



# Bone Densitometry Equipment Operator

The purpose of the *Bone Densitometry Equipment Operator Examination*, which is made available to state licensing agencies, is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of operators of bone densitometry equipment at entry into the profession. The 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.

The knowledge and skills covered by the examination were determined by administering a comprehensive practice analysis survey to a nationwide sample of bone density equipment operators. The results of the practice analysis are reflected in this document.<sup>1</sup>

The *Task Inventory for Bone Densitometry Equipment Operator* appears in *Attachment A* of this document. The content specifications identify the knowledge areas underlying performance of the tasks on the *Task Inventory for Bone Densitometry Equipment Operator*. 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, along with the number of test questions in each category. The remaining pages of this document list the specific topics addressed within each category.

<b>Section</b>	<b>Number of Scored Questions<sup>2</sup></b>
Patient Care	12
Safety	8
Image Production	15
Procedures	<u>25</u>
<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 15 unscored (pilot) questions.



## Patient Care

### 1. Osteoporosis

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

### 2. Bone Physiology

- A. Functions of Bone
  - 1. structural support and protection
  - 2. storage of essential minerals
- B. Types of Bone
  - 1. cortical bone
  - 2. trabecular bone
- C. Bone Remodeling Cycle
  - 1. resorption/formation
  - 2. osteoblasts/osteoclasts

### 3. Bone Health and Patient Education

- A. Nutrition
- B. Exercise
- C. Risk Factors
  - 1. controllable (\*e.g., smoking, alcohol, calcium, vitamin D, hormone therapy, medications)
  - 2. uncontrollable (heredity, race, gender, age, medical conditions)

### 4. Patient Preparation

- A. Patient Instructions and Explanation of Procedure
- B. Patient History
  - 1. medical history (e.g., bone disorder, prosthesis, peak height)
  - 2. contraindications (e.g., contrast agents, calcium supplements, pregnancy)
  - 3. clinical indications and guidelines (Bone Mass Measurement Act)
- C. Patient Factors
  - 1. limited mobility or mental impairment
  - 2. unusual anatomy, pathology, or body habitus
  - 3. removable artifacts
  - 4. pediatric patients

\* 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.

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## 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., Rad/Gray)
- B. Exposure (e.g., Rem/Sievert)

### 4. Radiation Protection in BD

- A. General Protection Issues
  - 1. radiation signs posted
  - 2. door closed
  - 3. only patient and operator 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



## **Image Production**

### **1. Fundamentals of X-ray Production**

- A. Properties of X-ray Beam
  - 1. quality (kVp)
  - 2. quantity (mA)
  - 3. duration/time (S)
- B. Filters and Collimators
- C. X-ray Energy Production
- D. Fan Beam DXA Systems

### **2. Quality Control**

- A. Equipment Safety (electrical, pinch points, emergency stop)
- B. Use of Phantoms and/or Calibration
- C. DXA Calibration
  - 1. in vivo precision study
  - 2. cross-calibration
- D. Troubleshooting
  - 1. shift or drift
  - 2. pass/fail
  - 3. need for service
- E. Record Maintenance

### **3. Measuring BMD**

- A. Basic Statistical Concepts
  - 1. mean
  - 2. standard deviation
  - 3. coefficient of variation
- B. Reporting Patient Results
  - 1. BMD formula
  - 2. Z-score
  - 3. T-score
- C. FRAX<sup>®</sup> (WHO Fracture Risk Assessment Tool)
- D. Vertebral Fracture Assessment (VFA)
- E. Pediatric/Adolescent Scanning (ages 5-19)

### **4. Determining Quality in BMD**

- A. Precision
- B. Accuracy
- C. Factors Affecting Accuracy and Precision
  - 1. scanner
  - 2. operator
  - 3. patient variables

### **5. File and Database Management**

- A. Storage and Retrieval of Data
- B. Back-up and Archiving



## Procedures

### 1. DXA Scanning of Lumbar Spine

- A. Anatomy
  - 1. regions of interest
  - 2. bony landmarks
  - 3. radiographic appearance
  - 4. adjacent structures
- B. Scan Acquisition
  - 1. patient instructions
  - 2. patient positioning
  - 3. evaluating pre-set scan parameters
- C. Scan Analysis
  - 1. accurate ROI placement
  - 2. BMC, area, and BMD
  - 3. T-score, Z-score
- D. Common Problems
  - 1. poor bone edge detection
  - 2. nonremovable artifacts
  - 3. variant anatomy
  - 4. fractures or pathology
- E. Follow-Up Scans
  - 1. unit of comparison
    - a. BMD
    - b. T-score
  - 2. reproduce baseline study

### 2. DXA Scanning of Proximal Femur

- A. Anatomy
  - 1. regions of interest
  - 2. bony landmarks
  - 3. radiographic appearance
  - 4. adjacent structures
- B. Scan Acquisition
  - 1. patient instructions
  - 2. patient positioning
  - 3. evaluating pre-set scan parameters
- C. Scan Analysis
  - 1. accurate ROI placement
  - 2. BMC, area, and BMD
  - 3. T-score, Z-score
- D. Common Problems
  - 1. poor bone edge detection
  - 2. nonremovable artifacts
  - 3. variant anatomy
  - 4. fractures or pathology

- E. Follow-Up Scans
  - 1. unit of comparison
    - a. BMD
    - b. T-score
  - 2. reproduce baseline study

### 3. DXA Scanning of Forearm

- A. Anatomy
  - 1. regions of interest
  - 2. bony landmarks
  - 3. radiographic appearance
  - 4. adjacent structures
- B. Scan Acquisition
  - 1. patient instructions
  - 2. patient positioning
  - 3. evaluating pre-set scan parameters
  - 4. selection (right versus left)
- C. Scan Analysis
  - 1. accurate ROI placement
  - 2. BMC, area, and BMD
  - 3. T-score, Z-score
- D. Common Problems
  - 1. poor bone edge detection
  - 2. nonremovable artifacts
  - 3. variant anatomy
  - 4. fractures or pathology
- E. Follow-Up Scans
  - 1. unit of comparison
    - a. BMD
    - b. T-score
  - 2. reproduce baseline study



**Attachment A**  
**Task Inventory for Bone Densitometry Equipment Operator**

<b>Activity</b>	<b>Content Categories</b>
	Legend: PC = Patient Care S = Safety, IP = Image Production, P = Procedures
1. Perform routine QC tests on scanning equipment according to manufacturer guidelines.	IP.2.
2. Inspect and interpret results of routine QC tests and determine need for corrective action.	IP.2.D.
3. Arrange for corrective action or repairs based on the results of the QC tests.	IP.2.D.3.
4. Record results of QC tests in binder, chart, or database.	IP.2.E.
5. Inspect equipment to make sure it is safe and operable (*e.g., cables, cords, table pads).	IP.2.A.
6. Troubleshoot mechanical problems of scanning equipment.	IP.2.D.
7. Perform an in vivo precision study.	IP.2.C.1.
8. Ensure that cross-calibration between new/existing machines is performed as needed.	IP.2.C.2.
9. Clean and disinfect work area.	PC.4.
10. Direct patients to where they can find more information about low bone density.	PC.1., PC.2., PC.3.
11. Answer basic questions put forth by the patient or family members (or refer them to the appropriate resources) concerning bone health, fall prevention, exercise, and nutrition.	PC.1., PC.2., PC.3.
12. Explain procedure of DXA exam including positioning, duration, and notification policy of results.	PC.4.A.
13. Record patient history relevant to bone densitometry.	PC.4.B.
14. Verify current clinical indications meet specifications of CMS billing and coding guidelines if appropriate.	PC.4.B.3.
15. Determine if patient has recently received a radiopaque contrast agent or radionuclide.	PC.4.B.2.
16. Determine if patient has recently ingested contraindicated medications or supplements (e.g., calcium).	PC.4.B.2.
17. Question female patients of childbearing age about possibility of pregnancy.	PC.4.B.2.
18. Measure and record patient's current height and weight.	PC.4.B.1.
19. Ask patients about their peak height.	PC.4.B.1.

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### Content Categories

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### Activity

20. Determine if patient anatomy, pathology, or other limitations require special consideration in patient positioning.	PC.4.C.2.
21. Ensure that artifact-producing objects (e.g., zippers, buttons, jewelry) within scan area have been removed from the patient.	PC.4.C.3.
22. Prevent unnecessary persons from remaining in the area during x-ray exposure.	S.4.
23. Take appropriate precautions to minimize occupational x-ray exposure.	S.
24. Take appropriate precautions to minimize x-ray exposure to patient.	S.
25. Provide mobility assistance to patients with disabilities or limited mobility.	PC.4.C.
26. Assist patient onto and off the scanning table.	PC.4.C.
27. Review patient records and provider's request to determine appropriate anatomical sites to scan.	PC.4.B.
28. Review prior scans and reproduce patient positioning during follow-up scan appointments.	IP.4., P.1.E., P.2.E., P.3.E.
29. Select appropriate immobilization devices or positioning aids.	P.1.B., P.2.B., P.3.B.
30. Record positioning details in patient records to ensure consistency.	P.1.B., P.2.B., P.3.B.
31. Enter accurate patient data necessary to initiate scan to utilize correct reference data.	IP.3.
32. Select appropriate exam modes and perform necessary scans.	IP.
33. Position patient to scan desired region of interest (ROI) using bony landmarks and surface anatomical features.	P.1.A., P.2.A., P.3.A.
34. Evaluate accuracy of vertebral labels and intervertebral markers for scan of lumbar spine and modify if necessary.	P.1.C.
35. Evaluate automatic placement of region of interest (ROI) and modify if necessary.	P.1.C, P.2.C., P.3.C.
36. Enhance or modify image appearance.	P.1.D., P.2.D., P.3.D.
37. Compare bone density measurements from two different occasions (for same patient) to assess changes over time.	P.1.E., P.2.E., P.3.E.
38. Evaluate scan results for technical problems (e.g., incorrect scan mode or site) and take corrective action.	IP.4.



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### Activity

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- |   |                        |
|---|------------------------|
| 39. Review scan results to identify bone density measurements that may be inaccurate due to artifacts, unusual anatomy, pathology, or positioning problems and rescan if necessary. | P.1.D., P.2.D., P.3.D. |
| 40. Review scan results to determine if scanning an additional site is required in order to obtain more precise bone density measurements.  | IP.4.                  |
| 41. Identify bone density measurements that require interpreting provider's attention (e.g., low T-score, unreliable results).  | IP.3.A., IP.3.B.       |
| 42. Utilize FRAX <sup>®</sup> tool to assess 10-year fracture risk.   | IP.3.C.                |
| 43. Maintain patient records to include the archiving, copying, deleting, and retrieving functions.   | IP.5.                  |
| 44. Perform bone densitometry scans using a fan beam system.  | IP.1.                  |
| 45. Perform and analyze bone densitometry scans of the forearm utilizing DXA equipment.   | P.3.                   |
| 46. Perform and analyze bone densitometry scans of the proximal femur utilizing DXA equipment.  | P.2.                   |
| 47. Perform and analyze bone densitometry scans of the lumbar spine PA utilizing DXA equipment.   | P.1.                   |
| 48. Perform bone densitometry scans of the spine – VFA (vertebral fracture assessment).   | IP.3.D.                |
| 49. Perform and analyze bone densitometry scans on pediatric patients (ages 5-19) utilizing DXA equipment.  | IP.3.E.                |