



Bone Densitometry Equipment Operator

The purpose of the 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 bone densitometry equipment operators for practice at entry level.

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 administers this examination on a computer at a standardized testing center.

ARRT determined the tasks that entry-level bone densitometry equipment operators typically perform by administering a comprehensive practice analysis survey to a nationwide sample of bone densitometry technologists.¹ From this survey, a list of tasks was adopted for bone densitometry equipment operators known as the task inventory. The *Task Inventory for Bone Densitometry Equipment Operator* appears in Attachment A of this document.

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

The table below presents the major content categories that the examination covers, along with the number of test questions in each category. The content outline, which makes up the remaining pages of this document, addresses specific topics within each category.

Content Category	Number of Scored Questions²
Patient Care	13
Safety	8
Image Production	14
Procedures	<u>25</u>
Total	60

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

² 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, sex assigned at birth, race, age, medical conditions)

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. medication 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 disabilities
 - 2. variant anatomy, pathology, or body habitus
 - 3. remove 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. indicates examples of the topics covered, but is 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 (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 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
 - 2. geometry

3. Quality Control (QC)

- A. Equipment Safety (e.g., electrical, pinch points, emergency stop)
- B. Use of Phantoms
 - 1. frequency
 - 2. types
- C. Recalibration (e.g., relocation, repair, 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. Reconfigure Report Settings (e.g., disable/enable auto analysis)
- E. FRAX® (WHO Fracture Risk Assessment Tool)
- F. Vertebral Fracture Assessment (VFA)
- G. Trabecular Bone Score (TBS)
- H. Whole Body DXA (e.g., body composition)
 - 1. pediatric/adolescent (ages 5-19) (e.g., total body less head [TBLH])
 - 2. adult

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., least significant change [LSC])
 - b. positioning
 - 3. patient variables (e.g., body habitus, variant anatomy)

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 the Lumbar Spine

- A. Anatomy
 1. region 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 variation in anatomy, body habitus, pathology, or low bone density
- C. Special Considerations Related to Positioning, ROI Placement, and Analysis
 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. vertebral exclusion
 6. window level
- E. Follow-Up Scans
 1. rate of change
 - a. BMD
 - b. T-score, Z-score
 2. reproduce baseline study

2. DXA Scanning of the Proximal Femur

- A. Anatomy
 1. region 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 Related to Positioning, ROI Placement, and Analysis
 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. rate of change
 - a. BMD
 - b. T-score, Z-score
 2. reproduce baseline study

3. DXA Scanning of the Forearm

- A. Anatomy
 1. region 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 Related to Positioning, ROI Placement, and Analysis
 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



Attachment A

Task Inventory for Bone Densitometry Equipment Operator

Activity		Content Categories PC = Patient Care S = Safety IP = Image Production P = Procedures
1.	Perform routine QC tests on scanning equipment according to manufacturer guidelines.	IP:3
2.	Record results of QC tests in binder, chart, or electronic database.	IP:3.E
3.	Interpret results of routine QC tests and determine the need for corrective action.	IP:3
4.	Arrange for corrective action or repairs based on the results of the QC tests as needed.	IP:3.D
5.	Coordinate manufacturer software upgrades with field service engineer, when recommended.	IP:3.C
6.	Perform software updates, when prompted.	IP:3.C
7.	Troubleshoot equipment errors (e.g.,* contact manufacturer for guidance), if needed.	IP:3.D
8.	Troubleshoot computer software errors (e.g., contact manufacturer for guidance), as needed.	IP:3.D
9.	Inspect equipment (e.g., cables, cords, table pads) to make sure it is operable and safe.	IP:3.A
10.	Clean and disinfect work area, facilities, and equipment.	PC:4.E
11.	Educate staff operators, ancillary staff, or students regarding bone densitometry.	PC:1, PC:2, PC:3
12.	Verify current clinical indications meet specifications of billing and coding guidelines, if appropriate.	PC:4.B
13.	Review the examination request to verify information is accurate, appropriate, complete (e.g., patient history, clinical diagnosis, provider's orders), and determine anatomical sites to scan.	PC:4.B
14.	Import previously archived or baseline studies for direct comparison.	IP:6
15.	Explain examination instructions (e.g., positioning, duration, policy of results notification) to the patient, patient's family, or authorized representative.	PC:4.A
16.	Inform patients regarding basic drug therapies/supplements related to bone health or refer them to appropriate resources.	PC:3.A, PC:4.A
17.	Answer basic questions the patient, the patient's family, or authorized representative asks (or direct them to the appropriate resources) concerning bone health, fall prevention, exercise, and nutrition.	PC:1, PC:2, PC:3
18.	Answer basic questions the patient, the patient's family, or authorized representative asks (or direct them to appropriate resources) concerning radiation dose and its effects.	S:1, S:2, S:4.C
19.	Determine if the patient has recently had previous studies that may interfere with DXA.	PC:4.B

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



Activity		Content Categories PC = Patient Care S = Safety IP = Image Production P = Procedures
20.	Determine if the patient has recently ingested contraindicated medications or supplements (e.g., calcium).	PC:4.B
21.	Screen patients of childbearing age for the possibility of pregnancy and take appropriate action.	PC:4.B
22.	Record patient history relevant to bone densitometry.	PC:3.B, PC:4.B
23.	Ask adult patients about their peak height, maximum height, or height loss.	PC:4.B
24.	Measure and record the patient's current height and weight.	PC:4.B
25.	Use proper body ergonomics and patient transfer devices to promote patient and personnel safety.	PC:4.D
26.	Assist patients with disabilities or limited mobility.	PC:4.C, PC:4.D
27.	Review prior scans and reproduce patient positioning during follow-up scan appointments.	P:1.E, P:2.E, P:3.E
28.	Determine if patient anatomy, pathology, or other limitations require special consideration in patient positioning.	PC:4.C, P:1.C, P:2.C, P:3.C,
29.	Use positioning aids as needed to enhance the examination and promote patient comfort and/or safety.	PC:4.B, P:1.B, P:2.B, P:3.B
30.	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
31.	Record positioning details in patient records to ensure consistency.	IP:6, P:1.E, P:2.E, P:3.E
32.	Ensure that artifact-producing objects (e.g., zippers, buttons, jewelry, medical devices) within scan area have been removed from the patient, when possible.	PC:4.C
33.	Enter accurate patient data necessary to initiate the scan so the correct reference data is used.	IP:6, P:1.E, P:2.E, P:3.E
34.	Take appropriate radiation safety precautions to minimize occupational and patient exposure.	S:4.B, S:4.C
35.	Keep all unnecessary people out of the immediate area during radiation exposure.	S:4.A
36.	Select appropriate exam modes and perform necessary scans.	IP:1, P:1, P:2, P:3
37.	Perform bone densitometry scans using a fan beam system.	IP:2
38.	Perform and analyze bone densitometry scans of the lumbar spine – PA using DXA equipment.	P:1
39.	Perform bone densitometry scans of the spine – VFA (vertebral fracture assessment) using DXA equipment.	IP:4.F
40.	Perform and analyze bone densitometry scans of the proximal femur using DXA equipment.	P:2
41.	Perform and analyze bone densitometry scans of the forearm using DXA equipment.	P:3
42.	Perform postprocessing analysis to create the trabecular bone score (TBS).	IP:4.G



Activity		Content Categories PC = Patient Care S = Safety IP = Image Production P = Procedures
43.	Perform and analyze bone densitometry scans on pediatric patients (ages 5-19) using DXA equipment.	PC:4.C, P:1, P:2, P:3, IP:4.H
44.	Perform and analyze bone densitometry scans of pediatric patients – total body less head (TBLH) using DXA equipment.	PC:4.C, IP:4.H
45.	Perform and analyze bone densitometry scans of the whole body (e.g., determine body composition, determine bone density).	IP:4.I
46.	Enhance or modify image appearance (e.g., adjust window level).	P:1.D, P:2.D, P:3.D
47.	Evaluate automatic placement of region of interest (ROI) (e.g., vertebral body exclusions, hardware) and modify, if necessary.	IP:4.A, P:1.D, P:2.D, P:3.D
48.	Review scan results to identify bone density measurements that may be inaccurate due to artifacts, variant anatomy, pathology, or positioning errors and rescan if necessary.	IP:4.A, P:1.D, P:2.D, P:3.D
49.	Evaluate scan results for technical problems (e.g., incorrect scan mode or site) and take corrective action.	IP:5
50.	Review scan results/analysis to determine if scanning an additional site is required to obtain more precise bone density measurements.	IP:4, IP:5, P:1.D, P:2.D, P:3.D
51.	Evaluate accuracy of vertebral labels and intervertebral markers for scan of lumbar spine and modify if necessary.	P:1.D
52.	Compare follow-up bone density measurements from two different occasions (for the same patient) to assess changes over time.	P:1.E, P:2.E, P:3.E
53.	Identify bone density measurements that require the interpreting provider's attention (e.g., low T-score, unreliable results, change in patient history – new medication, recent fracture).	PC:3, PC:4.B, PC:4.C, IP:4, IP:5, P:1.C, P:2.C, P:3.C
54.	Identify exam-limiting patient anatomy or pathology (e.g., scoliosis, severe arthritis) that requires the interpreting provider's attention.	P:1.C, P:2.C, P:3.C
55.	Use FRAX® tool to assess 10-year fracture risk.	IP:4.E
56.	Operate electronic digital imaging devices and record keeping information technology system devices including PACS/MIMPS and medical information systems (e.g., HIS, RIS, EMR).	IP:6
57.	Reconfigure the report settings (e.g., disable/enable auto analysis), as needed (may need to contact the manufacturer for guidance).	IP:4.D
58.	Conduct system backup and archive (e.g., external hard drive, DVD, network/PACS/MIMPS, DICOM, cloud system) as recommended by the manufacturer.	IP:6.A
59.	Perform an in vivo precision study to calculate least significant change (LSC).	IP:5.C