

# Mammography Curriculum

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# Introduction

This curriculum provides the professional community with a cognitive base of entry-level education in the practice of mammography. The curriculum is suitable for all programs in this specialty, including limited fellowships, short-term certificate programs and collegiate-based education programs. The curriculum recognizes that the educational components are dynamic, and therefore represent 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 that represent the essential components of a mammography educational program. No particular sequence is suggested. Each program should organize the content and objectives to meet its mission, goals and needs. 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 has three sections: foundations, core content and clinical experience requirements. The foundations section presents an inventory of pre-existing knowledge and skills gained during an entry-level radiography educational experience and reinforced through professional practice. The content in the foundations section is intended to aid technologists in planning their careers and program managers in developing preassessment tools for candidate selection.

The professional practice of mammography 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 to educate technologists in the post-primary practice of mammography.

The clinical experience requirements section acts as a guide in developing a well-rounded clinical experience. The section also includes information to aid in meeting the eligibility requirements for a post-primary certification examination in mammography.

## Contents

Foundations.....	1
Core Content.....	3
Breast Anatomy and Mammographic Correlation.....	4
Breast Viability and Pathology.....	6
Correlative Physical Breast Assessment.....	15
Department Organization and Regulation.....	18
Equipment.....	22
Interventional Procedures.....	26
Mammography Quality Management.....	29
Positioning.....	33
Sonomammography.....	38
Technical Applications.....	41
Appendix A.....	45
Clinical Practice.....	46
Digital Image Acquisition and Display.....	48
Ethics and Law in the Radiologic Sciences.....	50
Fundamentals of Radiologic Science and Health Care.....	51
Human Structure and Function.....	52
Patient Care in Radiologic Sciences.....	54
Pharmacology and Drug Administration.....	56
Radiation Production and Characteristics.....	57
Radiation Protection.....	58
Radiographic Pathology.....	60
Appendix B.....	61
Clinical Experience Requirements.....	62
Reference Resources.....	63

# Foundations

This section presents an inventory of pre-existing knowledge and skills gained during an entry-level radiography educational experience and reinforced through professional practice. The content in this section is intended to aid technologists in planning their careers and program managers in developing preassessment tools for candidate selection.

## **Clinical Practice**

Content and clinical practice experiences should be designed to sequentially develop, apply, critically analyze, integrate, synthesize and evaluate concepts and theories in performing radiologic procedures. Students discuss, examine and evaluate concepts of team practice, patient-centered clinical practice and professional development through structured, sequential, competency-based clinical assignments.

Clinical practice experiences should teach patient care and assessment, competent performance of radiologic imaging and total quality management. Levels of competency and outcomes measurement ensure the well-being of the patient preparatory to, during and following the radiologic procedure.

## **Digital Image Acquisition and Display**

Content imparts an understanding of the components, principles and operating the digital imaging systems found in diagnostic radiology. Factors that affect image acquisition, display, archiving and retrieval are discussed. Guidelines for selecting exposure factors and evaluating images within a digital system help students bridge the gap between film-based and digital imaging systems. Principles of digital system quality assurance and maintenance are presented.

## **Ethics and Law in the Radiologic Sciences**

Content provides a fundamental background in ethics. The historical and philosophical bases of ethics, as well as the elements of ethical behavior, are discussed. The student will examine a variety of ethical issues and dilemmas found in clinical practice.

This portion introduces legal terminology, concepts and principles. Topics include misconduct, malpractice, legal and professional standards and the ASRT scope of practice. The content emphasizes the importance of proper documentation and informed consent,

## **Fundamentals of Radiologic Science and Health Care**

Content presents an overview of the foundations in radiography and the practitioner's role in the health care delivery system. Principles, practices and policies of health care organizations are examined and discussed, in addition to the professional responsibilities of the radiographer.

## **Human Structure and Function**

Content establishes a knowledge base in anatomy and physiology. The components of the cells, tissues, organs and systems are described and discussed.

## **Patient Care in Radiologic Science**

Content provides the basic concepts of patient care, including consideration for the physical and psychological needs of the patient and family. This document describes routine and emergency patient care procedures, along with infection control procedures using standard precautions. The role of the radiographer in patient education is identified.

### **Pharmacology and Drug Administration**

Content provides the basic concepts of pharmacology, including the theory and practice of basic techniques of venipuncture and administration of diagnostic contrast agents and/or intravenous medications. The appropriate delivery of patient care during these procedures is emphasized.

### **Radiation Production and Characteristics**

Content establishes a basic knowledge of atomic structure and terminology. Also presented are the nature and characteristics of radiation, x-ray production and the fundamentals of photon interactions with matter.

### **Radiation Protection**

Content provides an overview of the principles of radiation protection, including the responsibilities of the radiographer for patients, personnel and the public. This document incorporates radiation health and safety requirements of federal and state regulatory agencies, accreditation agencies and health care organizations.

### **Radiographic Pathology**

Content introduces concepts related to disease and etiological considerations with an emphasis on the radiographic appearance of disease and its effect on exposure factor selection.

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

## Core Content

The professional practice of mammography requires specific knowledge and skills generally not obtained in basic educational programs in radiography. The core content section represents curriculum elements considered essential for educating technologists in the post-primary practice of mammography.

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# Breast Anatomy and Mammographic Correlation

## Description

Content establishes a knowledge base in breast anatomy and physiology. Correlation between breast anatomical structures and mammographic anatomical structure are described and discussed.

## Objectives

1. Identify and label anatomical structures of the breast.
2. Identify and label the breakdown of the single lobe.
3. Identify the three arterial branches supplying the breast and the three venous drainage channels.
4. Describe the lymphatic system and lymphatic drainage.
5. Correlate breast anatomical structures to mammographic anatomical structures.
6. Identify and label mammographic anatomical structures when presented with a mammographic image.

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## Content

### I. Gross Anatomy of the Normal Breast

- A. Definition of the breast
  - 1. Male vs. female
  - 2. Developmental stages
  
- B. External anatomy
  - 1. Breast margins
  - 2. Nipple
  - 3. Areola
  - 4. Montgomery's glands
  - 5. Morgagni's tubercles
  - 6. Skin
    - a. Sebaceous glands
    - b. Sweat (sudiferous) glands
    - c. Hair follicles
  - 7. Axillary tail
  - 8. Inframammary fold
  - 9. Margin of pectoralis major
  
- C. Internal anatomy
  - 1. Fascial layers
  - 2. Retromammary (fat) space
  - 3. Fibrous tissues
  - 4. Glandular (secretory) tissues
    - a. Glandular lobes
      - 1) Lobules
      - 2) Terminal ductal lobular unit (TDLU)
  - 5. Adipose (fatty) tissues
  - 6. Cooper's ligaments
  - 7. Pectoral muscle
  - 8. Circulatory (blood supply) system
  - 9. Lymphatic channels
  
- D. Histology
  - 1. Terminal ductal lobular unit
    - a. Extralobular terminal duct
    - b. Intralobular terminal duct
    - c. Ductal sinus (acinus)
  - 2. Cellular components
    - a. Epithelial cells
    - b. Myoepithelial cells
    - c. Basement membrane



# **Breast Viability and Pathology**

## **Description**

Content introduces the concepts of breast viability and pathology. This section presents benign and cancerous pathology, including their mammographic appearance.

## **Objectives**

1. Discuss and understand the changes the breast undergoes due to hormonal influences during puberty, menses, pregnancy and the postmenopausal life cycles.
2. Describe the physiologic changes caused by estrogen, progesterone and prolactin.
3. Describe breast augmentation and identify the types of implants, common implant locations and the anatomical changes to the augmented breast.
4. Describe the anomalies of development that can occur in the breast.
5. Recognize clinical breast changes.
6. List the physical changes of the breast related to pathology.
7. List the mammographic changes of the breast related to pathology and, given mammographic images, identify the common mammographic appearance of breast pathology.
8. Identify risk factors limited to breast cancer.
9. State the recommendations for asymptomatic women regarding mammography.
10. Provide information on the importance of manual and visual breast self-examination.
11. Define treatment options for breast cancer.
12. Describe the generally accepted (postulated) progression of breast cancers from the ductal epithelium and nonepithelial tissues.
13. Describe changes seen after breast reduction surgery or following lumpectomy and surgical excision.

## **Content**

### **I. Developmental Stages of Breast Tissue**

- A. Fetal
- B. Puberty
- C. Menstruation
- D. Pregnancy
- E. Lactation
- F. Menopause
- G. Postmenopause

### **II. Hormonal Influences**

- A. Birth control pills
- B. Estrogen
- C. Progesterone
- D. Prolactin
- E. Testosterone
- F. Other

### **III. Breast Augmentation or Reconstruction**

- A. Implants
  - 1. Types
    - a. Silicone
    - b. Saline
    - c. Other
- B. Breast reduction
- C. Post-surgical excision

### **IV. Breast Anomalies**

- A. Asymmetry
- B. Inverted nipples
- C. Accessory nipples

D. Other

**V. Clinical Breast Changes**

A. Lumps

1. Location
2. Size
3. Pain
4. Mobility

B. Thickening

1. Location

C. Swelling

1. Location

D. Dimpling

1. Location

E. Skin irritation

1. Location

F. Retraction

1. Location
2. Duration of time

G. Pain

1. Location
2. Duration of time

H. Discharge

1. Duration of time
2. Color of discharge
3. Ipsilateral or bilateral

I. Nipple and areola changes

1. Retraction
  - a. Location
  - b. Duration of time

J. Edema

K. Erythema

L. Other

## **VI. Mammographic Appearance of Pathology**

### **A. Masses**

1. Shape
  - a. Round
  - b. Oval
  - c. Lobulated
  - d. Irregular
  - e. Architectural distortion
2. Margins
  - a. Circumscribed
  - b. Obscured
  - c. Ill-defined (indistinct)
  - d. Spiculated
  - e. Microlobulated
3. Benign characteristics
  - a. Encapsulated
  - b. Low density
    - 1) Fat containing
  - c. Mixed density
  - d. Well circumscribed
4. Malignant characteristics
  - a. Spiculated
  - b. High density
  - c. Low density
  - d. Indistinct

### **B. Calcifications**

1. Characteristics
  - a. Number (quantity)
  - b. Size
  - c. Shape
  - d. Distribution
    - 1) Clustered or grouped
    - 2) Segmental
    - 3) Regional
    - 4) Diffuse (scattered)
    - 5) Multiple groups
2. Benign characteristics (typical)
  - a. Coarse
  - b. Rim or eggshell
  - c. Milk of calcium (teacup-like)
  - d. Dystrophic
  - e. Vascular
  - f. Skin (superficial)
  - g. Secretory
  - h. Fat necrosis

- i. Punctate
- 3. Malignant (nondeterminate characteristics)
  - a. Indistinct (amorphous)
  - b. Granular (clustered)
  - c. Irregular
  - d. Casting
- C. Nodules
  - 1. Characteristics
    - a. Shape
    - b. Fluid or cystic
    - c. Solid or indistinct
- D. Other indicators of pathology
  - 1. Asymmetry
  - 2. Contour changes
  - 3. Prominent ductal pattern
  - 4. Prominent venous or arterial pattern
  - 5. Skin changes
  - 6. Other

## **VII. Risk Factors Associated With Breast Cancer**

- A. Male vs. female
- B. Age
- C. Family history of breast cancer
- D. Family history of ovarian or other reproductive cancer
- E. Menses
  - 1. Early age at menarche
  - 2. Late age at menopause
- F. Exposure to cyclical estrogen
- G. Parity
  - 1. Nulliparity
  - 2. Primiparity
  - 3. Multiparity
  - 4. Age at primiparity
- H. Educational level and socioeconomic status
- I. Diet

## **VIII. Early Detection of Breast Cancer**

- A. Screening mammograms
  - 1. Baseline between the ages of 35 and 40
  - 2. Women 40 and older, annual mammograms
  
- B. Clinical examinations
  - 1. Women 20 to 40, every 3 years
  - 2. Women older than 40, every year

## **IX. Breast Self-examination**

- A. Age
  - 1. Puberty through old age
  
- B. Time
  - 1. Monthly
    - a. Seven to 10 days after last menstrual period
    - b. First day of each month after menopause or hysterectomy
  
- C. Technique
  - 1. Fingerpads
  - 2. Superficial pressure
  - 3. Deep pressure
  - 4. Axillae and clavicular areas
  
- D. Methods
  - 1. Spiral method
  - 2. Grid method
  - 3. Pie wedge method
  - 4. Visual inspection

## **X. Treatment Options for Breast Cancer**

- A. Surgery
  - 1. Lumpectomy
  - 2. Partial mastectomy
  - 3. Simple mastectomy
  - 4. Modified radical mastectomy
  - 5. Radical mastectomy
  - 6. Reconstructive surgery
  
- B. Radiation therapy
  
- C. Chemotherapy
  
- D. Hormone therapy

## **XI. Breast Carcinomas**

- A. Postulated development of breast cancer
  - 1. Epithelial hyperplasia
  - 2. Atypical epithelial hyperplasia
  - 3. Carcinoma in situ
  - 4. Invasive carcinoma
  
- B. Pathological types
  - 1. Ductal carcinomas
    - a. Medullary
    - b. Mucinous
    - c. Tubular
    - d. Inflammatory
    - e. Comedo
  - 2. Lobular
  - 3. Paget disease
  
- C. Carcinoma categories
  - 1. In situ
  - 2. Intraductal
  - 3. Invasive
  
- D. Stromal cancer
  - 1. Sarcoma
  
- E. Other
  - 1. Lymphoid malignancy
  - 2. Metastatic to the breast from other primary
  
- F. Diagnosis of breast carcinoma
  - 1. Fine-needle aspiration
  - 2. Core biopsy
  - 3. Surgical biopsy
  - 4. Other
  
- G. TNM classification of breast cancer
  - 1. Primary tumor
    - a. Clinical
    - b. Diagnostic
    - c. Surgery
    - d. Postsurgical treatment
    - e. Re-treatment
    - f. Autopsy
  - 2. N subclasses
    - a. Regional lymph node involvement
    - b. Regional lymph node metastasis
    - c. Increasing degree of demonstrable lymph node abnormalities

3. Metastasis
  - a. No evidence
  - b. Evidence of distant metastasis
  - c. Assessment of distant metastasis cannot be met

## **XII. Benign Breast Pathology**

- A. Cyst
  1. Etiology
  2. Mammographic appearance
  3. Diagnosis
  4. Treatment
  
- B. Galactocele
  1. Etiology
  2. Mammographic appearance
  3. Diagnosis
  4. Treatment
  
- C. Fibroadenoma
  1. Etiology
  2. Mammographic appearance
  3. Diagnosis
  4. Treatment
  
- D. Lipoma
  1. Etiology
  2. Mammographic appearance
  3. Diagnosis
  4. Treatment
  
- E. Hamartoma (fibroadenolipoma)
  1. Etiology
  2. Mammographic appearance
  3. Diagnosis
  4. Treatment
  
- F. Papilloma
  1. Etiology
  2. Mammographic appearance
  3. Diagnosis
  4. Treatment
  
- G. Ductal ectasia
  1. Etiology
  2. Mammographic appearance
  3. Diagnosis



- 4. Treatment
- H. Breast infection
  - 1. Etiology
  - 2. Mammographic appearance
  - 3. Diagnosis
  - 4. Treatment
- I. Abscess
  - 1. Etiology
  - 2. Mammographic appearance
  - 3. Diagnosis
  - 4. Treatment
- J. Hematoma
  - 1. Etiology
  - 2. Mammographic appearance
  - 3. Diagnosis
  - 4. Treatment
- K. Fat necrosis
  - 1. Etiology
  - 2. Mammographic appearance
  - 3. Diagnosis
  - 4. Treatment
- L. Inflammation vs. inflammatory cancer
  - 1. Etiology
  - 2. Mammographic appearance
  - 3. Diagnosis
  - 4. Treatment
- M. Radial scarring
  - 1. Etiology
  - 2. Mammographic appearance
  - 3. Diagnosis
  - 4. Treatment
- N. Paget's disease of the breast
  - 1. Etiology
  - 2. Mammographic appearance
  - 3. Diagnosis
  - 4. Treatment

# Correlative Physical Breast Assessment

## Description

Content introduces technologist-performed physical breast assessment. Content includes discussions regarding preliminary patient assessment, physical breast assessment and documentation of findings required of a comprehensive examination to correlate breast imaging.

## Objectives

1. Identify current epidemiology and risk factors of breast cancer.
2. Describe elements of breast cancer screening protocols.
3. Demonstrate an understanding of breast anatomy and topographical orientation.
4. Detail a breast assessment.
5. Implement proper techniques and procedures for conducting a breast assessment.
6. Use nondiagnostic descriptors to record findings and document observations arising from the breast exam.
7. Participate in patient education regarding breast self-examination.
8. Modify procedures to assist patients with special needs.

## **Content**

### **I. Description of Physical Breast Assessment for Imaging Correlation**

- A. Benefits
  
- B. Disadvantages
  
- C. Focused medical history
  - 1. General risk factors
  - 2. Family history
  - 3. Breast pain
  - 4. Mass
  
- D. Physical examination
  - 1. Area to be examined
  - 2. Visual inspection of breasts
  - 3. Visual inspection of nipples
  - 4. Palpation
  
- E. Upright exam
  - 1. Regional lymph node palpation
  
- F. Supine exam
  
- G. Palpation techniques
  - 1. Vertical strip
  
- H. Examination of lumpectomy/mastectomy site
  
- I. Examination after reconstruction/augmentation/reduction
  
- J. Normal breast examination features
  - 1. Consistent features
  - 2. Variations in parenchyma
  - 3. Fibrocystic changes
  
- K. Abnormal breast examination features
  - 1. Characteristics of abnormal findings
    - a. Infection
    - b. Abscess
    - c. Nipple discharge
    - d. Fat necrosis
    - e. Fibroadenoma
    - f. Breast cancer
  - 2. Documentation of findings
    - a. Palpable findings
    - b. Masses

3. Skin findings
4. Nipple findings
5. Previous surgeries
6. Clock face description
7. Accuracy of measurements
8. Mammographic correlation

## **II. Patient Education: Breast Self-examination (BSE)**

- A. Target population
- B. Benefits
- C. Rationale for performing BSE
- D. Possible reasons for not performing BSE
- E. When to do BSE

## **III. Patients With Special Needs**

- A. Patients in a wheelchair
- B. Cultural barriers
- C. Morbidly obese patients

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# Department Organization and Regulation

## Description

Content provides students with an overview of the mammography facility and its personnel. It provides a foundation for the types of patient services offered and the regulations that affect the operation of a facility or service.

## Objectives

1. Identify key personnel and discuss regulations of the Mammography Quality Standards Act of 1992.
2. Define a mammography facility.
3. Explain patient services in the mammography department.
4. Discuss MQSA, American College of Radiology and Food and Drug Administration (FDA) guidelines and accreditations.

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## **Content**

### **I. The Mammography Facility Defined**

- A. Hospitals
- B. Outpatient departments
- C. Clinics
- D. Radiology practices
- E. Mobile units
- F. Department of Veterans Affairs
- G. Other

### **II. Ancillary Personnel**

- A. Interpreting physicians
  - 1. Training requirements
    - a. Medical licensing
  - 2. Experience
    - a. Interpretation of mammograms according to MQSA guidelines
  - 3. Certification
    - a. FDA-approved bodies
  - 4. Continuing education
    - a. Regulations
    - b. Requirements
  - 5. Continuing experience
- B. Mammographers
  - 1. Training requirements
    - a. Licensing
    - b. Certification
  - 2. Experience
  - 3. Continuing education
    - a. Regulations
    - b. Requirements
      - 1) General
      - 2) Equipment/system specific
      - 3) DR vs. film screen
  - 4. Continuing experience
- C. Medical physicist
  - 1. Training
    - a. License or approval by state
  - 2. Experience

3. Certification
4. Continuing education
  - a. Regulations
  - b. Requirements
5. Continuing experience

### **III. Patient Services**

- A. Screening mammography
  1. Asymptomatic patients
  2. Self-referring
  3. Self-requesting
- B. Diagnostic mammography (consultative mammography)
  1. Clinical signs, symptoms or physical findings
  2. Abnormal or questionable screening mammogram
  3. History of breast cancer
  4. Augmented breasts
- C. Other
  1. Experimental mammography
  2. Localization procedures
  3. Biopsy procedures

### **IV. National Quality Standards**

- A. FDA
  1. Approved accrediting bodies
    - a. Private, nonprofit organizations
    - b. State agencies
  2. Responsibilities of accrediting bodies
    - a. Facility standards
      - 1) Physician standards
      - 2) Mammographer standards
      - 3) Medical physicist standards
      - 4) X-ray equipment characteristics
      - 5) Quality assurance and quality control programs
      - 6) Phantom image quality testing
      - 7) Radiation dose limits
      - 8) Information update provisions
      - 9) Medical records
      - 10) Patient notification requirements
      - 11) Clinical image review
- B. MQSA requirements
  1. Accreditation of mammography facilities by approved accrediting bodies
  2. Annual mammography facility physics survey, consultation and evaluation performed by a certified or state-licensed medical physicist

3. Annual inspection of mammography facilities, performed by federally certified or state-certified inspectors
4. Qualification standards for interpreting physicians, mammographers, medical physicists and mammography facility inspectors
5. Specified boards or organizations eligible to certify the training and experience of mammography personnel
6. Quality standards for mammography equipment and practices, including quality assurance and quality control programs
7. A National Mammography Quality Assurance Advisory Committee
8. Standards governing record-keeping for patient files and requirements concerning mammography reporting and patient notification by physicians

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# Equipment

## Description

Content gives the student a foundation of the concepts of mammography equipment. The types and function of mammographic and quality control equipment, along with the mandated requirements governing their use, are described and discussed.

## Objectives

1. Label the components of the mammographic unit.
2. Demonstrate and properly operate mammography equipment and demonstrate the correct use of compression devices, filtration devices, the magnification setup, use of grids and automatic exposure controls.
3. State the specifications of the various components in a mammography unit (half-value layer, focal spot size, source-to-image distance and the minimum requirements based on MQSA guidelines).
4. Define heel effect.
5. Define reciprocity law failure.
6. Differentiate between the various types of x-ray generators used in mammography.
7. Discuss and define digital mammography.
8. Explain the additional functions available with digital imaging – measuring the area of interest, filtration of image, magnification, contrast, density, subtraction of image.
9. Define compression, its usefulness and minimum and maximum requirements, based on MQSA guidelines.
10. State the purpose of magnification.
11. State the procedure used when magnifying breast tissue.
12. Accessorize equipment according to the procedure being performed.
13. Set appropriate kVp, mA and time or automatic exposure control (AEC) and the correct position of the photosensor.
14. Process film and reload cassettes with mammography film.
15. Produce hard copy images of digital images.

## Content

### I. Dedicated Mammography Equipment

- A. C-arm x-ray tube stand
  
- B. Mammography tube
  1. Rotating vs. stationary anodes
  2. Target materials
    - a. Molybdenum
    - b. Specialized tungsten
    - c. Rhodium
  3. Focal spot
    - a. Standard
    - b. Magnification
    - c. Actual focal spot
    - d. Effective focal spot
  4. Source-to-image distance (SID)
  5. Object-to-image distance (OID)
  6. Filtration
    - a. Tube filtration
      - 1) Molybdenum
      - 2) Rhodium
      - 3) Yttrium
      - 4) Aluminum
    - b. Exit window filtration
      - 1) Glass
      - 2) Beryllium
    - c. Heel effect
      - 1) Effects on intensity
      - 2) Effects on apparent focal spot size
    - d. Effects on dose
    - e. Effects on contrast
  7. Generator
    - a. Types
      - 1) Single-phase
      - 2) Three-phase
      - 3) High-frequency
      - 4) Constant potential
    - b. Homogenous x-ray beam
    - c. Ripple factor
    - d. Tube capacity (mA output)
  8. Automatic exposure control (AEC)
    - a. Purpose
    - b. Types
      - 1) Photomultiplier
      - 2) Ionization chamber
      - 3) Solid state

9. Grids
  - a. Types
    - 1) Reciprocating
    - 2) Stationary
  - b. Ratio
10. Beam limiting devices
  - a. Purpose
  - b. Collimation
    - 1) Three-sided
11. Compression devices
  - a. Purpose
  - b. Compression testing
  - c. Types
    - 1) Manual
    - 2) Motorized
  - d. Paddle shapes, sizes and purposes
12. Magnification
  - a. Purpose
  - b. Focal spot size
  - c. Air gap technique
  - d. Effect of dose
  - e. Magnification factor

## **II. Digital Mammography**

- A. Theory
  1. Phosphor screens
  2. CCD (charged coupled device)
  3. Matrix/pixels
  4. Optical density vs. noise ratio
- B. Approaches of digital mammography
  1. Slot scanning approach
  2. Single-exposure approach
  3. Multiple-exposure approach
- C. Benefits
  1. Radiation dose reductions
  2. Image enhancement
  3. Time
  4. Possible computer-aided diagnosis
  5. Telemammography

## **III. FDA/MQSA Requirements**

- A. Mammography equipment
  1. Dedicated
  2. Gantry assembly motion

- a. Rigidly fixed
- b. Rotation requirements
- c. Visual indication of gantry angle
3. Image receptors
  - a. Classification of sizes
  - b. Film-screen receptors (moving grids)
  - c. Magnification devices (removable grids)
  - d. Grid motion impedance
4. Compression
5. Beam limitation and light fields
  - a. Alignment of light field to x-ray field
  - b. Illumination requirements
  - c. Exposure interlock systems
6. Source-to-image receptor distance
  - a. Minimum requirements
  - b. Visual indication of selected SID
7. Dose limitations
8. Infection control

#### **IV. Quality Assurance of Equipment**

- A. Facility quality assurance program
- B. Maintenance of logbooks
- C. Phantom images
- D. Clinical image monitoring
- E. Clinical image interpretation
- F. Physicist surveys
- G. Medical records

# Interventional Procedures

## Description

Content establishes a knowledge base in the type and application of interventional procedures involving mammography.

## Objectives

1. Illustrate the sterile technique.
2. Describe standard needle lesion localization.
3. Describe stereotactic lesion localization.
4. Describe fine-needle aspiration biopsy.
5. Delineate Galactography.
6. Explain pneumocystography.
7. Describe a stereotactic or core biopsy.

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## **Content**

### **I. Interventional Procedures**

- A. Sterile technique
  - 1. Spread of infection
    - a. Exogenous
    - b. Endogenous
    - c. Iatrogenic
    - d. Nosocomial
  - 2. Preparation of local anesthetics, contrast media, etc.
  - 3. Proper glove usage
  - 4. Skin preparation
  - 5. Sterile tray preparation
  - 6. Disposal of items
  
- B. Standard lesion localization
  - 1. Definition
  - 2. Application
  - 3. Technique
  
- C. Stereotactic lesion localization
  - 1. Definition
  - 2. Application
  - 3. Technique
  
- D. Ultrasound
  - 1. Definition
  - 2. Application
  - 3. Technique
  
- E. Cyst aspirations and fine-needle aspiration biopsies
  - 1. Definition
  - 2. Application
  - 3. Technique
  - 4. Lab analysis (pathology)
  
- F. Pneumocystography
  - 1. Definition
  - 2. Application
  - 3. Technique
  
- G. Galactography
  - 1. Definition
  - 2. Application
  - 3. Technique

- H. Core biopsy
  - 1. Definition
  - 2. Application
  - 3. Technique
  - 4. Specimen radiographs
  - 5. Pathologic analysis

ASRT

# Mammography Quality Management

## Description

Content establishes a protocol for quality assurance and quality control that incorporates all operations and functions of a mammography facility or service. The interrelatedness of accreditation and service delivery standards are demonstrated and discussed.

## Objectives

1. Perform quality control test procedures according to ACR and MQSA guidelines.
2. Document control test results.
3. Determine and implement appropriate corrective measures when established quality control standards are out of tolerance.
4. Perform safety checks on radiographic equipment and accessories.

ASRT



## **Content**

### **I. Daily Quality Assurance Procedures**

- A. Darkroom
  - 1. Purpose of quality assurance
  - 2. Regulations and recommendations
  
- B. Processor
  - 1. Purpose of quality assurance
  - 2. Control film
  - 3. Data plotted
    - a. Film medium density
    - b. Film density difference
    - c. Film base and fog
  - 4. Corrective measures
    - a. Chemistry
      - 1) Developer
      - 2) Fixer
      - 3) Water (rinse)
    - b. Temperature
      - 1) Developer
      - 2) Fixer
      - 3) Water (rinse)
      - 4) Dryer
    - c. Time
    - d. Film
    - e. Ventilation

### **II. Weekly Quality Assurance Procedures**

- A. Screen cleanliness
  - 1. Purpose
  - 2. Procedure
  - 3. Documentation
  
- B. Viewbox maintenance
  - 1. Purpose
  - 2. Procedure
  - 3. Magnifying glasses
  - 4. Documentation
  
- C. Phantom images
  - 1. Purpose
  - 2. Congruity of image
    - a. Cassette
    - b. Phototimer
    - c. Viewbox
  - 3. Documentation

- a. Exposure time
  - b. Optical density
  - c. Density difference
  - d. Fibers
  - e. Speck groups
  - f. Masses
4. Problem-solving steps

### **III. Monthly Quality Assurance Procedures**

- A. Visual checklist
  1. Purpose
  2. Documentation

### **IV. Quarterly Quality Assurance Procedures**

- A. Repeat analysis
  1. Purpose
  2. Analyze data
  3. Document data
  4. Problem-solving steps
- B. Fixer retention test
  1. Purpose
  2. Procedure
  3. Documentation
  4. Problem-solving steps

### **V. Semiannual Quality Assurance Procedures**

- A. Darkroom fog test
  1. Purpose
  2. Procedure
  3. Documentation
  4. Problem-solving steps
- B. Film-screen contact test
  1. Purpose
  2. Procedure
  3. Documentation
  4. Problem-solving steps
- C. Compression test
  1. Purpose
  2. Procedure
  3. Documentation
  4. Problem-solving steps

## **VI. Annual Quality Assurance Procedures**

- A. Physicist's survey
  - 1. Analysis and follow-up
  
- B. Qualification standards
  - 1. Physicians
  - 2. Mammographers
  - 3. Medical physicists
  
- C. Inspection by federally-certified or state-certified inspectors
  - 1. On-site testing of equipment
  - 2. Analysis of QA program

## **VII. Quality Assurance Programs for Digital Equipment**

- A. Mammography equipment
- B. Reporting system
- C. PACS

ASRT

# Positioning

## Description

Content provides a knowledge base of the various positions and projections used in mammography. Content includes discussions on clinical data needed to perform the exam and positioning techniques for screening and diagnostic mammography.

## Objectives

1. Question the patient or check the patient's wristband to verify patient's name and information on request form or doctor's order.
2. Ask appropriate questions, listen to patient responses and accurately document the information.
3. Observe any outstanding physical characteristics and document the findings.
4. Explain procedure and the need for compression to the patient before proceeding with the mammogram.
5. Achieve the best demonstration of breast tissue by manipulating the breast into proper placement, adjusting the patient, mammography equipment and cassettes, and placing the marker correctly.
6. Process and evaluate the completed image.
7. Identify the qualities necessary for an acceptable mammogram.
8. Identify anatomical structures or pathological findings.
9. Repeat films or additional views if necessary.
10. Be professional, competent, confident and nonjudgmental.

## **Content**

### **I. Clinical Data of Patient**

#### **A. History**

1. Gender
2. Age
3. Age at onset of menses
4. Parity
  - a. Nulliparity
  - b. Multiparity
  - c. Age at primiparity
5. Menstrual status
  - a. Last menstrual cycle
  - b. Age at menopause
  - c. Hysterectomy
  - d. Oophorectomy
6. Medications
  - a. Estrogen
  - b. Progesterone
  - c. Prolactin
  - d. Steroids – males
  - e. Estrogen inhibitors
7. Previous breast biopsies
  - a. Surgical biopsy and pathologic results
  - b. Core biopsy and pathologic results
  - c. Cyst aspirations
8. Previous breast surgery
  - a. Augmentation
  - b. Reduction
  - c. Other
9. Family history of breast cancer
10. Other
  - a. Previous chest surgery (open heart, etc.)
  - b. Port-a-caths, pacemakers
  - c. Moles
  - d. Accessory nipple
  - e. Unusual landmarks
  - f. Date of most recent Clinical Breast Exam (CBE) by a qualified health care provider

### **II. Screening Mammography**

#### **A. Craniocaudal (CC) projection**

1. Purpose
2. Anatomical structures demonstrated
3. Part position (x-ray tube assembly and image receptor)
4. Patient position
5. Other (patient in wheelchair, male patient, patient with Port-a-caths, etc.)

- B. Mediolateral oblique (MLO) projection
  - 1. Purpose
  - 2. Anatomical structures demonstrated
  - 3. Part position (x-ray tube assembly and image receptor)
  - 4. Patient position
  - 5. Other (pectus excavatum patients, pectus carinatum patients, patients with protruding abdomens, etc.)
  
- C. Ninety degree or true lateral projection
  - 1. Mediolateral (ML) projection
    - a. Purpose
    - b. Anatomical structures demonstrated
    - c. Part position (x-ray tube assembly and image receptor)
    - d. Patient position
    - e. Other
  - 2. Lateromedial (LM) projection
    - a. Purpose
    - b. Anatomical structures demonstrated
    - c. Part position (x-ray tube assembly and image receptor)
    - d. Patient position
    - e. Other

### **III. Diagnostic and Additional Projections**

- A. Exaggerated craniocaudal (XCCL) projection
  - 1. Purpose
  - 2. Anatomical structures demonstrated
  - 3. Part position (x-ray tube assembly and image receptor)
  - 4. Patient position
  - 5. Other
  
- B. Spot compression projection and view
  - 1. Purpose
  - 2. Anatomical structures demonstrated
  - 3. Part position (x-ray tube assembly and image receptor)
  - 4. Patient position
  - 5. Other
  
- C. Cleavage (CV) projection
  - 1. Purpose
  - 2. Anatomical structures demonstrated
  - 3. Part position (x-ray tube assembly and image receptor)
  - 4. Patient position
  - 5. Other
  
- D. Tangential (TAN) projection
  - 1. Purpose

2. Anatomical structures demonstrated
  3. Part position (x-ray tube assembly and image receptor)
  4. Patient position
  5. Other
- E. Axillary tail (AT) projection
1. Purpose
  2. Anatomical structures demonstrated
  3. Part position (x-ray tube assembly and image receptor)
  4. Patient position
  5. Other
- F. Rolled (RL and RM) projections
1. Purpose
  2. Anatomical structures demonstrated
  3. Part position (x-ray tube assembly and image receptor)
  4. Patient position
  5. Other
- G. Superolateral to inferomedial oblique (SIO) projection
1. Purpose
  2. Anatomical structures demonstrated
  3. Part position (x-ray tube assembly and image receptor)
  4. Patient position
  5. Other
- H. Caudocranial (FB) projection
1. Purpose
  2. Anatomical structures demonstrated
  3. Part position (x-ray tube assembly and image receptor)
  4. Patient position
  5. Other
- I. Implant displaced (ID) projection
1. Purpose
  2. Anatomical structures demonstrated
  3. Part position (x-ray tube assembly and image receptor)
  4. Patient position
  5. Other
- J. Magnification (M) projection
1. Purpose
  2. Anatomical structures demonstrated
  3. Part position (x-ray tube assembly and image receptor)
  4. Patient position
  5. Other

K. Patients requiring modification of positioning techniques

1. Males
2. Kyphotic patients
3. Large breasts
4. Small breasts
5. Encapsulated implants
6. Pectus excavatum
7. Pectus carinatum
8. Protruding abdomens
9. Pacemaker
10. Stretcher
11. Wheelchair
12. Port-A-Cath
13. Physically handicapped
14. Mentally handicapped

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# Sonomammography

## Description

Content develops an understanding of basic principles of sonomammography. Where applicable, ultrasonographic examinations that complement breast imaging are discussed.

## Objectives

1. Identify the basic principles of ultrasonographic imaging to include sound wave characteristics, attenuation and echoes.
2. Describe how transducer selection affects image resolution.
3. Describe the presentation of images using color-Doppler.
4. Identify basic bioeffects and patient safety concerns associated with sonography.
5. Identify how select ultrasonographic images complement breast imaging studies.
6. Delinieate normal breast tissue and indicators of common pathology seen on ultrasound.

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## **Content**

### **I. Ultrasound**

- A. Sound
- B. Pulsed ultrasound
- C. Attenuation
- D. Echo reflection
- E. Spectral Doppler
- F. Color Doppler

### **II. Transducers**

- A. Construction and operation
- B. Beams and focusing
- C. Detail resolution

### **III. Artifacts**

- A. Shadowing
- B. Enhancement
- C. Edge reflection

### **IV. Bioeffects and Safety**

### **V. Breast Imaging With Ultrasound**

- A. Sonographic appearance
  - 1. Skin line, nipple and retromammary layer
  - 2. Areolar area
  - 3. Cooper's ligament and connective tissue
  - 4. Variations with age
- B. Patient position
- C. Image orientation and labeling/scanning technique
  - 1. Side
  - 2. Scan planes
    - a. Radial vs. antiradial
    - b. Longitudinal vs. transverse
  - 3. Clock face orientation

- D. Protocols and clinical reasoning
- E. Mammographic correlation for area of interest

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# Technical Applications

## Description

Content establishes a knowledge base of factors that govern and influence producing and recording mammographic images.

## Objectives

1. Perceive the purpose for automatic exposure control (AEC) and relate it to an automatic kVp system.
2. Describe how kVp, mA, time and compression affect the mammographic image.
3. Identify the maximum permissible dose per mammography exam based on MQSA standards.
4. Identify the average dose per mammographic exposure.
5. Describe how kVp, mA, time and compression affect the radiation dose to the patient.
6. Select the correct technical variable based on variations in breast anatomy.
7. Identify imaging artifacts on mammography film.
8. Understand different film-screen combinations, their functions within the imaging system and their effect on the mammographic image.
9. Describe different types of processing and their importance in the mammographic imaging chain.
10. Identify processing artifacts on the mammography film.

## Content

### I. Technical Variables

- A. Density
- B. Contrast
- C. kVp
  - 1. Range
  - 2. Rationale
  - 3. Effect on image quality
  - 4. Relationship to exposure time/reciprocity law failure and optimum optical density
  - 5. Effect on contrast
- D. mAs
  - 1. Range
  - 2. Relationship to mR
  - 3. Relationship to exposure time/reciprocity law failure
  - 4. Effect on density
- E. Compression
  - 1. Density
  - 2. Contrast
  - 3. Detail
  - 4. Radiation dose
- F. Automatic exposure control (AEC)
  - 1. Definition
  - 2. Effect of kVp
  - 3. Effect of consistent image quality
  - 4. Backup timing
  - 5. Photocell placement
  - 6. Tracking
  - 7. Reproducibility
  - 8. MQSA requirements
- G. Half-value layer (HVL)
  - 1. Heterogeneous and homogeneous radiation
  - 2. MQSA requirements
- H. Reciprocity law failure
  - 1. Definition
  - 2. Correlation to generator type and mR/mAs
  - 3. Correlation to exposure time
  - 4. Correlation to film-screen combination

- I. Collimation
  - 1. Purpose and importance
  - 2. Film size
  - 3. MQSA requirements

## II. Screen and Film Variables

- A. Screens
  - 1. Intensifying differences
    - a. Slow
    - b. Medium
    - c. Fast
    - d. Rare earth
  - 2. Single screens
    - a. Advantages
    - b. Disadvantages
  - 3. Double screens
    - a. Advantages
    - b. Disadvantages
  - 4. Cassettes
  - 5. Care and maintenance of screens
  - 6. MQSA requirements and tests
  - 7. Artifacts
- B. Image receptors (film systems)
  - 1. Single emulsion
  - 2. Double emulsion
  - 3. Speed
  - 4. Contrast
  - 5. H&D curves
  - 6. Artifacts

## III. Processing

- A. Darkroom
  - 1. Safelight standard
  - 2. Airflow (ventilation)
  - 3. Humidity
  - 4. Design
  - 5. MQSA requirements
- B. Dedicated and nondedicated processing
- C. Standard and extended processing
  - 1. Chemistry
  - 2. Temperature
  - 3. Replenishment rates
  - 4. Roller transport

5. Guideshoes
6. Airflow

D. Artifacts

E. Laser imaging systems

ASRT

## Appendix A

This section provides an inventory of pre-existing knowledge and skills gained through entry-level radiography education and reinforced by professional practice. The content in this section aids technologists in career planning and provides preassessment tools for program managers to use in developing candidate selection criteria.

ASRT



## Clinical Practice

### Description

Content and clinical practice experiences should sequentially develop, apply, critically analyze, integrate, synthesize and evaluate concepts and theories used to perform radiologic procedures. Through structured, sequential, competency-based clinical assignments, students discuss, examine and evaluate concepts of team practice, patient-centered clinical practice and professional development.

Clinical practice experiences should teach students to provide patient care and assessment and competently perform radiologic imaging and total quality management. Levels of competency and outcomes measurement ensure the well-being of the patient prior to, during and after the radiologic procedure.

### Objectives

- Exercise the priorities required in daily clinical practice.
- Execute medical imaging procedures under an appropriate level of supervision.
- Adhere to team practice concepts that focus on organizational theories, roles of team members and conflict resolution.
- Adapt to changes and varying clinical situations.
- Describe the role of health care team members in responding/reacting to a local or national emergency.
- Provide patient-centered clinically effective care for all patients regardless of age, gender, disability, special needs, ethnicity or culture.
- Integrate appropriate and effective written, oral and nonverbal communication with patients, the public and members of the health care team in the clinical setting.
- Integrate appropriate personal and professional values into clinical practice.
- Recognize the influence of professional values on patient care.
- Explain how a person's cultural beliefs toward illness and health affect his or her health status.
- Use patient and family education strategies appropriate to the comprehension level of the patient/family.
- Provide desired psychosocial support to the patient and family.
- Demonstrate competent assessment skills through effective management of the patient's physical and mental status.
- Respond appropriately to medical emergencies.
- Examine demographic factors that influence patient compliance with medical care.
- Adapt procedures to meet the age-specific, disease-specific and cultural needs of patients.
- Assess the patient and record clinical history.
- Demonstrate basic life support procedures.
- Use appropriate charting methods.
- Recognize a life threatening ECG tracing.
- Apply standard and transmission-based precautions.
- Apply the appropriate medical asepsis and sterile technique.

- Demonstrate competency in the principles of radiation protection standards.
- Apply the principles of total quality management.
- Report equipment malfunctions.
- Examine procedure orders for accuracy and make corrective actions when applicable.
- Demonstrate safe, ethical and legal practices.
- Integrate the radiographer's practice standards into the clinical practice setting.
- Maintain patient confidentiality standards and meet HIPAA requirements.
- Demonstrate the principles of transferring, positioning and immobilizing patients.
- Comply with departmental and institutional response to emergencies, disasters and accidents.
- Differentiate between emergency and non-emergency procedures.
- Adhere to national, institutional and departmental standards, policies and procedures regarding care of patients, providing radiologic procedures and reducing medical errors.
- Select technical factors to produce quality diagnostic images with the lowest radiation exposure possible.
- Critique images for appropriate anatomy, image quality and patient identification.
- Determine corrective measures to improve inadequate images.

## Digital Image Acquisition and Display

### Description

Content imparts an understanding of the components, principles and operation of digital imaging systems found in diagnostic radiology. Factors that affect image acquisition, display, archiving and retrieval are discussed. Guidelines provide a bridge between film-based and digital imaging systems for selecting exposure factors and evaluating images within a digital system, Principles of digital system quality assurance and maintenance are presented.

### Objectives

- Define terminology associated with digital imaging systems.
- Describe the various types of digital receptors.
- Discuss the fundamentals of digital radiography, distinguishing between cassette-based systems and cassette-less systems.
- Compare the image acquisition and extraction of cassette-based vs. cassette-less systems, including detector mechanism, initial image processing, histogram analysis, automatic rescaling and the exposure index determination.
- Describe the evaluative criteria for digital radiography detectors.
- Describe the response of digital detectors to exposure variations.
- Compare the advantages and limits of each system.
- Given the performance criteria for a digital radiography detector, evaluate the spatial resolution and dose effectiveness.
- Compare the dynamic range to latitude of a screen/film receptor system to that of a digital radiography system.
- Describe the histogram and the process or histogram analysis as it relates to automatic rescaling and determining an exposure indicator.
- Describe or identify the exposure indices used by each photostimulable phosphor (PSP)-based system.
- Describe the difference between dose area product (DAP) measured with a flat panel system vs. the exposure index for a PSP-based system.
- Relate the receptor exposure indicator values to technical factors, system calibration, part/beam/plate alignment and patient exposure.
- Describe image acquisition precautions necessary for computed radiography.
- Describe the response of PSP systems to background and scatter radiation
- Utilize appropriate methods of scatter control.
- Avoid grid use errors associated with grid cut off and Moiré effect.
- Identify common limitations and technical problems encountered when using PSP systems.
- Employ appropriate beam/part/receptor alignment to avoid histogram analysis errors.
- Describe the various image processing employed for digital images.
- Associate impact of image processing parameters to the image appearance.
- Associate effects of inappropriate processing on image clarity or conspicuity.
- Describe the fundamental physical principles of exposure for digital detectors.
- Apply the fundamental principles to digital detectors.

- Describe the selection of technical factors and technical factor systems to assure appropriate receptor exposure levels for digital detectors.
- Evaluate the effect of a given exposure change on histogram shape, data width and image appearance.
- Describe the conditions that cause quantum mottle in a digital image.
- Formulate a procedure or process to minimize histogram analysis and rescaling errors.
- Describe the exposure precautions and limitations associated with PSP-based systems.
- Avoid poor quality images by observing acquisition precautions.
- Examine the potential impact of digital radiographic systems on patient exposure and methods of practicing the as low as reasonably achievable (ALARA) concept with digital systems.
- Describe the Picture Archival and Communications System (PACS) and its function.
- Identify components of the PACS,
- Describe patient benefits gained through using teleradiology.
- Identify modality types that may be incorporated into a PACS.
- Define the Accession Number.
- Describe Worklist and correct usage.
- Define digital imaging and communications in medicine (DICOM).
- Describe how an image is associated with a radiology order to create a DICOM image.
- Describe data flow for a DICOM image from an imaging modality to a PACS.
- Describe Health Insurance Portability and Accountability Act (HIPAA) concerns with electronic information.
- Identify common problems associated with retrieving and viewing images within a PACS.
- Identify the primary uses of the Diagnostic Display Workstation and Clinical Display Workstation.

## Ethics and Law in the Radiologic Sciences

### Description

Content provides a fundamental background in ethics. The historical and philosophical bases of ethics, as well as the elements of ethical behavior, are 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 is 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

- Discuss the origins of medical ethics.
- Apply medical/professional ethics in the context of a broader societal ethic.
- Explain the role of ethical behavior in health care delivery.
- Differentiate between empathetic rapport and sympathetic involvement in relationships with patients and relate these to ethical conduct.
- Explain concepts of personal honesty, integrity, accountability, competence and compassion as ethical imperatives in health care.
- Identify legal and professional standards and relate each to practice in health professions.
- Identify specific situations and conditions that give rise to ethical dilemmas in health care.
- Explain select concepts embodied in the principles of patients' rights, the doctrine of informed (patient) consent and other issues related to patients' rights.
- Explain the legal implications of professional liability, malpractice, professional negligence and other legal doctrines applicable to professional practice.
- Describe the importance of accurate, complete, correct methods of documentation as a legal/ethical imperative.
- Explore theoretical situations and questions relating to the ethics of care and health care delivery.
- Explain legal terms, principles, doctrines and laws specific to the radiologic sciences.
- Outline the conditions necessary for a valid malpractice claim.
- Describe institutional and professional liability protection typically available to the radiographer.
- Describe the components and implications of informed consent.
- Identify standards for disclosure relative to informed consent.
- Describe how consent forms are used relative to specific radiographic procedures.
- Identify the four sources of law to include statutory, administrative, common and constitutional.
- Differentiate between civil and criminal liability.
- Define tort and explain the differences between intentional and unintentional torts.
- Exhibit critical data research retrieval and analysis skills to compose an evidence-based narrative that addresses an ethical dilemma found in the patient care setting.

## Fundamentals of Radiologic Science and Health Care

### Description

Content provides an overview of the foundations in radiography and the practitioner's role in the health care delivery system. Principles, practices and policies of health care organizations are examined and discussed along with the professional responsibilities of radiographers.

### Objectives

- Identify other health science professions that participate in the patient's total health care.
- Identify various settings involved in delivering health care.
- Discuss the reimbursement/payment options for health care services.
- Discuss the role and value of a mission statement in operating an institution.
- Discuss the relationship between institutional administrative personnel and radiology services.
- Describe relationships and interdependencies of departments within a health care institution.
- Discuss the responsibilities and relationships of all personnel in the radiology department.
- Explain patient services available in the radiology department.
- Differentiate between programmatic and institutional accreditation.
- Define accreditation, credentialing, certification, registration, licensure and regulations.
- Explain the purposes of accreditation and certification and identify the agencies involved.
- Discuss the general employment outlook for the graduate radiographer.
- Discuss career advancement and opportunities for the radiographer.
- Identify the benefits of continuing education as related to improved patient care and professional enhancement.

## Human Structure and Function

### Description

Content establishes a knowledge base in anatomy and physiology. Components of the cells, tissues, organs and systems are described and discussed.

### Objectives

- Discuss the basics of anatomical nomenclature.
- Describe the chemical composition of the human body.
- Identify cell structure and elements of genetic control.
- Explain the essentials of human metabolism.
- Describe the types and functions of human tissues.
- Classify tissue types, describe the functional characteristics of each and give examples of their location within the human body.
- Describe the composition and characteristics of bone.
- Identify and locate the bones of the human skeleton.
- Identify bony processes and depressions found on the human skeleton.
- Describe articulations of the axial and appendicular skeleton.
- Differentiate the primary and secondary curves of the spine.
- Summarize the functions of the skeletal system.
- Label different types of articulations.
- Compare the types, locations and movements permitted by the different types of articulations.
- Examine how muscle is organized at the gross and microscopic levels.
- Differentiate between the structures of each type of muscle tissue.
- State the function of each type of muscle tissue.
- Name and locate the major muscles of the skeleton.
- Differentiate between the structure and function of different types of nerve cells.
- State the structure of the brain and the relationship of its component parts.
- Describe brain functions.
- List the meninges and describe the function of each.
- Outline how cerebrospinal fluid forms, circulates and functions.
- Describe the structure and function of the spinal cord.
- Determine the distribution and function of cranial and spinal nerves.
- Summarize the structure and function of components that comprise the autonomic nervous system.
- Describe the structures and functions of the components that comprise the human eye and ear.
- List the component body parts involved in the senses of smell and taste.
- List the somatic senses.
- Define endocrine.
- Describe the characteristics and functions of the components that comprise the endocrine system.

- Describe the hard and soft palates.
- Describe the structure and function of the tongue.
- Identify the structure, function and locations of the salivary glands.
- Describe the composition and characteristics of the primary organs of the digestive system.
- Describe the function(s) of each primary organ of the digestive system.
- Differentiate between the layers of tissue that comprise the esophagus, stomach, small intestine, large intestine and rectum.
- Differentiate between peritoneum, omentum and mesentery.
- List and label the accessory organs of the digestive system and describe their function.
- Identify the secretions and function of each accessory organ of the digestive system.
- Explain the purpose of digestion.
- List the digestive processes that occur in the body.
- Describe the composition and characteristics of blood.
- List the types of blood cells and state their functions.
- Differentiate between blood plasma and serum.
- Outline the clotting mechanism.
- List the blood types.
- Explain the term “Rh factor.”
- Explain the antigen/antibody relationship and its use in blood typing.
- Label the parts of the human heart.
- Describe the flow of blood through the body and identify the main vessels.
- Describe the structure and function of arteries, veins and capillaries.
- Differentiate between arterial blood in systemic circulation and arterial blood in pulmonary circulation.
- Outline the major pathways of lymphatic circulation.
- Correlate cardiac electrophysiology to a normal ECG tracing.
- Differentiate between nonspecific defenses and specific immunity.
- Explain antibody production and function.
- List the different types and functions of T- and B-cells and explain their functions.
- Label the components of the respiratory system.
- Describe the physiology and regulation of respiration.
- Label the parts of the kidneys, ureters, bladder and urethra.
- Describe the function of each organ of the urinary system.
- Describe the composition and formation of urine.
- Explain micturition.
- Label the anatomy of the male and female reproductive organs.
- Analyze the function of each of the male and female reproductive organs.
- Identify major anatomical structures found within sectional images.



## Patient Care in Radiologic Sciences

### Description

Content provides the basic concepts of patient care, which include consideration for the physical and psychological needs of the patient and family. Routine and emergency patient care procedures are described, as well as infection control procedures using standard precautions. The role of the radiographer in patient education is identified.

### Objectives

- Identify the responsibilities of the health care facility and members of the health care team.
- List the general responsibilities of the radiographer.
- Describe the practice standards for the radiographer as defined by the ASRT and state licensure.
- Discuss the interrelationship between personal, community and societal values.
- Explain the influence a person's value system has on his or her behavior.
- Discuss the development of personal and professional values.
- Describe how professional values influence patient care.
- Differentiate between culture and ethnicity.
- Explain how a person's cultural beliefs toward illness and health affect his or her health status.
- Explain perceptions of death and dying from the viewpoint of both patient and radiographer.
- Describe ethical, emotional, personal and physical aspects of death.
- List the stages of dying and describe the characteristics of each stage.
- Identify the support mechanisms available to the terminally ill.
- Identify methods for determining the correct patient for a given procedure.
- Explain the use of various communication devices and systems.
- Explain specific aspects of a radiographic procedure to the patient.
- Demonstrate correct principles of body mechanics applicable to patient care.
- Demonstrate techniques for specific types of patient transfer.
- Demonstrate select procedures to turn patients with various health conditions.
- Describe select immobilization techniques for various types of procedures and patient conditions.
- Describe specific patient safety measures and concerns.
- Explain the purpose, legal considerations and procedures for reporting an accident or incident.
- Describe methods to evaluate patient physical status.
- List the information to be collected prior to a patient examination.
- Describe vital signs used to assess patient condition that include sites for assessment and normal values.
- Recognize and describe abnormal respiratory patterns.
- State the terms used to describe respiratory rates that are above and below normal values.
- Identify terms used to describe above and below normal pulse rates.
- Assess patient vital signs.
- List the normal ranges for specific laboratory studies.

- Define terms related to infection control.
- Describe the importance of standard precautions and isolation procedures that includes sources and modes of transmission of infection and disease and institutional control procedures.
- Identify symptoms related to specific emergency situations.
- Describe the emergency medical code system for the institution and the role of a student during a medical emergency.
- Explain the special considerations necessary when performing radiographic procedures on an infant or child.
- Explain the special considerations necessary when performing radiographic procedures on a geriatric patient.
- Describe the symptoms and precautions necessary for a patient with a head injury.
- Describe three areas that are assessed by the Glasgow Coma Scale and the numbers associated with each area.
- Explain the types, immobilization devices and positioning for upper and lower extremity fractures.
- Describe the symptoms and precautions taken for a patient with traumatic injury.
- Describe the symptoms and medical interventions for a patient with a contrast agent reaction.
- Explain the role of the radiographer in patient education.
- Discuss family dynamics, culture, social, ethnic and lifestyle considerations and their impact on health status.
- Describe the patient preparation for barium studies.
- Identify specific types of tubes, lines, catheters and collection devices.
- Outline the steps in operating and maintaining suction and oxygen equipment and demonstrate their use.
- Demonstrate competency in basic life support (BLS).
- Demonstrate the use of specific medical emergency equipment and supplies.
- Describe the monitoring, pre- and post-procedure care, drug administration and special precautions for a patient undergoing invasive procedures.
- Demonstrate the appropriate procedure for gathering information prior to performing a mobile radiographic examination.
- Describe the initial steps in performing a mobile procedure.
- Explain the procedure for placing an image receptor under a patient in an orthopedic bed frame.
- Describe the special problems faced in performing procedures on a patient with a tracheotomy and specific tubes, drains and catheters.
- Describe the procedure for producing diagnostic images in the surgical suite.
- Explain the appropriate radiation protection required when performing mobile/surgical radiography.

## Pharmacology and Drug Administration

### Description

Content provides basic concepts of pharmacology. The theory and practice of basic techniques of venipuncture and administration of diagnostic contrast agents and/or intravenous medications is included. The appropriate delivery of patient care during these procedures is emphasized.

### Objectives

- Distinguish among the chemical, generic and trade names for select drugs.
- Describe pharmacokinetic and pharmacodynamic principles of drugs.
- Classify drugs according to specific categories.
- Explain the actions, uses and side effects for select drugs.
- Explain the effects of select drugs on medical imaging procedures.
- Define the categories of contrast agents and give specific examples for each category.
- Explain the pharmacology of barium and iodine compounds.
- Describe methods and techniques for administering various types of contrast agents.
- Identify and describe the routes of drug administration.
- Discuss the purposes and advantages of intravenous drug administration over other routes.
- Demonstrate appropriate venipuncture technique.
- Differentiate between the two major sites of intravenous drug administration.
- Identify, describe and document complications associated with intravenous drug therapy and appropriate actions to resolve these complications.
- Discuss the various elements of initiating and discontinuing intravenous drug therapy.
- Differentiate and document dose calculations for adult and pediatric patients.
- Prepare for injecting contrast agents/intravenous medications using aseptic technique.
- Explain the current legal and ethical status of the radiographer's role in drug administration.
- Explain a radiographer's professional liability concerning drug administration.

## Radiation Production and Characteristics

### Description

Content establishes a basic knowledge of atomic structure and terminology. Also presented are the nature and characteristics of radiation, x-ray production and the fundamentals of photon interactions with matter.

### Objectives

- Describe fundamental atomic structure.
- Explain the processes of ionization and excitation.
- Describe the electromagnetic spectrum.
- Describe wavelength and frequency and how they are related to velocity.
- Explain the relationship of energy, wavelength and frequency.
- Explain the wave-particle duality phenomena.
- Identify the properties of x-rays.
- Describe the processes of ionization and excitation.
- Describe charged and uncharged forms of particulate radiation.
- Differentiate between ionizing and nonionizing radiation.
- Describe radioactivity and radioactive decay in terms of alpha, beta and gamma emission.
- Compare the production of bremsstrahlung and characteristic radiations.
- Describe the conditions necessary to produce x-radiation.
- Describe the x-ray emission spectra.
- Identify the factors that affect the x-ray emission spectra.
- Discuss various photon interactions with matter by describing the interaction, relation to atomic number, photon energy and part density, and their applications in diagnostic radiology.
- Discuss relationships of wavelength and frequency to beam characteristics.
- Discuss the clinical significance of the photoelectric and modified scattering interactions in diagnostic imaging.

# Radiation Protection

## Description

Content presents 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

- Identify and justify the need to minimize unnecessary radiation exposure of humans.
- Distinguish between somatic and genetic radiation effects.
- Differentiate between the stochastic (probabilistic) and nonstochastic (deterministic) effects of radiation exposure.
- Explain the objectives of a radiation protection program.
- Define radiation and radioactivity units of measurement.
- Identify effective dose limits (EDL) for occupational and nonoccupational radiation exposure.
- Describe the ALARA concept.
- Identify the basis for occupational exposure limits.
- Distinguish between perceived risk and comparable risk.
- Describe the concept of the negligible individual dose (NID).
- Identify ionizing radiation sources from natural and manufactured sources.
- Comply with the legal and ethical radiation protection responsibilities of radiation workers.
- Describe the relationship between irradiated area and effective dose.
- Describe the theory and operation of radiation detection devices.
- Identify appropriate applications and limitations for each radiation detection device.
- Describe how isoexposure curves are used for radiation protection.
- Identify performance standards for beam-limiting devices.
- Describe procedures used to verify performance standards for equipment and indicate the potential consequences if the performance standards fail.
- Describe the operation of various interlocking systems for equipment and indicate potential consequences of interlock system failure.
- Identify conditions and locations evaluated in an area survey for radiation protection.
- Distinguish between controlled and non-controlled areas and list acceptable exposure levels.
- Describe “Radiation Area” signs and identify appropriate placement sites.
- Describe the function of federal, state and local regulations governing radiation protection practices.
- Describe the requirements for and responsibilities of a radiation safety officer.
- Express the need and importance of personnel monitoring for radiation workers.
- Describe personnel monitoring devices, including applications, advantages and limitations for each device.
- Interpret personnel monitoring reports.
- Compare values for individual effective dose limits for occupational radiation exposures (annual and lifetime).

- Identify anatomical structures that are considered critical for potential late effects of whole body irradiation exposure.
- Identify dose equivalent limits for the embryo and fetus in occupationally exposed women.
- Distinguish between primary and secondary radiation barriers.
- Demonstrate how the operation of various x-ray and ancillary equipment influences radiation safety and describe the potential consequences of equipment failure.
- Perform calculations of exposure with varying time, distance and shielding.
- Discuss the relationship between workload, energy, HVL, TVL, use factor and shielding design.
- Identify emergency procedures to be followed when x-ray equipment fails.
- Demonstrate how time, distance and shielding can be manipulated to minimize radiation exposures.
- Explain the relationship of beam-limiting devices to patient radiation protection.
- Discuss added and inherent filtration in terms of their effect on patient dosage.
- Explain the purpose and importance of patient shielding.
- Identify various types of patient shielding and state the advantages and disadvantages of each type.
- Use the appropriate method of shielding for a given radiographic procedure.
- Explain the relationship of exposure factors to patient dosage.
- Explain how patient position affects the dose to radiosensitive organs.
- Identify the appropriate image receptor that will result in an optimum diagnostic image with the minimum radiation exposure to the patient.
- Select the immobilization techniques used to eliminate voluntary motion.
- Describe the minimum source-to-tabletop distances for fixed and mobile fluoroscopic devices.
- Apply safety factors for the patient (and others) in the room during mobile radiographic procedures.

## Radiographic Pathology

### Description

Content introduces concepts related to disease and etiological considerations, with an emphasis on the radiographic appearance of disease and its effect on exposure factor selection.

### Objectives

- Define basic terms related to pathology.
- Describe the basic manifestations of pathological conditions and their relevance to radiologic procedures.
- Discuss the trauma classifications.
- Describe imaging procedures used in diagnosing disease.
- List the causes of tissue disruption.
- Describe the healing process.
- Identify complications connected with the repair and replacement of tissue.
- Describe the various systemic classifications of disease in terms of etiology, types, common sites, complications and prognosis.
- Describe the radiographic appearance of diseases.
- Identify the imaging procedures and interventional techniques that are appropriate for diseases common to each body system.
- Identify diseases that genetic factors contribute to or cause,

## Appendix B

The clinical experience requirements section provides information regarding the development of a well-rounded clinical experience. Information regarding the eligibility requirements for a post-primary certification examination in mammography is provided in this section.

ASRT



## Clinical Experience Requirements

The most current information regarding the eligibility requirements for a post-primary certification examination in mammography can be found at the link below.

The ARRT Clinical Experience Requirements document is located at [http://arrt.org/education/mam\\_ex\\_2006.pdf](http://arrt.org/education/mam_ex_2006.pdf).

ARRT

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