Bone Densitometry Curriculum

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Introduction

The goal of this curriculum is to provide the professional community with a cognitive base of entry-level education in the practice of bone densitometry. The curriculum is suitable for all programs in this specialty, including limited fellowships, short-term certificate programs as well as collegiate-based education programs. The curriculum recognizes that the educational components are not static, but are representative of current practice and trends in the field. It is the responsibility of educators to incorporate new concepts and trends in the curriculum as they occur.

The curriculum is divided into specific content areas representing essential components of a bone densitometry educational program. No particular sequence is suggested. The content and objectives should be organized to meet the mission, goals and needs of each program. Faculty members are encouraged to expand and broaden these fundamental objectives as they incorporate them into their curricula. Specific instructional methods are intentionally omitted to allow for programmatic prerogative as well as creativity in instructional delivery.

The curriculum document consists of three sections: foundations, core content and clinical experience requirements. The foundations section represents an inventory of pre-existing knowledge and skills gained through an entry-level radiography educational experience and reinforced through professional practice. The content in the foundations section is intended to aid technologists in career planning and program managers in the development of preassessment tools for candidate selection.

The professional practice of bone densitometry requires specific knowledge and skills generally not obtained in basic educational programs in radiography. The core content section represents curriculum elements that are considered essential in educating technologists in the postprimary practice of bone densitometry.

The clinical experience requirements section is intended as a guide to the development of a well-rounded clinical experience. Information to aid in meeting the eligibility requirements for a postprimary certification examination in bone densitometry also is included in this section.

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Contents

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Foundations

Ethics and Law in the Radiologic Sciences
Content is designed to provide a fundamental background in ethics. The historical and philosophical basis of ethics, as well as the elements of ethical behavior, will be discussed. The student will examine a variety of ethical issues and dilemmas found in clinical practice.

An introduction to legal terminology, concepts and principles also will be presented. Topics include misconduct, malpractice, legal and professional standards and the ASRT scope of practice. The importance of proper documentation and informed consent is emphasized.

Human Diversity
Content is designed to promote better understanding of patients, the patients' families and professional peers through comparison of diverse populations based on their value systems, cultural and ethnic influences, communication styles, socioeconomic influences, health risks and life stages. Content will include the study of factors that influence relationships with patients and professional peers. Understanding human diversity assists the student in providing better patient care.

Human Structure and Function
Content is designed to establish a knowledge base in surface and bony anatomy.

Patient Assessment, Management and Education
Content introduces a model for clinical thinking to aid in patient assessment. Content includes a focus on the application of normal anatomy and physiological phenomena to ill and injured individuals. Interviewing skills and assessment techniques with clinical focus will be discussed. An emphasis on the analysis and interpretation of physiological data to assist in patient assessment and management will be introduced.

Patient Care in Radiologic Science
Content is designed to provide the basic concepts of patient care, including consideration for the physical and psychological needs of the patient and family. Routine and emergency patient care procedures will be described, as well as infection control procedures using standard precautions. The role of the radiographer in patient education will be identified.

Patient Information Management
Content is designed to provide the basic concepts of patient information management. Medical records management including privacy and regulatory issues will be examined. The role of the technologist in managing patient information will be identified and discussed.

Quality Management
Content is designed to impart an understanding of quality management activities of a typical radiology department. Benefits of a quality management program to the patient and department will be presented. Tools, procedures and evaluation criteria used in the performance assessment of imaging modalities and image processing will be discussed.

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Radiation Protection

Content is designed to present an overview of the principles of radiation protection including the responsibilities of the radiographer for patients, personnel and the public. Radiation health and safety requirements of federal and state regulatory agencies, accreditation agencies and health care organizations are incorporated.

Refer to Appendix A for a detailed list of objectives for each content area.

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Core Content

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Bone Densitometry Overview

Description

Content establishes a basic knowledge of bone densitometry and its purposes. The techniques from the past and present are explained, with an emphasis on dual-energy x-ray absorptiometry (DXA) and how it compares with conventional radiography.

Objectives

1. Define bone densitometry.
2. Discuss the various uses for bone densitometry.
3. Explain the historical and current techniques, including peripheral adaptations.
4. Discuss and evaluate advantages and disadvantages of DXA.
5. Compare and contrast DXA to conventional radiography.

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Content

I. Bone Densitometry

A. Definition

B. Uses
   1. Quantitative measurement of bone density
   2. Monitor therapy
   3. Predict future fracture risk
   4. Other

C. DXA
   1. Most versatile method
   2. Advantages
      a. Low radiation dose
      b. High-resolution images
      c. Good precision
      d. Stable calibration
      e. Other
   3. Disadvantages
      a. Higher cost for equipment and scans
      b. Generally not portable
      c. More operator training and skill required
      d. Other

D. DXA compared with conventional radiography
   1. Only two x-ray photon energies used
   2. Computer manipulation required
   3. Images used for positioning and region of interest (ROI), not for diagnosis
   4. Manufacturer-specific operation
   5. Low radiation dose

II. Technique History and Overview

A. Radiographic absorptiometry (RA)

B. Radiogammetry

C. Quantitative computed tomography (QCT)

D. Single and dual photon absorptiometry (SPA/DPA)

E. Single and dual-energy x-ray absorptiometry (SXA/DXA)

F. Quantitative ultrasound (QUS)

G. Peripheral skeleton adaptations

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Bone Density Laboratory Organization, Record Keeping and Quality Improvement

Description

Content establishes basic guidelines for bone density laboratory organization, record keeping and quality improvement. Emphasis is on reception training and organization, scanning room setup, proper record keeping procedures, quality control monitoring and staff communication.

Objectives

1. Identify reception staff responsibilities and training needs.
2. Identify sources of patient education materials appropriate for the reception area.
3. List accessory equipment and documents that should be readily accessible in the patient scanning room.
4. Apply good charting rules to written records.
5. Identify patient, scanner and personnel records that should be documented and stored.
6. Set up a quality improvement program.

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Content

I. Reception Area

A. Staff responsibilities and training
   1. Scheduling protocol
   2. Patient preparation instructions
   3. Patient medical history form distribution
   4. Insurance coding and billing

B. Literature for patient education
   1. Sources
      a. National Osteoporosis Foundation
      b. Pharmaceutical companies
      c. Government agencies
      d. Others

II. Scanning Room

A. Manufacturer patient positioning aids accessible and in good repair
   1. Additional equipment
      a. Caliper for measuring patient thickness if required by manufacturer
      b. Pillows, positioning sponges, restraint devices

B. Manufacturer quality control phantoms

C. Manufacturer operator's manual for each specific scanner model

III. Record Keeping

A. Charting rules
   1. All entries legible, dated and initialed
   2. Corrections legible, dated and initialed
      a. No liquid erasure
   3. All repeat scans or analyses documented with reason and date

B. Patient records
   1. Scan log filled out at time of scanning
      a. Patient and technologist identification
      b. Scans performed
      c. Electronic file name and archive location
      d. Comments about unusual positioning, scanning or analysis procedures
   2. Hard copies of scans
   3. Physician's report and other correspondence
   4. State, local and institutional policies regarding how long to keep records

C. Scanner records
   1. Quality control binder
      a. Daily phantom plots and other quality control printouts
      b. Installation and upgrade records

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c. Preventive maintenance and repair records

D. Personnel records
1. Resumes or curriculum vitae
2. Licenses required for scanning or reporting by state and county
3. Training records
4. Signature and initial form

IV. Quality Improvement

A. Monitoring by designated quality control staff
1. Scanner quality control data
2. Patient scan acquisition and analysis
3. Patient education, flow through lab and satisfaction
4. Patient report distribution and other interactions with referring physicians
5. Staff training
6. Record keeping

B. Communication via regular staff meetings
1. Discuss and resolve quality control issues
2. Determine and document routine protocols with reporting physician
a. Who chooses anatomical sites to scan?
1) Referring physician
2) Laboratory routine
3) Specific to diagnosis or history
b. Areas in which the radiologic technologist may alter the routine
1) Which side of body to scan
2) How to analyze variant numbers of standard four vertebrae
3) Arthritis
4) Vertebral fracture or deformity
5) Scoliosis
6) Degenerative changes
7) Aortic or other calcifications
8) Surgery

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Bone Remodeling and Osteoporosis

Description

Content establishes a knowledge of bone remodeling and how a remodeling imbalance produces the disease osteoporosis. Osteoporosis is defined and its consequences, risk factors, prevention and treatment discussed. The diagnosis of osteoporosis by DXA is developed through definition and discussion of reference populations, T-score, Z-score, World Health Organization (WHO) criteria and fracture risk assessment.

Objectives

1. Describe cortical and trabecular bone and locations with a high percentage of each.
2. Describe the bone remodeling sequence, how it changes throughout the lifespan and factors that affect remodeling.
3. Discuss how the definition of osteoporosis has evolved over time.
4. Compare and contrast the reference populations available for DXA.
5. Define and contrast young normal peak bone mass and age-adjusted bone mass.
6. Define a standard deviation and relate it to a Z-score and T-score.
7. Define the WHO criteria for diagnosis of osteoporosis and discuss its advantages and disadvantages.
8. Discuss fracture risk assessment.
9. Identify the consequences of osteoporosis.
10. Describe and discuss the risk factors, prevention and treatment of osteoporosis.

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Content

I. Bone Remodeling

A. Types of bone
   1. Cortical
      a. Relevant anatomical sites with high percentage
   2. Trabecular
      a. Relevant anatomical sites with high percentage
   3. Ratio of cortical to trabecular bone in total body

B. Remodeling sequence
   1. Bone resorption
   2. Bone formation

C. Bone mass throughout the lifespan
   1. Bone accrual
   2. Peak bone mass
   3. Postmenopausal bone loss
   4. Bone loss in the elderly

D. Factors that affect remodeling
   1. Calcium
   2. Vitamin D
   3. Estrogen
   4. Other hormones

E. Factors that affect peak bone mass
   1. Genetics
   2. Diet
   3. Exercise
   4. Disease

II. Osteoporosis

A. Definitions
   1. Historically based on fragility fracture
   2. 1990 Consensus Development Panel
   3. 1994 WHO criteria

B. Diagnosis by DXA
   1. Reference populations
      a. Manufacturer specific
      b. National Health and Nutrition Examination Survey (NHANES) for total hip
      c. Young normal peak bone mass
      d. Age-adjusted bone mass
   2. Standard deviations
      a. Z-score
      b. T-score

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c. WHO criteria
1) Clinical need for cutpoint definition
2) Disadvantages of cutpoint definition
3. Fracture risk assessment

C. Consequences
1. Fragility fractures
a. Wrist
b. Spine
c. Hip
d. Other
2. Chronic complications of fracture
a. Kyphosis
b. Pain
c. Digestive difficulties
d. Pulmonary compromise
e. Ambulation difficulties
f. Depression
g. Loss of self-esteem
h. Loss of independence or nursing home admission
i. Increased risk for subsequent fractures
3. Acute complications of fracture
a. Hospitalization
b. Surgery
c. Infection
d. Thromboembolism
e. Death
1) Secondary to acute and chronic complications
2) Increased mortality due to hip fracture

D. Risk factors
1. Gender
2. Age
3. Race/ethnicity
4. Menopause
5. Family history and genetics
6. Use of certain medications
7. Presence of certain diseases or conditions
8. Lifestyle
9. Low calcium intake
10. Build
11. Propensity to fall
12. Smoking
13. Alcohol abuse

E. Prevention

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1. Exercise
2. Diet
3. Hormone replacement therapy
4. Other medications

F. Treatment
   1. Mechanisms of action
      a. Decrease rate of bone resorption
      b. Actively build new bone
   2. Estrogens
      a. Mechanism
      b. Oral
         1) Major brand names
      c. Transdermal
         1) Major brand names
      d. Vaginal
         1) Major brand names
   3. Bisphosphonates
      a. Mechanism
      b. Major brand names
   4. Selective Estrogen Receptor Modulator (SERM)
      a. Mechanism
      b. Major brand names
   5. Calcitonin
      a. Mechanism
      b. Major brand names
   6. Parathyroid hormone
      a. Mechanism
      b. Major brand names
   7. Calcium
      a. Mechanism
      b. Different forms
      c. Major brand names
   8. Vitamin D
      a. Mechanism
      b. Sunlight
      c. Supplementation
   9. Others
      a. Fluoride
      b. Others under development

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Computers and Networks

Description
Content establishes a basic knowledge of the personal computer (PC) as used in DXA scanning. PC components and operating systems are described and demonstrated. Database concepts and backup procedures are discussed. Computer networks and image file transfer applications are described.

Objectives
1. Define a computer as it pertains to DXA instrumentation.
2. Contrast the concepts of computer hardware and software.
3. List the hardware and software components of a PC and categorize them into functional groups, with emphasis on components required by DXA scanners.
4. Understand the methods by which the PC interfaces with the DXA scanner and how the scanner output is converted into and stored as digital data.
5. Describe file naming conventions and the tree structure of data organization.
6. Understand and demonstrate basic Windows® point and click and drag and drop techniques.
7. Describe the internal organization of computer data and the concept of a relational database as it applies to DXA scanners.
8. Explain the importance of periodic data backup and the basic concepts of copying and archiving DXA data.
9. Describe the application of networking for file and image transfer to DXA (optional).

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Content

I. Basic Concepts

A. Computer

B. Hardware

C. Software

II. Hardware Components

A. Central processing unit (CPU)

B. Memory

C. Input and output devices
   1. Keyboard and mouse
   2. Drives and naming conventions
   3. Graphics boards
   4. Printers

D. Data storage

E. Scanner detector interface and communications
   1. Analog-digital converter
   2. Scanner interface board

III. Software Components

A. Operating system

B. Application programs

C. Data files

IV. Windows® Operating System

A. Hardware
   1. Mouse
      a. Point and click
      b. Drag and drop

B. Software
   1. Versions
   2. Desktop icons and shortcuts
   3. Start menu
      a. Programs
      b. Help
      c. Shut down
   4. Taskbar

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C. DXA software
    1. Startup and exit
    2. Scan and database archiving

V. Backup and Archive Procedures

A. Differences between backup, archive, copy and move in DXA software

B. Why and when

C. Types
    1. Complete
    2. Incremental
    3. Differential

VI. DXA Networks and Data Transfer [Optional]

A. Basic concepts of computer networks
    1. Why and when
    2. Shared resources
    3. Modem
    4. Transport protocols
    5. Terminology
        a. Local area network (LAN)
        b. Wide area network (WAN)
        c. Digital Imaging and Communications in Medicine (DICOM)

B. DXA applications
    1. Network scanners and workstations
    2. Remote access
        a. Image, scan file and database transfer
        b. Backup and archive
    3. Security
        a. Passwords and access rights

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Forearm DXA Scanning

Description
Content establishes a base of knowledge for competent performance of forearm scans with a table DXA scanner. (See Peripheral Bone Densitometry course for peripheral technologies.) The relevant skeletal anatomy and pathology, patient positioning and scan acquisition, analysis and reporting are described and demonstrated. Common problems are discussed.

Objectives
1. Identify and label gross anatomical structures of the skeleton relevant to forearm positioning and scan analysis.
2. Describe and demonstrate correct selection of scanning parameters.
3. Describe and demonstrate correct forearm positioning.
4. Describe and demonstrate correct scan acquisition.
5. Describe and demonstrate correct scan analysis, including standard placement of ROIs.
6. Describe common positioning, acquisition and analysis problems and possible solutions.
7. Explain the scan report.

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Content

I. Gross Anatomy and Pathology

A. Bones and bony landmarks
   1. Radius
      a. Styloid process
      b. Distal cortical endplate
   2. Ulna
      a. Olecranon process
         1) How to palpate
      b. Styloid process
         1) How to palpate
   3. Carpal bones
      a. Scaphoid
      b. Lunate

B. Common pathology
   1. Colle's fracture
   2. Arthritis

II. Scan Acquisition

A. Select appropriate forearm
   1. Dominant vs. nondominant
   2. Fractures or surgical procedures
   3. Arthritis or congenital anomalies
   4. Prolonged immobilization

B. Select scan parameters according to manufacturer specifications
   1. Adjust field width to include air

C. Position patient and scan
   1. Measure forearm length only once and record
   2. Designate one stable chair
   3. Stabilize forearm
      a. Restraining devices cannot be in scan field
   4. Common scan problems
      a. 33% radius or ulna styloid not in scan field
      b. Forearm not straight and centered
      c. Motion

III. Scan Analysis and Report

A. Various locations for radius and ulna ROI
   1. 33% based on length of ulna
   2. Ultradistal radius based on cortical endplate

B. Common analysis problems
   1. Manual correction to ultradistal bone edges

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2. Small ROI areas very sensitive to changes in positioning or bone edge detection

C. Report
1. Define regions

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Instrument Quality Control

Description

Content establishes a basic knowledge of quality control (QC) methods and procedures for bone densitometry instruments, particularly DXA scanners. Phantom measurement methods, plotting longitudinal QC data, applying statistical and Shewhart rules and making proper pass or fail decisions are demonstrated. QC procedures for scanner maintenance, repair, relocation, software modification or upgrade are described.

Objectives

1. Define QC.
2. Discuss the purpose and importance of instrument QC in bone densitometry.
3. Demonstrate manufacturer-specific QC procedures for at least one model of scanner.
4. Identify several types of QC phantoms.
5. Create a longitudinal QC plot of phantom data.
6. Apply correct statistical and Shewhart rules to a QC plot.
7. Apply correct pass or fail criteria to QC data from at least one model of scanner.
8. Describe proper QC procedures for preventive maintenance, repair, relocation, software modification or scanner upgrade.

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Content

I. Basic Concepts

A. Definition of QC

B. Purpose
   1. Monitor scanner function and calibration
   2. Timely repairs and recalibration

C. Importance
   1. Effects of scanner function and calibration on patient results

II. Phantom Methods and Procedures

A. Manufacturer-specific QC
   1. Operator's manual
   2. Position, acquire, analyze and interpret consistently
   3. Frequency of performance
   4. QC data archive

B. Types of phantoms
   1. Calibration block
   2. Anthropomorphic or semi-anthropomorphic
      a. Hydroxyapatite spine and hip block
      b. Aluminum spine
      c. Others

C. Statistics
   1. Average (mean)
   2. Standard deviation (SD)
   3. Percent coefficient of variation (% CV or CV)
   4. Shewhart rules

D. Longitudinal QC plots
   1. Automated
   2. Hand graph
   3. Shewhart control chart

E. Pass or fail criteria
   1. When to repeat QC test
   2. When to postpone scanning and contact service provider

III. Scanner Maintenance, Repair and Upgrade

A. Preventive maintenance

B. Relocation, repair or hardware and software modification
   1. Calibration check and reset
   2. Re-establish QC plot mean and standard deviation

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C. Upgrade to new scanner
    1. Intramanufacturer
        a. Cross-calibrate new scanner to old
        b. Re-establish QC plot mean and standard deviation
    2. Intermanufacturer
        a. Not recommended
        b. Apply standardized BMD (sBMD) formulas with caution
        c. Re-establish QC plot mean and standard deviation

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Patient Care and Preparation for DXA Scanning

Description
Content establishes basic guidelines for patient care and safety during DXA scanning and patient and scanner preparation for baseline and follow-up scanning. Equipment safety guidelines are discussed.

Objectives
1. Design and provide a safe environment for the DXA patient.
2. List specific steps to prevent patients from falling.
3. Describe proper care for patients with special needs.
4. Explain the DXA scan procedures accurately and thoroughly to a patient.
5. Describe correct patient preparation and enlist the patient's cooperation to produce a scan free of motion and artifacts.
6. Design, collect, record and interpret a relevant DXA history.
7. Recognize and compensate for physical conditions that adversely affect DXA.
8. Document relevant patient history, extraordinary scanning procedures and sources of error for the reporting physician.
9. List necessary steps for producing a follow-up scan that is comparable to baseline.
10. Discuss DXA equipment safety, including electrical safety.
11. List applicable state DXA scanner registration and inspection requirements.
12. Demonstrate use of scanner emergency stop button and location of pinch points.

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Content

I. Patient Preparation

A. Care and safety
1. Fall prevention
   a. Wheelchair ramps
   b. Clear walkways
   c. Long-handled shoe horn
   d. Assistance on and off table
   e. Step stool with handrail
      1) Check for vertigo before exiting table
2. Special needs
   a. Wheelchair, walker, stretcher
   b. IV pole, oxygen
   c. Parkinson's disease, Alzheimer's disease, mental impairment, pediatrics

B. Scan information
1. Staff introductions
2. Explain exam
   a. Movement and proximity of scanner arm
   b. Noise of motor
   c. Time
   d. Number and types of scans
   e. Reporting system
3. Discuss motion and breathing
4. Answer patient's questions

C. Clothing
1. Remove heavy, constricting clothing
2. Remove shoes if required by scanning device
3. Document nonremovable external or internal artifacts
4. Remove all metal from scan field

D. Relevant DXA history
1. Fracture
2. Surgery, prosthesis, implants
3. Metabolic and degenerative diseases
4. Recent radiopaque dye, radioisotope or barium
5. Pregnancy
6. Previous DXA scans
7. Medications and supplements
   a. Time of last calcium supplement
8. Physical activity level
9. Lifestyle choices

II. Scanning Preparation

A. Measure and record height and weight at every visit

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1. Effect of body habitus and weight change on DXA
2. Scan mode adjustment

B. Enter accurate patient information on computer screen(s)
1. How to correct after scanning

C. Recognize and compensate for difficult patients
1. Thin
2. Thick/obese
3. Large weight change between scans
4. Low bone density
5. Degenerative disease
6. Very elderly

D. Motion prevention
1. Restraining and positioning devices

E. Document extraordinary positioning, acquisition or analysis procedures

F. Document sources of error
1. Anatomy
2. Pathology
3. Body habitus
4. Nonremovable artifacts

III. Follow-up Scanning

A. Update patient information on computer screen(s)

B. Baseline printout available

C. Reproduce baseline acquisition parameters, positioning, ROI placement

D. Document changes from baseline procedures and patient history

IV. Equipment Safety

A. Registration per state regulations

B. Electrical safety

C. Pinch points

D. Emergency stop button

E. Inspections
1. Manufacturer preventive maintenance
2. Annual physicist inspection

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F. Table weight limits

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Peripheral Skeleton Scanning

Description
Content establishes basic knowledge and competence in the technologies and methods for measuring bone density of the peripheral skeleton. The advantages and disadvantages of peripheral densitometry, compared to central densitometry, are evaluated. Anatomy, pathology and proper scanning of the peripheral skeleton are demonstrated.

Objectives
1. State the anatomical sites and technologies approved for central and peripheral bone densitometry.
2. Evaluate the advantages and disadvantages of peripheral densitometry, especially in relation to central densitometry.
3. Identify and label gross anatomical structures and ROIs of the peripheral skeleton relevant to bone densitometry.
4. Describe and demonstrate correct selection of scanning parameters for peripheral densitometry.
5. Describe and demonstrate correct anatomical positioning for peripheral densitometry.
6. Describe and demonstrate correct scan acquisition for peripheral densitometry.
7. Describe and demonstrate correct scan analysis for peripheral densitometry.

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Content

I. Basic Comparison of Peripheral With Central Bone Densitometry

A. Central sites and technology
   1. Lumbar spine
      a. DXA, QCT
   2. Proximal femur
      a. DXA

B. Peripheral sites and technology
   1. Distal forearm
      a. DXA, SXA, peripheral QCT (pQCT)
   2. Calcaneus
      a. SXA, QUS
   3. Finger phalanges
      a. DXA, conventional x-ray
   4. Tibia
      a. QUS

C. Uses for peripheral densitometry
   1. Screening
      a. Indications for referral
   2. Fracture risk prediction
   3. Monitoring therapy
      a. Limitations

D. Comparison of peripheral with central bone densitometry
   1. Advantages of peripheral
      a. Facilitates screening
         1) Lower cost
         2) Smaller size
         3) Some portable
      b. No special scanner for conventional x-ray technique
      c. No ionizing radiation for QUS
      d. Less operator skill and education required
   2. Disadvantages of peripheral
      a. Does not measure at sites of most important fragility fractures
      b. T-scores may vary significantly from T-scores at spine or proximal femur
      c. Limited utility for monitoring therapy
      d. No image to check positioning on nonimaging scanners

II. Gross Anatomy and Pathology

A. Forearm – see Forearm DXA Scanning course

B. Calcaneus
   1. Fracture or surgical procedures
   2. Severe bone spurs

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3. Congenital anomalies or deformities

C. Finger phalanges
   1. Fracture or surgical procedures
   2. Arthritis
   3. Congenital anomalies, deformities, amputation

III. Scan Acquisition and Analysis

A. Select scan parameters according to manufacturer specifications
   1. Most fully automatic

B. Select appropriate side of body
   1. Dominant vs. nondominant
   2. Fracture or pathology
   3. Prolonged immobilization

C. Position and scan according to manufacturer specifications
   1. Designate one stable chair and use consistently
   2. Restraining devices cannot be in scan field

D. Analyze scan according to manufacturer specifications
   1. Most fully automatic

IV. Scan Quality Check List

A. Calcaneus (as appropriate for scanner model)
   1. Heel straight and fully inserted into scanner
   2. ROI centered and completely within image
   3. Bone edge markers displayed
   4. No internal, external or movement artifacts
   5. Side scanned matches side mode selected
   6. Note anatomical or degenerative changes that affect analysis

B. Forearm (as appropriate for scanner model)
   1. Forearm straight and centered
   2. All landmarks in scan field
   3. Appropriate amounts of soft tissue and air
   4. Ulna/radius intercept and 30 mm length correctly identified
   5. Bone edge markers displayed
   6. No internal, external or movement artifacts
   7. Side scanned matches side mode selected
   8. Note anatomical or degenerative changes that affect analysis

C. Finger phalanges (as appropriate for scanner model)
   1. Conventional x-ray: correct positioning, exposure of fingers and step wedge
   2. DXA: fully automated

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Physical Principles and Instrumentation of Quantitative Ultrasound

Description

Content establishes a basic knowledge of the physical principles and instrumentation of quantitative ultrasound (QUS) of bone. The generation and mechanical characteristics of ultrasound are explained. The two types of instrumentation and their operation are described and the reported parameters are defined.

Objectives

1. Describe the purpose of ultrasound transducers.
2. Describe the behavior and parameters of mechanical waves.
3. List the characteristics, intensity and power levels of the ultrasound beam.
4. Explain sound-tissue interaction, including propagation speed and attenuation.
5. Define the QUS-reported parameters and what they measure.
6. Describe the operation of through transmission devices.
7. List the classes of through transmission devices.
8. Interpret the display and results of through transmission devices.
9. Describe the operation of speed-of-sound, refraction-based devices.
10. List the classes of speed-of-sound, refraction-based devices.
11. Interpret the display and results of speed-of-sound, refraction-based devices.

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Content

I. Fundamental Principles

A. Ultrasound generation
   1. Transducers
   2. Mechanical wave behavior
   3. Wave parameters
      a. Wavelength
      b. Frequency
   4. Characteristics of the ultrasound beam
   5. Intensity and power levels
      a. Spatial peak temporal average (SPTA) intensity
      b. Safety of diagnostic ultrasound

B. Sound-tissue interaction
   1. Propagation speed
   2. Attenuation
      a. Reflection
      b. Scattering
      c. Absorption
      d. Other

II. Reported Parameters

A. Measured

B. Speed of sound (SOS)

C. Broadband ultrasound attenuation (BUA)
   1. Derived
   2. Stiffness

D. Quantitative ultrasound index (QUI)

E. Estimated heel BMD

F. Ultrasound bone profile score

III. Instrumentation and Operation

A. Through transmission devices
   1. Transducers
      a. Materials and construction
      b. Stationary configurations
      c. Moving configurations
   2. Classes
      a. Water-coupled
      b. Gel-coupled, contact
   3. Signal processing

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a. Frequency range
b. Detection methods
c. Calculation algorithms

4. Display and results
   a. Imaging
   b. Presentation and quality
      1) ROI determination
         a) Device-integrated
         b) Printers
         c) Ancillary computers
         d) Reported parameters

B. Speed-of-sound, refraction-based devices
   1. Classes
      a. Single site (tibia)
      b. Multiple site (tibia, phalanges, radius, calcaneus)
   2. Principles of operation
      a. Refraction and Snell's Law (acoustic refractive index)
      b. Transducer configuration (multi-element)
      c. Patient measurement procedure
   3. Signal processing
      a. Frequency range
      b. Detection
      c. Calculation algorithms
   4. Display and results
      a. Device-integrated
      b. Printers
      c. Ancillary computers
      d. Reported parameters

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Physical Principles and Instrumentation of DXA

Description

Content establishes a basic knowledge of the physical principles and instrumentation of dual-energy x-ray absorptiometry (DXA). The various x-ray production and detection techniques, pencil vs. fan and smart fan beam methodologies and geometry and fundamental data analysis processes and parameters are defined and discussed. The principles of accuracy and precision are defined. Special applications of DXA technique to body composition, lateral vertebral assessment (LVA) and orthopedics are presented.

Objectives

1. Describe the relationship between subject density and x-ray absorption.
2. Explain the use of two photon energies to separate soft tissue from bone in DXA.
3. Discuss the advantages and limitations of DXA.
4. Define accuracy and precision and discuss their importance in bone densitometry.
5. Describe the two methods of x-ray production in DXA.
6. Describe the two methods of x-ray detection in DXA.
7. Discuss the differences between pencil and fan beam systems.
8. Discuss the geometric considerations of fan beam systems.
9. Explain the importance of soft-tissue calculation during scan analysis.
10. Explain the issue of bone edge detection during scan analysis.
11. Define bone mineral density (BMD), bone mineral content (BMC) and area, including the calculation formulas.
12. Describe the application of DXA to body composition, LVA and orthopedics.

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Content

I. Fundamental Principles

A. Relationship between subject density and absorption of x-rays

B. Two x-ray energies
   1. Typical energies
   2. DXA equations
   3. Advantages and limitations of DXA

C. Accuracy and precision
   1. Definitions
   2. Importance

II. DXA Components

A. X-ray production
   1. K-edge filtering
   2. Energy switching

B. Radiation detection
   1. Scintillation detector systems
      a. Photo-multiplier tube
      b. Energy discrimination
      c. Spillover (cross-over) correction
   2. Solid-state detector systems
      a. High-voltage switching circuitry
      b. Calibration wheel or drum

III. Pencil Beam vs. Fan Beam Systems

A. Mechanics of pencil beam
   1. Beam collimation
   2. Single detector
   3. Scan arm motion
      a. Raster
      b. Longitudinal/transverse

B. Mechanics of fan beam
   1. Beam collimation
   2. Multiple detector system
   3. Detector uniformity correction
   4. Scan arm motion

C. Fan beam geometry
   1. Source-to-object-to-detector distances
   2. Magnification and distortion
   3. Object centering
   4. Estimated BMC and area

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IV. Scan Analysis Software

A. Calculating soft-tissue density or baseline

B. Bone edge detection

C. Definition and calculation of BMC, area, BMD

V. Sources of Accuracy and Precision Errors

A. Scanner speed and current
   1. Effect of wrong settings
   2. Reproducing settings at follow-up scan

B. Positioning
   1. Effect on BMC, area, BMD
   2. Reproducing positions at follow-up scan

C. Anatomy and pathology
   1. Variations from normal
      a. Effect on BMC, area, BMD
      b. Bone edge detection problems
      c. Comparison to reference population
   2. Body habitus
      a. Decrease current in thin patients
      b. Increase current, decrease speed in thick patients

D. Geometry
   1. Centering
   2. Small areas subject to large percent changes, poorer precision

E. Scanner calibration
   1. Stability
   2. Quality control

F. Scanner replacement
   1. Cross-calibration
   2. Standardized BMD
      a. Limitations

VI. Special DXA Applications

A. Total body scans
   1. Body composition
   2. Bone density

B. C-arm
   1. Lateral spine

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2. Vertebral morphometry

C. Vertebral morphometry
   1. LVA
   2. Instant vertebral assessment (IVA)
   3. Anterior Posterior vertebral assessment (APVA)

D. Orthopedics
   1. Decubitus lateral position
   2. Grading system

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Proximal Femur DXA Scanning

Description
Content establishes a base of knowledge for competent performance of proximal femur DXA scans. The relevant skeletal anatomy and pathology, patient positioning and scan acquisition, analysis and reporting are described and demonstrated. Common problems are discussed.

Objectives
1. Identify and label gross anatomical structures of the skeleton relevant to proximal femur positioning and scan analysis.
2. Describe and demonstrate correct selection of scanning parameters.
3. Describe and demonstrate correct proximal femur positioning.
4. Describe and demonstrate correct dual femur positioning.
5. Describe and demonstrate correct scan acquisition.
6. Describe and demonstrate correct scan analysis, including standard placement of ROIs.
7. Describe common positioning, acquisition and analysis problems and possible solutions.
8. Explain the scan report.

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Content

I. Gross Anatomy and Pathology

A. Bones and bony landmarks
   1. Pelvis
      a. Iliac crest
      b. Anterior superior iliac spine
      c. Symphysis pubis
      d. Ischium
      e. Acetabulum
   2. Proximal femur
      a. Head
      b. Neck
      c. Ward's area
      d. Greater trochanter
      e. Lesser trochanter
      f. Shaft

B. Common pathology
   1. Arthritis
   2. Fracture
   3. Paget's disease

II. Scan Acquisition

A. Select appropriate femur
   1. Left side most common or accessible
   2. Fractures or surgical procedures
   3. Arthritis or congenital anomalies
   4. Prolonged immobilization
   5. Polio

B. Select scan parameters according to manufacturer recommendations
   1. Adjust to thickness of scan site selection

C. Position patient and scan according to manufacturer recommendations
   1. Optimal femoral neck rotation
      a. Manufacturer foot positioner
   2. Optimal abduction or adduction of femoral shaft
   3. Positioning for dual femur scan
   4. Proper placement of manufacturer tissue-equivalent material

D. Common positioning problems
   1. Inability to rotate or abduct leg
   2. Motion

III. Scan Analysis and Report

A. Place ROIs according to manufacturer recommendations

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1. Automatic analysis
2. Manual analysis
3. Technologist's intervention
4. Femoral neck ROI placed medially or laterally according to manufacturer recommendations

B. Common analysis problems
   1. Short femoral neck
   2. Inadequate space between ischium and femur
   3. Ischium underlying neck
   4. Poor bone edge detection
   5. Small ROI areas very sensitive to changes in positioning or bone edge detection
   6. Bone islands – osteoids

C. Report
   1. Define regions
   2. Total hip
      a. How calculated
      b. Used for NHANES reference population
      c. More precise due to larger area
   3. Dual hips
      a. Mean BMD value
      b. Hip axis length

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Quantitative Computed Tomography

Description
Content establishes a base of knowledge for competent performance of spine quantitative computed tomography (QCT) scans performed on a standard computed tomography (CT) scanner. The relevant skeletal anatomy and pathology are described, QCT physics are discussed and quality control, patient positioning and scan acquisition and analysis are demonstrated.

Objectives
1. Identify and label gross anatomical structures of the skeleton relevant to spine QCT.
2. Recognize relevant degenerative conditions.
3. Describe the equipment and software required for QCT.
4. Describe how standard CT is adapted to perform QCT.
5. Compare and contrast the different methods for performing QCT.
6. Describe and evaluate the various calibration phantoms.
7. Demonstrate correct quality control procedures.
8. Demonstrate correct patient positioning.
9. Demonstrate correct scan acquisition and analysis.
10. Demonstrate correct scan archival.

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Content

I. Gross Anatomy and Pathology

A. Vertebral column
   1. Thoracic
   2. Lumbar
   3. Thoracolumbar junction
   4. Vertebral body
      a. Cortical bone
      b. Trabecular bone
      c. Cross-sectional anatomy

B. Relevant degenerative conditions
   1. Deformity of vertebral body
   2. Fracture of vertebral body
   3. Scoliosis

II. Physics

A. Equipment
   1. Standard CT scanner
   2. QCT software and hardware packages
   3. Archive system
      a. Tape
      b. Optical disk

B. Adaptation of standard CT
   1. Low radiation dose scan
   2. Purpose of calibration phantom
      a. Simultaneous imaging
      b. ROI placements
      c. Relating mean Hounsfield units to equivalent bone mineral density

C. Methods
   1. Single energy
   2. Dual energy

III. Quality Control

A. Calibration phantoms
   1. Liquid
      a. Construction
      b. Advantages and disadvantages
   2. Solid
      a. Construction
      b. Advantages and disadvantages

B. Phantomless system
   1. Advantages and disadvantages

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C. Scanning procedures
   1. Frequency

D. Analysis and interpretation
   1. Common problems

E. Cross-calibration of replacement scanner

IV. Patient Positioning

A. Supine

B. Feet first into gantry

C. T11 – L5 centered over phantom
   1. Fill air gap with gel pack

V. Scan Acquisition and Analysis

A. Acquisition
   1. Patient biography
   2. Table height
   3. Number of slices
   4. Gantry angle
   5. Technique: kVp, mA, time
   6. Field of view size
   7. Matrix size

B. Analysis
   1. Use available automated functions
   2. Check lines are centered through vertebral body
   3. Identify artifacts

VI. Scan Archiving

A. Tape

B. Optical disk

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Radiation Safety and Protection

Description
Content establishes a knowledge base for how to adapt general radiation safety and protection principles and practices to bone densitometry techniques using ionizing radiation, in particular DXA.

Objectives
1. Discuss applicable state regulations concerning license and registration to own and operate ionizing bone densitometry equipment.
2. Discuss applicable state regulations concerning surveys of ionizing bone densitometry equipment by qualified physicists.
3. Discuss applicable state regulations concerning registration or permit to perform bone densitometry scans.
4. Discuss comparable effective doses of diagnostic radiographs, various bone density measurement techniques and background radiation.
5. Discuss the meaning of As Low As Reasonably Achievable (ALARA).
6. Describe radiation safety practices in terms of bone densitometry equipment.
7. Describe radiation safety practices in terms of bone densitometry operators.
8. Describe radiation safety practices in terms of bone densitometry patients.

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Content

I. Basic Principles

A. Effective doses in microsieverts (µSv)
   1. Background radiation
   2. Diagnostic radiographs
   3. Bone density measurement techniques
      a. Pencil
      b. Fan
      c. Smart fan
      d. Cone

B. As Low As Reasonably Achievable (ALARA)

II. Safety Practices

A. Equipment
   1. License and registration
   2. Survey by qualified physicist
   3. Preventive maintenance and repair
   4. Quality control
   5. Monitoring
      a. Scatter radiation
      b. Climate control
   6. Posting radiation caution signs

B. Operator
   1. Registration and permit
   2. Education
      a. Device specific by manufacturer
      b. Certification
         1) International Society for Clinical Densitometry (ISCD)
         2) ARRT Bone Densitometry added Qualifications Exam
         3) Other
      c. Continuing education
         1) Local bone densitometry clubs and lectures
         2) National and international conferences and courses
         3) ISCD courses
         4) Online credits
         5) Journals
         6) Other
   3. Personal radiation monitor
   4. Recommended distance between workstation and scanner
      a. > 1 meter for fan beam at full aperture
      b. = 1 meter for pencil beam
      c. = 1 meter for smart fan
      d. = 2 meters for core bean
   5. Pregnancy

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a. Voluntary disclosure in writing

C. Patient
1. Scan request verification
2. Patient cooperation
   a. Explain exam and answer patient questions
   b. Artifacts
      1) Remove external
      2) Document nonremoveable artifacts
   c. Motion and breathing
      1) Proper instructions
3. Pregnancy
   a. Documentation
   b. 10-day rule
   c. Reschedule when appropriate

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Spine DXA Scanning

Description
Content establishes a base of knowledge for competent performance of lumbar spine DXA scans. The relevant skeletal anatomy and pathology, patient positioning and scan acquisition, analysis and reporting are described and demonstrated. Common problems are discussed.

Objectives
1. Identify and label gross anatomical structures of the skeleton relevant to lumbar spine positioning and scan analysis.
2. Describe and demonstrate correct selection of scanning parameters.
3. Describe and demonstrate correct lumbar spine positioning.
4. Describe and demonstrate correct scan acquisition.
5. Describe and demonstrate correct scan analysis, including standard placement of ROIs.
6. Describe common positioning, acquisition and analysis problems and possible solutions.
7. Explain the scan report.

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Content

I. Gross Anatomy and Pathology

A. Bones and bony landmarks
   1. Pelvis
      a. Iliac crest
      b. Anterior superior iliac spine
   2. Thoracic spine
      a. T12 vertebra
      b. Ribs
      c. Thoracic-lumbar junction
   3. Lumbar spine
      a. L1 to L5 vertebrae
         1) Spinous processes
         2) Posterior elements
         3) Characteristic shapes in DXA
      b. L4-L5 junction
         1) Relationship to iliac crest
      c. Variant number of standard five lumbar vertebrae
      d. Lumbar rib
      e. Lordotic curve
      f. Kyphosis
      g. Scoliosis

B. Common pathology
   1. Arthritis
   2. Vertebral fracture or deformity
   3. Scoliosis
   4. Degenerative changes
      a. Osteophytes
      b. Facet hypertrophy
      c. Disk space narrowing
   5. Aortic and other calcifications
   6. Surgery
      a. Harrington rods or other hardware
      b. Laminectomy
      c. Fusion
      d. Vertebroplasty
      e. Kyphoplasty

II. Scan Acquisition

A. Select scan parameters according to manufacturer recommendations
   1. Adjust to thickness of scan site selected

B. Position patient and scan according to manufacturer recommendations
   1. Leg block angle of degree
   2. Include iliac crest and ribs

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C. Common positioning problems
    1. Asymmetry due to scoliosis

III. Scan Analysis and Report

A. Place ROIs according to manufacturer recommendations
    1. Use characteristic shapes and landmarks

B. Common analysis problems
    1. Intervertebral spaces obscured
    2. Scoliosis
    3. Overlying calcifications
    4. Variant number of standard five lumbar vertebrae
        a. Analysis protocols
    5. Lumbar ribs analysis
    6. Poor bone edge detection
        a. When and how to change bone edges
    7. Deleting vertebrae
        a. When and how
        b. Special considerations for lateral scans
        c. Comparison to reference population

C. Report
    1. Define regions
    2. Total BMD
        a. How to hand calculate

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Total Body DXA Scanning

Description
Content establishes a base of knowledge for competent performance of total body DXA scans. The relevant skeletal anatomy and pathology, patient positioning and scan acquisition, analysis and reporting are described and discussed. The additional parameters of body composition are described. Common problems are discussed.

Objectives
1. Identify and label gross anatomical structures and pathology of the skeleton relevant to total body DXA positioning and scan analysis.
2. Describe and demonstrate correct patient positioning and alternative positioning for large body size or abnormal anatomy.
3. Demonstrate correct scan analysis, including standard placement of ROIs and alternative placements due to unusual patient positioning because of large body size or abnormal anatomy.
4. Describe the differences between reporting bone mass and body composition.
5. Identify when an external tissue bar is required and describe and demonstrate its correct use.
6. Describe common positioning, acquisition and analysis problems and possible solutions.
7. Explain the scan report.

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Content

I. Gross Anatomy and Pathology

A. Basic bones and regions
   1. Head
   2. Long bones
   3. Cervical, thoracic and lumbar spines
   4. Pelvis
   5. Appendages: hands, feet

B. Major joints
   1. Shoulder
   2. Hip

C. Pathology
   1. Scoliosis
   2. Long bone deformity

II. Scan Acquisition

A. Select scan parameters according to manufacturer specifications
   1. Slower speed for thick patients

B. Position patient and scan according to manufacturer specifications
   1. Common positioning and scanning problems
      a. Tall
      b. Obese
      c. Placement of hands and feet
      d. Motion
      e. Nonremovable artifacts
   2. External tissue bar placement

III. Scan Analysis and Report

A. Place ROIs according to manufacturer specifications
   1. Common analysis problems
      a. Obesity
      b. Scoliosis
      c. Artifacts

B. Report
   1. Define regions
   2. Bone mass
      a. Parameters: area, BMC, BMD
   3. Body composition
      a. Internal or external tissue bar
      b. Parameters: BMC, fat, lean, total, percent fat

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Appendix A

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Ethics and Law in the Radiologic Sciences

Description
Content is designed to provide a fundamental background in ethics. The historical and philosophical basis of ethics, as well as the elements of ethical behavior, will be discussed. The student will examine a variety of ethical issues and dilemmas found in clinical practice.

An introduction to legal terminology, concepts and principles also will be presented. Topics include misconduct, malpractice, legal and professional standards and the ASRT scope of practice. The importance of proper documentation and informed consent is emphasized.

Objectives
1. Describe specialized standards of behavior for the healing arts as a continuum, with historical and philosophical roots in the earliest periods of human history.
2. List the major milestones in the development of codes of behavior and ethical standards in the healing arts.
3. Explain ethics as a branch of philosophy and the moral, social and cultural basis of the development of an ethic.
4. Describe the moral, social and cultural basis of ethics.
5. Apply medical/professional ethics in the context of a broader societal ethic.
6. Explain the role of ethical behavior in health care delivery.
7. Differentiate between empathetic rapport and sympathetic involvement in relationships with patients and relate these to ethical conduct.
8. Explain concepts of personal honesty, integrity, accountability, competence and compassion as ethical imperatives in health care.
9. List legal/professional standards and their relationship to practice in health professions.
10. Identify specific situations and conditions that give rise to ethical dilemmas in health care.
11. Discuss the *US Genome Project* relative to the cause of genetically induced disease.
12. Explore the ethical issues of genetic screening.
13. Explain the genetic counseling responsibility of health care providers.
14. Employ a basic system of examination, clarification, determination of alternatives and decision-making in addressing ethical questions.
15. Explain select concepts embodied in principles of patients' rights, the doctrine of informed (patient) consent and other issues related to patients' rights.
16. Explain the legal implications of professional liability, malpractice, professional negligence/carelessness and other legal doctrines applicable to professional practice.
17. Describe the importance of accurate, complete, correct methods of documentation as a legal/ethical imperative.
18. Explore theoretical situations and questions relating to the ethics of care and health care delivery.
19. Explain specific legal terms, principles and laws.
20. Outline the elements necessary for a valid malpractice claim.
21. Define specific legal doctrines to include vicarious liability, *respondeat superior*, and *res ipsa loquitur*.

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22. Describe the scope of practice for radiography, the elements that comprise it and responsibilities of the radiographer.
23. Differentiate between professional and legal standards and describe how each relates to the radiography profession.
24. Describe institutional and professional liability protection typically available to the radiographer.
25. Describe the elements and implications of informed consent.
26. Identify standards for disclosure relative to informed consent.
27. Describe how consent forms are utilized relative to specific radiographic procedures.

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Human Diversity

Description

Content is designed to promote better understanding of patients, the patients' families and professional peers through comparison of diverse populations based on their value system, cultural and ethnic influences, communication styles, socioeconomic influences, health risks and life stages. Content will include the study of factors that influence relationships with patients and professional peers. Understanding human diversity assists the student in providing better patient care.

Objectives

1. Explain the development of a personal value system.
2. Discuss the interrelationship between personal, community and societal values.
3. Explain the influence a person's value system has on his or her behavior.
4. Discuss the development of personal and professional values.
5. Describe how professional values influence patient care.
6. Examine Kohlberg's theory on how an individual's morality influences his or her behavior.
7. Differentiate between culture and ethnicity.
8. Explain how a person's cultural beliefs toward illness affect his or her recovery.
9. Explain the origins of medical ethnocentrism.
10. Discuss the societal factors that influence the quality of health care.
11. Compare alternative/complementary medicine to the traditional Western model.
12. Describe the culture of poverty and its effect on health care.
13. Discuss family dynamics in a cultural, social, ethnic and lifestyle context.

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Human Structure and Function

Description
Content is designed to establish a knowledge base in surface and bony anatomy.

Objectives
1. Identify the location of structures using directional and orientation terms.
2. Indicate where various planes lie in relation to the body.
3. Identify the structural limits, functions and contents of each of the body cavities.
4. Explain the terms atom, ion, atomic number and atomic weight.
5. Classify tissue types, describe the functional characteristics of each and give examples of their location within the human body.
6. Identify and locate the bones of the human skeleton.
7. Identify bony processes and depressions found on the human skeleton.
8. Describe articulations of the axial and appendicular skeleton.
9. Differentiate the primary and secondary curves of the spine.
10. Describe sesamoid bones and locate examples on radiographs.
11. Summarize the functions of the skeletal system.
12. Label different types of articulations.
13. Compare the types, locations and movements permitted by the different types of articulations.
14. Demonstrate the use of topographical landmarks to locate internal structures.

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Patient Assessment, Management and Education

Description

Content introduces a model for clinical thinking to aid in patient assessment. Content includes a focus on the application of normal anatomy and physiological phenomena to ill and injured individuals. Interviewing skills and assessment techniques with clinical focus will be discussed. An emphasis on the analysis and interpretation of physiological data to assist in patient assessment and management will be introduced.

Objectives

1. Develop clinical thinking skills applied to the patient care setting.
2. Develop skills in conducting patient interviews to document a patient's medical history.
3. Apply the techniques and procedures for conducting a patient physical assessment and procedures to document findings.
4. Obtain and critically analyze a patient's vital signs.
5. Compose a plan for managing the patient based upon patient needs.
6. Participate in patient education.
7. Foster relationship centered patient care.
8. Adapt communications techniques to address patient needs.

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Patient Care in Radiologic Sciences

Description
Content is designed to provide the basic concepts of patient care, including consideration for the physical and psychological needs of the patient and family. Routine and emergency patient care procedures will be described, as well as infection control procedures using standard precautions. The role of the radiographer in patient education will be identified.

Objectives
1. Identify the responsibilities of the health care facility and members of the health care team.
2. List the general responsibilities of the radiographer.
3. Describe the scope of practice for the radiographer as defined by the ASRT and state licensure.
4. Identify methods for determining the correct patient for a given procedure.
5. Explain the use of various communication devices and systems.
6. Explain specific aspects of a radiographic procedure to the patient.
7. Demonstrate correct principles of body mechanics applicable to patient care.
8. Demonstrate techniques for specific types of patient transfer.
9. Demonstrate select procedures for turning patients with various health conditions.
10. Describe select immobilization techniques for various types of procedures and patient conditions.
11. Describe specific patient safety measures and concerns.
12. Explain the purpose, legal considerations and procedures for reporting an accident or incident.
13. Describe methods for evaluation of patient status.
14. List the information to be collected prior to patient examination.
15. Assess patient vital signs.
16. List the normal ranges for specific laboratory studies.
17. Define terms related to infection control.
18. Describe the importance of Standard Precautions and Isolation Procedures.
19. Explain sources and modes of transmission of infection and disease.
20. List institutional/departmental procedures for infection control.
21. Describe methods for the prevention of infection to the health worker and patient.
22. Identify symptoms related to specific emergency situations.
23. Describe the emergency medical code system for the institution and the role of the student during a medical emergency.
24. Explain the special considerations necessary when performing radiographic procedures on an infant or a child.
25. Explain the special considerations necessary when performing radiographic procedures on a geriatric patient.
26. Describe the symptoms and precautions taken for a patient with a spinal injury.
27. Explain the types, immobilization devices and positioning for upper and lower extremity fractures.
28. Explain the role of the technologist in patient education.
29. Identify specific types of tubes, lines, catheters and collection devices.

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30. Explain the purpose, precautions and care of tubes, lines, catheters and collection devices.
31. Outline the steps in the operation and maintenance of suction and oxygen equipment and demonstrate their use.
32. Demonstrate competency in cardiopulmonary resuscitation (CPR).
33. Demonstrate the use of specific medical emergency equipment and supplies.
34. Demonstrate select first aid techniques.
35. Describe the special problems faced in performing procedures on a patient with tracheotomy and specific tubes, drains and catheters.

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Patient Information Management

Description
Content is designed to provide the basic concepts of patient information management. Medical records management including privacy and regulatory issues will be examined. The role of the technologist in managing patient information will be identified and discussed.

Objectives
1. Discuss the JCAHO standards regarding the accountability and protection of patient information.
2. List the requirements of a patient consent document.
3. Identify challenges to the protection of patient information.
4. Distinguish between various types of patient records.
5. Explain the contents of the medical record.
6. Demonstrate proper protocols for charting patient information.
7. Explain the procedures for document administration.
8. Discuss privacy and regulatory issues related to patient information.
9. Assess the application of the Health Insurance Portability and Accountability Act (HIPAA) to patient information systems.
10. Define medical informatics and describe examples of informatics systems found in today's patient care setting.
11. Identify potential abuses for the use of confidential patient information.

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Quality Management

Description
Content is designed to impart an understanding of the tasks and protocols making up the quality management activities of a typical bone densitometry department. The roles and responsibilities of all parties contributing to the quality management effort will be presented. Tools, procedures and evaluation criteria used in the performance assessment of bone densitometry and image processing will be discussed.

Objectives
1. Discuss practical considerations in setting standards for acceptable image quality.
2. Employ a quality control program for the densitometer.
3. Identify the purpose of a daily quality control program for densitometers.
4. Differentiate between quality improvement/management, quality assurance and quality control.
5. List the benefits of a quality management program to the patient and to the department.
6. List elements of a quality management program and discuss how each is related to the quality management program.
7. Identify common equipment malfunctions that affect bone mineral density values.
8. Apply the principles of total quality management.
9. Ensure that performance reflects professional competence in the selection of technical factors to produce quality diagnostic images with lowest radiation exposure possible.
10. Critique images for appropriate clinical information, image quality and patient documentation.

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Radiation Protection

Description
Content is designed to present an overview of the principles of radiation protection including the responsibilities of the radiographer for patients, personnel and the public. Radiation health and safety requirements of federal and state regulatory agencies, accreditation agencies and health care organizations are incorporated.

Objectives
1. Identify and justify the need to minimize unproductive radiation exposure of humans.
2. Distinguish between somatic and genetic radiation effects.
3. Differentiate between the stochastic and nonstochastic (deterministic) effects of radiation exposure.
4. Explain the objectives of a radiation protection program.
5. Define radiation and radioactivity units of measurement.
6. Identify dose equivalent limits (DEL) for occupational and nonoccupational radiation exposure.
7. Describe the as low as reasonably achievable (ALARA) concept.
8. Identify the basis for occupational exposure limits.
9. Distinguish between perceived risk and comparable risk.
10. Describe the concept of negligible individual risk level (NIRL).
11. Identify ionizing radiation sources from natural and man-made sources.
12. Comply with legal and ethical radiation protection responsibilities of radiation workers.
13. Calculate dose equivalent limits (DEL) with reference to the latest National Council on Radiation Protection and Measurements (NCRP) reports.
14. Describe the theory and operation of radiation detection devices.
15. Identify appropriate applications and limitations for each radiation detection device.
16. Describe how isoexposure curves are used for radiation protection.
17. Identify performance standards for beam-directing, -defining and -limiting devices.
18. Describe procedures used to verify performance standards for equipment and indicate potential consequences of performance standards failure.
19. Describe the operation of various interlocking systems for equipment and indicate potential consequences of interlock system failure.
20. Identify conditions and locations evaluated in an area survey for radiation protection.
21. Distinguish between controlled and noncontrolled areas and list acceptable exposure levels.
22. Describe “Radiation Area” signs and identify appropriate placement sites.
23. Describe the function of federal, state and local regulations governing radiation protection practices.
24. Describe the requirements for and responsibilities of a radiation safety officer.
25. Express the need and importance of personnel monitoring for radiation workers.
26. Describe personnel monitoring devices, including applications, advantages and limitations for each device.
27. Interpret personnel monitoring reports.
28. Compare values for dose equivalent limits for occupational radiation exposures (annual and lifetime).

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29. Identify anatomical structures that are considered critical for potential late effects of whole body irradiation exposure.
30. Identify dose equivalent limits for the embryo and fetus in occupationally exposed women.
31. Distinguish between primary and secondary radiation barriers.
32. Demonstrate how the operation of various x-ray and ancillary equipment influences radiation safety and describe the potential consequences of equipment failure.
33. Perform calculations of exposure with varying time, distance and shielding.
34. Discuss the relationship between HVL and shielding design.
35. Identify emergency procedures to be followed during failures of x-ray equipment.
36. Demonstrate how time, distance and shielding can be manipulated to keep radiation exposures to a minimum.
37. Explain the relationship of beam-limiting devices to patient radiation protection.
38. Discuss added and inherent filtration in terms of the effect on patient dosage.
39. Explain the purpose and importance of patient shielding.
40. Use the appropriate method of shielding for a given radiographic procedure.
41. Explain the relationship of exposure factors to patient dosage.
42. Identify the appropriate image receptor that will result in an optimum diagnostic image with the minimum radiation exposure to the patient.
43. Select the immobilization techniques used to eliminate voluntary motion.
44. Describe the minimum source-to-tabletop distances for bone densitometry devices.

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Appendix B

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Clinical Experience Requirements

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BONE DENSITOMETRY
CLINICAL EXPERIENCE REQUIREMENTS

Eligibility Requirements Effective for Examinations Beginning January 1, 2001

All applicants for the Examination in Bone Densitometry are required to perform certain clinical procedures to establish eligibility for certification. This document identifies the minimum core clinical experience requirements for certification. The ARRT encourages individuals to obtain education and experience beyond these core requirements.

Directions

1. ***Perform the Procedure***s: Applicants are required to demonstrate performance in the following areas: (1) DXA scanning of the spine and femur; (2) daily quality control procedures for DXA units; (3) a choice of elective activities related to scanning and patient/community education. Applicants must complete all clinical experience requirements during the 12 months immediately before submitting the application for examination.

2. ***Document Performance:*** Applicants must use the attached Clinical Experience Documentation Form to record completion of required and elective procedures. Documentation includes the date performed, the initials of the supervisor who verified performance, and other essential information. The name and address corresponding to each set of initials also must appear on the form. Applicants must keep the Clinical Experience Documentation Form in their files for at least 24 months.

3. ***Apply for the Examination:*** When applying for examination, applicants must complete the verification section of the exam application to attest that they have completed all requirements. Mail only the application for examination to the ARRT; do not send the Clinical Experience Documentation Form to ARRT with the application. Submitting false documentation is a violation of the ARRT Standards of Ethics and may result in revocation of ARRT registration.

4. ***Maintain Your Records***: Applicants must keep the Clinical Experience Documentation Form for 24 months after submitting the application for examination. The ARRT conducts **audits** of some applications for examination. Applicants who are audited will be required to send the Clinical Experience Documentation Form to ARRT. Additional documentation may be required from individuals who are audited.

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Bone Densitometry Clinical Experience Requirements

All applicants are required to document clinical experience in the following areas: (1) patient scanning of the spine and femur; (2) daily quality control procedures for a DXA unit; (3) a choice of elective activities. Applicants must document their performance of the clinical procedures on the *Clinical Experience Documentation Form* which follows.

1. Patient Scanning

Applicants must perform scans of the anatomical locations listed below utilizing dual energy x-ray absorptiometry (DXA) equipment. All scans must be completed in the 12 months prior to exam application and must be verified by a technologist or physician supervisor. Use Sections 1a and 1b to document all scans.

	# of times
• Lumbar spine	50
• Femur	50

If a patient is scanned at two or more anatomical sites, each scan can be counted as a separate occurrence. However, scanning the same site two or more times on a single patient counts only as one scan. Scans must be performed on humans; scans of phantoms and other types of simulated tissue cannot be counted as scans.

Applicants must incorporate the following clinical activities into each DXA examination.

Patient Preparation

Explain the procedure; obtain relevant patient history (including screening for possible pregnancy); assure that all artifact-producing objects have been removed; and verify that patient has not been subjected to medical procedures that may invalidate the scan results (e.g., received contrast, prosthetic devices).

Acquisition and Analysis

Enter patient data required to utilize reference data; select positioning aides and position patient; record unusual positioning details; and perform DXA scan.

Evaluation of Results

Verify regions of interest; evaluate quality of measurements for problems due to artifacts, pathology, etc.; recommend additional scans as necessary; flag values that require physician's attention (low T-score; unreliable results, etc.); and archive results.

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2. Quality Control / Quality Assurance

Applicants must complete the following quality control procedure the number of times specified. Use Section 2 of the *Clinical Experience Documentation Form* to record each performance.

	# of times
• Perform and interpret results of required daily QC tests on DXA scanning equipment according to manufacturer guidelines.	10

3. Elective Procedures (select 3)

Applicants must complete at least 3 of the following activities the number of times specified. Use Section 3 of the *Clinical Experience Documentation Form* to record each performance.

	# of times
• Perform DXA scans on the forearm. *	10
• Directly observe an experienced operator perform DXA scans of the forearm. *	20
• Perform and analyze scans for *in vitro* precision study (e.g., 10 times before and after scanner relocation or repair).	1
• Perform and analyze scans for *in vivo* precision study.	1
• Install manufacturer software upgrades.	1
• Perform follow- up scan and compare bone density measurements from two occasions (for same patient) to assess changes over time.	10
• Answer basic questions from patients or family members about lifestyle choices related to bone health, fall prevention, and drug therapies.	10
• Develop or update instructional materials related to bone health and bone densitometry (e.g., brochure, video).	1
• Give lecture to other health care professionals or provide community education workshop related to bone health and bone densitometry. scanning equipment according to manufacturer guidelines.	1

Note: Applicants who choose either of the forearm electives must study DXA forearm scanning (e.g., read operator's manual, view manufacturers' training video) prior to completing these electives.

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Clinical Experience Documentation Form – Bone Densitometry

Section 1-a: ***Spine***

Applicants are required to complete 50 DXA scans of the spine. Document each scan below. The "Verified" column should be initialed by your supervisor (e.g., physician, technologist, other).

Date Performed	Time of Day	Scanner System #	Verified (initials)

Date Performed	Time of Day	Scanner System #	Verified (initials)

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Section 1-b: ***Femur***

Applicants are required to complete 50 DXA scans of the proximal femur. Document each scan below. The "Verified" column should be initialed by your supervisor (e.g., physician, technologist, other).

Date Performed	Time of Day	Scanner System #	Verified (initials)

Date Performed	Time of Day	Scanner System #	Verified (initials)

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Section 2: ***Quality Control / Quality Assurance***

Applicants are required to perform and interpret results of required daily QC tests on DXA scanning equipment, according to manufacturer guidelines, at least 10 times. Document each performance. The "Verified" column should be initialed by your supervisor (e.g., physician, technologist, other).

Date Performed	Time of Day	Scanner System #	Verified (initials)

Date Performed	Time of Day	Scanner System #	Verified (initials)

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Section 3: ***Elective Procedures***

Applicants must complete at least 3 different elective activities the number of times specified on these clinical experience requirements. Document each performance below. The "Verified" column should be initialed by your supervisor (e.g., physician, technologist, other).

Elective Procedures. List each procedure below. If performed multiple times, then list the procedure multiple times. Abbreviations are acceptable.	Date Performed	Scanner System # or Time of Day	Verified (initials)

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Section 4: ***List of Supervisors Verifying Performance*** (Please Print)

Initials	Name and Credentials	Address

Section 5: ***Applicant Signature***

Applicants must fill in the dates below and sign when clinical experience requirements are completed. All requirements must be completed during the 12 months immediately before submitting the application for examination. By signing this *Clinical Experience Documentation For*m, the applicant attests to the accuracy of the information in Sections 1 through 4 on this form.

Applicants should keep this form and related documentation in a file for 24 months. Do not mail this Clinical Experience Documentation Form to the ARRT with the application for examination. The ARRT will request a copy of this form only from those selected for random audit.

Please indicate the dates during which you completed the clinical experience requirements:

First date documented on this form _____/_____/_____

Last date documented on this form _____/_____/_____

_____ _____

Applicant Signature Date of signature

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Reference Resources

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J Clinical Densitometry. 4 issues/year. Totowa, NJ: Humana Press.

Osteoporosis International. 6 issues/year. Godalming, Surrey, UK: Springer-Verlag London Ltd.

Radiologic Technology. 6 issues/year. Albuquerque, NM: American Society of Radiologic Technologists.

Organizations

International Society for Clinical Densitometry (ISCD). Certification courses for technologists and physicians, site accreditation and continuing education. The society newsletter, *SCAN*, and Web site provide listings of domestic and international meetings and courses with relevant content for technologists. Contact: ISCD, www.iscd.org

National Osteoporosis Foundation (NOF). Source of osteoporosis information and educational materials for staff and patients. Contact: NOF, 1232 22nd St. N.W., Washington, DC 20037-1292; www.nof.org

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