - b. femoral shaft placement
  - 4. compensation for variations in anatomy, body habitus, pathology, or low bone density
- C. **Special Considerations** ~~Common Problems and Potential Causes~~
  - 1. poor bone edge detection

- 2. nonremovable artifacts
- 3. variant anatomy (e.g., short femoral neck, inadequate space between ischium and femur)
- 4. fractures or pathology

- D. Scan Analysis
  - 1. accurate ROI placement
  - 2. BMC, area, and BMD
  - 3. T-score, Z-score
  - 4. graphical display
  - 5. **window level**

- E. Follow-Up Scans
  - 1. ~~unit of comparison~~ **rate of change**
    - a. BMD
    - b. T-score, **Z-score**
  - 2. reproduce baseline study

### 3. DXA Scanning of Forearm

- A. Anatomy
  - 1. regions of interest (ROI)
  - 2. bony landmarks
  - 3. radiographic appearance
  - 4. significant adjacent structures (e.g., carpal bones, soft tissue)

- B. Scan Acquisition
  - 1. patient instructions
  - 2. selection (right versus left)
  - 3. forearm length
  - 4. patient positioning
  - 5. compensation for variations in anatomy, body habitus, pathology, or low bone density

- C. **Special Considerations** ~~Common Problems and Potential Causes~~
  - 1. poor bone edge detection
  - 2. nonremovable artifacts
  - 3. variant anatomy
  - 4. fractures or pathology

- D. Scan Analysis
  - 1. accurate ROI placement
  - 2. BMC, area, and BMD
  - 3. T-score, Z-score
  - 4. graphical display
  - 5. **window level**

- E. Follow-Up Scans
  - 1. **rate of change**
    - a. BMD
    - b. T-score, **Z-score**
  - 2. **reproduce baseline study**