

# Mammography 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 mammography. 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 mammography 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 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 in educating technologists in the postprimary practice of mammography.

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 mammography also is included in this section.

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# Foundations

## **Computers in Radiologic Sciences**

Content is designed to introduce knowledge in computing and information processing. Computer applications in the radiologic sciences related to image capture, display, storage and distribution are presented.

## **Human Structure and Function**

Content is designed to establish a knowledge base in anatomy and physiology. Components of the cells, tissues, organs and systems will be described and discussed.

## **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 utilizing standard precautions. The role of the radiographer in patient education will be identified.

## **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 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.

## **Pharmacology**

Content is designed to broaden the technologist's knowledge of pharmacology. Topics include consumer safety and drug regulation, sources and bodily effects of drugs and safe dose preparation. Types of drug preparations, principles of responsible drug administration including routes and techniques are included. An introduction to clinical drug trials and a classification of drugs related to body systems are included as topics for presentation.

## **Quality Management**

Content is designed to impart an understanding of the tasks and protocols making up the quality management activities of a typical radiology 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 imaging modalities and image processing will be discussed. The role of the B.S.R.S. technologist will be identified and discussed. Special attention is given to American College of Radiology (ACR) and Mammography Quality Standards Act (MQSA) guidelines for mammography.

**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.

**Radiographic Pathology**

Content is designed to introduce theories of disease causation and the pathophysiologic disorders that compromise healthy systems. Etiology, pathophysiologic responses, clinical manifestations, radiographic appearance and management of alterations in body systems will be presented.

**Sectional Anatomy**

Content is designed to study normal sectional anatomy via diagrams and radiologic images.

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

## Core Content

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# Breast Anatomy and Mammographic Correlation

## Description

Content establishes a base of knowledge in breast anatomy and physiology. Correlation between breast anatomical structures and mammographic anatomical structure will be 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.

## 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 concepts of breast viability and pathology. Benign and cancerous pathology, including their mammographic appearance, will be presented.

## **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, the 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.

## **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

### **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. Menses

- 1. Early age at menarche
- 2. Late age at menopause

E. Exposure to cyclical estrogen

F. Parity

- 1. Nulliparity
- 2. Primiparity
- 3. Multiparity
- 4. Age at primiparity

G. Educational level and socioeconomic status

H. 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

# Correlative Physical Breast Assessment

## Description

Content provides an introduction to technologist-performed physical breast assessment. Content includes discussions regarding the preliminary patient assessment, physical breast assessment and documentation of findings required for a comprehensive examination for imaging correlation of the breasts.

## Objectives

1. Identify current epidemiology and risk factors of breast cancer.
2. Describe elements of breast cancer screening protocols.
3. Demonstrate an understanding of the anatomy of the breast and topographical orientation.
4. Provide a detailed description of breast assessment.
5. Implement proper techniques and procedures for conducting breast assessment.
6. Record findings and document observations arising from the breast exam with nondiagnostic descriptors.
7. Participate in patient education regarding breast self-examination.
8. Modify procedures when dealing with 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 the facility or service.

### Objectives

1. Identify key personnel and discuss regulations of the MQSA of 1992.
2. Define a mammography facility.
3. Explain patient services in the mammography department.
4. Discuss MQSA, ACR 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
- B. Mammographers
  - 1. Training requirements
    - a. Licensing
    - b. Certification
  - 2. Experience
  - 3. Continuing education
    - a. Regulations
    - b. Requirements
- C. Medical physicist
  - 1. Training
    - a. License or approval by state
  - 2. Experience
  - 3. Certification
  - 4. Continuing education
    - a. Regulations
    - b. Requirements

### **III. Patient Services**

- A. Screening mammography
  - 1. Asymptomatic patients
- 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. Specification of boards or organizations eligible to certify the training and experience of mammography personnel
  - 6. Establishment of quality standards for mammography equipment and practices, including quality assurance and quality control programs

7. Establishment of a National Mammography Quality Assurance Advisory Committee
8. Establishment of 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, will be 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, 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 according to 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 – measurement of area of interest, filtration of image, magnification, contrast, density, subtraction of image.
9. Define compression, its usefulness and minimum and maximum requirements, according to 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
    - 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 log books
- 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. Sterile technique.
2. A standard needle lesion localization.
3. A stereotactic lesion localization.
4. A fine-needle aspiration biopsy.
5. Galactography.
6. Pneumocystography.
7. 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

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# 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 will be 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.

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## **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. Analysis of data
  3. Documentation of 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

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# 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. Identify patient's name from the request form or doctor's order to confirm the information on the request form by questioning the patient or by checking the patient's wristband.
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. Manipulate breast into proper placement to achieve the best demonstration of breast tissue by adjusting the patient, mammography equipment and cassettes and using correct marker placement.
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
    - c. Moles
    - d. Accessory nipple
    - e. Unusual landmarks

### **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 (wheelchair patient, 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 is designed to develop an understanding of basic principles of sonomammography. Where applicable, ultrasonographic examinations that complement breast imaging will be discussed.

## Objectives

1. Identify the basic principles of ultrasonographic imaging to include sound wave characteristics, attenuation and echoes.
2. Describe the impact transducer selection has on image resolution.
3. Describe the presentation of images using color-Doppler.
4. Identify basic bioeffects and patient safety concerns associated with ultrasonographic imaging.
5. Identify how select ultrasonographic images complement breast imaging studies.
6. Identification of 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 in factors that govern and influence the production and recording of mammographic images.

## Objectives

1. Perceive the purpose for automatic exposure control (AEC) and relate it with 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, according to 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 the 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

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## Appendix A

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# Computers in Radiologic Sciences

## Description

Content is designed to introduce knowledge in computing and information processing. Computer applications in the radiologic sciences related to image capture, display, storage and distribution are presented.

## Objectives

1. Identify various types of computers.
2. Define analog to digital conversion and digital signal processor.
3. Identify various terms related to computer fundamentals and components.
4. Describe major functions of the central processing unit (CPU).
5. Differentiate the various input and output devices.
6. Give examples of various types of memory.
7. Describe computer care and preventive maintenance.
8. Explain computer operation.
9. Distinguish between analog computers and digital computers.
10. Discuss application of various types of software.
11. Explain the following computing applications as they relate to radiology: radiology information system (RIS), hospital information systems (HIS) and picture archiving communication system (PACS).
12. Define digital imaging and communications in medicine (DICOM).
13. Discuss the impact the Internet has on the distribution of health information.

# 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 will also 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.

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.

# Human Structure and Function

## Description

Content is designed to establish a knowledge base in anatomy and physiology. Components of the cells, tissues, organs and systems will be described and discussed.

## 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. Describe the nature of chemical bonds and compare the different types of chemical bonds.
6. Apply the pH scale to differentiate between acid and base substances.
7. Differentiate between polar and nonpolar compounds, and relate these to water solubility.
8. List different types of carbohydrates and give examples of each type.
9. Differentiate between the different types of lipids and determine common characteristics.
10. Describe the structure and functions of proteins.
11. Describe the structure of deoxyribonucleic acid (DNA) and the law of complementary base pairing.
12. Describe the structure of ribonucleic acid (RNA) and name the different types of RNA.
13. Characterize the structure of the cell membrane and the cytoskeleton.
14. Compare endocytosis and exocytosis.
15. Identify the structure and function of cilia and flagella.
16. Diagram the replication of DNA.
17. Diagram the phases of the cell cycle.
18. Describe genetic transcription and the post-transcriptional modifications that change pre-mRNA into mRNA.
19. List the functions of mRNA, tRNA and rRNA.
20. List the functions of the rough endoplasmic reticulum and Golgi apparatus in post-transcriptional modifications of secretory proteins.
21. Outline the sequence of events that occur in the synthesis packaging and exocytosis of secretory proteins.
22. Differentiate between the stages of meiosis and mitosis and identify the stages of each reproductive process.
23. Define the following: anabolism, catabolism and metabolism.
24. Characterize the role of enzymes in metabolism.
25. Describe carbohydrate metabolism.
26. Describe lipid metabolism.
27. Describe the Krebs cycle in general terms and its functional significance.
28. Express the significance of ketone.
29. List the factors that affect the basal metabolic rate.
30. Diagram the germinal layers of the embryo.
31. Classify tissue types, describe the functional characteristics of each and give examples of their location within the human body.
32. Identify and locate the bones of the human skeleton.

33. Identify bony processes and depressions found on the human skeleton.
34. Describe articulations of the axial and appendicular skeleton.
35. Differentiate the primary and secondary curves of the spine.
36. Describe sesamoid bones and locate examples on radiographs.
37. Summarize the functions of the skeletal system.
38. Label different types of articulations.
39. Compare the types, locations and movements permitted by the different types of articulations.
40. Examine the organization of muscle at the gross and microscopic levels.
41. Differentiate between the structures of each type of muscle tissue.
42. State the function of each type of muscle tissue.
43. Name and locate the major muscles of the skeleton.
44. Differentiate between the structure and function of different types of nerve cells.
45. State the structure of the brain and the relationship of its component parts.
46. Describe the brain functions.
47. List the meninges and describe the function of each.
48. Outline the formation, circulation and function of cerebrospinal fluid.
49. Describe the structure and function of the spinal cord.
50. Determine the distribution and function of cranial and spinal nerves.
51. Summarize the structure and function of components making up the autonomic nervous system.
52. Describe the structures and functions of the components making up the human eye and ear.
53. List the component body parts involved in the senses of smell and taste.
54. List the somatic senses.
55. Define endocrine.
56. Describe the characteristics and functions of the components making up the endocrine system.
57. Identify the location and describe the structure of each component of the endocrine system.
58. Identify the major hormone(s) secreted by each component of the endocrine system.
59. Describe the hard and soft palates.
60. Differentiate between deciduous and permanent teeth in terms of age for eruption and number.
61. Differentiate between the types of teeth in terms of number, location within the jaws and their function.
62. Label the component parts of a tooth.
63. Describe the structure and function of the tongue.
64. Identify the structure, function and locations of the salivary glands.
65. Recite and label the primary organs of the digestive system.
66. Describe the function(s) of each primary organ of the digestive system.
67. Differentiate between the layers of tissue that comprise the esophagus, stomach, small intestine, large intestine and rectum.
68. Differentiate between peritoneum, omentum and mesentery.
69. List and label the accessory organs of the digestive system, and describe their function.
70. Identify the secretions of accessory organs of the digestive system and the function of each.
71. Explain the purpose of digestion.
72. List the digestive processes that occur in the body.

73. Describe the composition and characteristics of blood.
74. List the types of blood cells and state their functions.
75. Differentiate between blood plasma and serum.
76. Outline the clotting mechanism.
77. List the blood types.
78. Explain the term Rh factor.
79. Explain the antigen/antibody relationship and its use in blood typing.
80. Label the parts of the human heart.
81. Describe the flow of blood through the body and identify the main vessels.
82. Describe the structure and function of arteries, veins and capillaries.
83. Differentiate between arterial blood in systemic circulation and arterial blood in pulmonary circulation.
84. Differentiate between normal and common abnormal electrocardiogram (ECG) tracings.
85. Summarize the structure, distribution and function of lymphatic vessels.
86. Outline the major pathways of lymphatic circulation.
87. Identify the location of major lymph node clusters.
88. Differentiate between nonspecific defenses and specific immunity.
89. Explain antibody production and function.
90. List the different types and functions of T- and B-cells and explain their functions.
91. Label the components of the respiratory system.
92. Describe the physiology and regulation of respiration.
93. Label the parts of the kidneys, ureters, bladder and urethra.
94. Describe the function of each organ of the urinary system.
95. Describe the composition and formation of urine.
96. Explain micturition.
97. Label the anatomy of the male and female reproductive organs.
98. Analyze the function of each of the male and female reproductive organs.
99. Demonstrate the use of topographical landmarks to locate internal structures.
100. Identify major anatomical structures found within sectional images.

# Imaging and Processing

## Description

Content is designed to establish a knowledge base in factors that govern and influence the production and recording of radiologic images. Film and electronic imaging with related accessories will be emphasized. Class demonstrations/labs are used to demonstrate application of theory.

## Objectives

1. Discuss practical considerations in setting standards for acceptable image quality.
2. Assess radiographic density on radiographic images.
3. Distinguish between acceptable and unacceptable image densities.
4. Analyze the relationships of factors that control and affect image density.
5. Critique the radiographic contrast within various radiographic images.
6. Differentiate between subject contrast and image receptor contrast.
7. Distinguish between acceptable and unacceptable contrast scales.
8. Compare long-scale and short-scale contrast images.
9. Analyze the relationships of factors that control and affect radiographic contrast.
10. Critique recorded detail on various radiographic images.
11. Differentiate between umbra and focal spot blur.
12. Analyze the relationships of factors affecting recorded detail.
13. Define distortion.
14. Differentiate between shape and size distortion.
15. Perform calculations to determine image magnification and percent magnification.
16. Differentiate between magnification as distortion and macroradiography.
17. Summarize the relationships of factors affecting distortion.
18. Formulate a plan of action to decrease image distortion.
19. Summarize the relationships of factors affecting exposure latitude.
20. Describe the operation and applications for different types of beam-limiting devices.
21. Evaluate beam-limiting devices.
22. Select the most appropriate beam-limiting device to be used for a given clinical situation.
23. Explain beam filtration.
24. Describe the change in the half-value layer (HVL) when additional filtration is added to the beam.
25. Summarize the relationships of factors affecting scattered and secondary radiation.
26. Evaluate the effects of scattered radiation on the image.
27. Compare types of grid.
28. Articulate the advantages and disadvantages of grid use.
29. Describe grid maintenance.
30. Select the most appropriate grid for a given clinical situation.
31. Interpret grid efficiency in terms of grid ratio and frequency.
32. Define grid cut-off.
33. Summarize the factors influencing grid cut-off.
34. Evaluate grid artifacts.
35. Formulate a set of rules for grid use to prevent grid cut-off and artifacts.



36. Explain the use of standardized radiographic technique charts.
37. Explain exposure factor considerations involved in technique selection.
38. Compare fixed kilovolt peak (kVp) and variable kVp systems.
39. Formulate a technique chart using either a fixed kVp or variable kVp system.
40. Calculate the photographic effect when exposure factors are given.
41. Apply mAs reciprocity to clinical simulations.
42. Describe the function of each component of radiographic film.
43. Explain latent image formation.
44. Discuss photostimulable phosphor plates as image receptors.
45. Discuss how an image is retrieved from a photostimulable phosphor.
46. Describe the features of the characteristic curve and explain its purpose.
47. Compare the characteristic curve for differing types of image receptors, both film and photostimulable phosphor plates.
48. Select the most appropriate image receptor to be used for given clinical situations.
49. Describe various types of image receptor holders.
50. Describe the function of each component of an intensifying screen.
51. Select the most appropriate intensifying screen for given clinical situations.
52. Explain the classifications of intensifying screens and the applications of each.
53. Identify procedures that ensure a long screen life devoid of artifacts and distortion.
54. Employ a quality control program for intensifying screens.
55. Differentiate between traditional intensifying screens and photostimulable phosphors.
56. Discuss darkroom-related OSHA standards for health and safety.
57. Discuss safelight illumination appropriate for specific image receptor systems.
58. Discuss the possible causes and health implications of "darkroom chemical sensitivity."
59. Describe the effects of storage on image quality.
60. List image archiving options.
61. Describe the operation and utilization of wet and dry processing.
62. Analyze the effects of processing on image quality.
63. Identify key components of an automatic film processor.
64. Demonstrate how various film sizes are fed into the film processor.
65. Analyze the steps of the processing cycle providing the specific action and duration of time for each step.
66. Identify the purpose of a daily quality control program for processors.
67. Discuss digital image processing and postprocessing.
68. Identify types of image artifacts and analyze the artifacts to determine the cause.
69. Compare methods of silver recovery.
70. Evaluate silver recovery security in terms of control, theft and misappropriation.

# Patient Assessment, Management and Education

## Description

Content is designed to introduce 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.

# 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 utilizing 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. Explain select perceptions of death and dying from patient and technologist viewpoints.
5. Describe ethical, emotional, personal and physical aspects of death.
6. List the stages of dying and describe the characteristics of each stage.
7. Identify the support mechanisms available to the terminally ill.
8. Identify methods for determining the correct patient for a given procedure.
9. Explain the use of various communication devices and systems.
10. Explain specific aspects of a radiographic procedure to the patient.
11. Demonstrate correct principles of body mechanics applicable to patient care.
12. Demonstrate techniques for specific types of patient transfer.
13. Demonstrate select procedures for turning patients with various health conditions.
14. Describe select immobilization techniques for various types of procedures and patient conditions.
15. Describe specific patient safety measures and concerns.
16. Explain the purpose, legal considerations and procedures for reporting an accident or incident.
17. Describe methods for evaluation of patient status.
18. List the information to be collected prior to patient examination.
19. Describe vital signs used to assess patient condition.
20. Convert a Fahrenheit measurement to the Celsius equivalent.
21. State the normal temperature values for the oral and rectal routes of measurement.
22. Describe the method of monitoring respiration and state the normal values expected.
23. Identify the normal values for blood pressure for males and females.
24. Identify the seven major sites for monitoring the pulse and indicate the normal values.
25. Assess patient vital signs.
26. List the normal ranges for specific laboratory studies.
27. Define terms related to infection control.
28. Describe the importance of Standard Precautions and Isolation Procedures.
29. Explain sources and modes of transmission of infection and disease.
30. List institutional/departmental procedures for infection control.
31. Describe methods for the prevention of infection to the health worker and patient.
32. Identify symptoms related to specific emergency situations.

33. Describe the emergency medical code system for the institution and the role of the student during a medical emergency.
34. Explain the special considerations necessary when performing radiographic procedures on an infant or a child.
35. Explain the special considerations necessary when performing radiographic procedures on a geriatric patient.
36. Describe the symptoms and precautions taken for a patient with a head injury.
37. Describe the symptoms and precautions taken for a patient with a spinal injury.
38. Explain the types, immobilization devices and positioning for upper and lower extremity fractures.
39. Describe the symptoms and precautions taken for a patient with massive wounds.
40. Describe the classifications and medical interventions for burns.
41. Describe the symptoms and medical interventions for a patient having a contrast agent reaction.
42. Explain the role of the technologist in patient education.
43. Describe the patient preparation for various barium studies.
44. Describe the procedure to properly prepare a patient for a barium study.
45. Identify specific types of tubes, lines, catheters and collection devices.
46. Explain the purpose, precautions and care of tubes, lines, catheters and collection devices.
47. Outline the steps in the operation and maintenance of suction and oxygen equipment and demonstrate their use.
48. Demonstrate competency in cardiopulmonary resuscitation (CPR).
49. Demonstrate the use of specific medical emergency equipment and supplies.
50. Demonstrate select first aid techniques.
51. Describe the monitoring, preprocedure and postprocedure care, drug administration and special precautions for a patient undergoing myelography and urography.
52. Demonstrate the appropriate procedure for gathering information prior to performing a mobile radiographic examination.
53. Describe the initial steps in performing a mobile procedure.
54. Explain the procedure for placing an image receptor under a patient in an orthopedic bed frame.
55. Describe the special problems faced in performing procedures on a patient with tracheotomy and specific tubes, drains and catheters.
56. Describe the procedure for producing diagnostic images in the surgical suite.
57. Explain the appropriate radiation protection required when performing mobile/surgical radiography.

# 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 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.

# Pharmacology

## Description

Content is designed to broaden the technologist's knowledge of pharmacology. Topics include consumer safety and drug regulation, sources and bodily effects of drugs and safe dose preparation. Types of drug preparations, principles of responsible drug administration including routes and techniques are included. An introduction to clinical drug trials and a classification of drugs related to body systems are included as topics for presentation.

## Objectives

1. Identify key drug laws impacting consumer safety.
2. Identify the five schedules of controlled substances and cite a drug example of each.
3. Identify the role of the FDA and DEA in the regulation and control of consumer drugs.
4. Implement strategies for health care workers involved in dispensing medications to comply with the restrictions of drug laws.
5. Interpret common abbreviations and symbols used for medication orders.
6. Translate drug measurements across measurement systems.
7. Differentiate among drug names (generic, chemical, trade, official).
8. Explain the restrictions of drug sales implied by the designation of: over the counter, legend drug and controlled substance.
9. List common material sources from which drugs are developed.
10. Describe the biological processing of drugs in the body.
11. List common variables affecting drug action within the body.
12. Describe common unexpected responses to drugs.
13. Accurately perform calculations for drug dose delivery.
14. Describe dose modifiers for pediatric and geriatric patients.
15. Describe various forms of drug preparations and supplies.
16. Incorporate the principles of responsible drug administration in the patient care setting to prevent medication error.
17. Describe administration routes and techniques for select medications.
18. Describe the principles associated with a controlled clinical drug trial.
19. Distinguish between single-blind and double-blind drug trials.
20. Organize drugs according to body system.

# Quality Management

## Description

Content is designed to impart an understanding of the tasks and protocols making up the quality management activities of a typical radiology 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 imaging modalities 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 intensifying screens.
3. Describe the effects of storage on image quality.
4. Analyze the effects of processing on image quality.
5. Identify the purpose of a daily quality control program for processors.
6. Differentiate between quality improvement/management, quality assurance and quality control.
7. List the benefits of a quality management program to the patient and to the department.
8. List elements of a quality management program and discuss how each is related to the quality management program.
9. Identify common equipment malfunctions that affect image quality.
10. Apply the principles of total quality management.
11. Ensure that performance reflects professional competence in the selection of technical factors to produce quality diagnostic images with lowest radiation exposure possible.
12. Critique images for appropriate clinical information, image quality and patient documentation.

# 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).



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 fixed and mobile fluoroscopic devices.
45. Apply safety factors for the patient (and others) in the room during mobile radiographic procedures.

# Sectional Anatomy

## Description

Content is designed to study normal sectional anatomy via diagrams and radiologic images.

## Objectives

1. Differentiate between sagittal, coronal and axial planes of the body.
2. Review the principles of imaging for imaging modalities using relevant terminology.
3. Compare the imaging modalities for application to radiation therapy.
4. Identify normal anatomical structures on sectional images.
5. Identify topographic anatomy used to locate underlying internal structures.

ASRT

## Appendix B

ASRT

## Clinical Experience Requirements

The ARRT Clinical Experience Requirements is reprinted by the permission of the ARRT. The ARRT Clinical Experience Requirements and all parts thereof are copyrighted by the ARRT.

ARRT

# MAMMOGRAPHY CLINICAL EXPERIENCE REQUIREMENTS



*Effective January 2002\**

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All applicants must demonstrate core clinical procedures to establish eligibility for ARRT Examination. The requirements listed in this document are the minimum core clinical procedures necessary to establish eligibility for the ARRT Mammography Examination. ARRT encourages individuals to obtain education and experience beyond these core requirements.

## Directions

1. **Perform the Procedures:** Applicants are required to complete: (a) 40 hours of training / education; (b) a specified number of mammographic examinations; (c) quality control procedures; (d) selected special procedures; (e) mammographic review and critique with a radiologist. Training requirements must be completed within the 24 months immediately before application for examination. All procedures must be performed within the 12 month period immediately before application for examination.
2. **Document Performance:** Applicants must use the attached Mammography Clinical Experience Documentation Form to record the performance of each repetition of the procedures. The documentation includes: name of procedure, date performed, time of day completed, name of facility where performed, and initials of supervisor verifying performance. The “Verified By” column on the form must be initialed by the supervising mammography technologist or the supervising mammography radiologist. The name and address corresponding to each set of initials must be provided on the form.
3. **Apply for the Examination:** When applying for the examination, applicants must complete the verification section of the exam application to attest to the completion of the requirements. Mail only the application for examination to the ARRT; do not send the Clinical Experience Document Form to ARRT with the application. Submitting false documentation to ARRT as part of the application process is a violation of the ARRT Standards of Ethics and may result in sanctions up to and including revocation of eligibility for certification in all categories, including those already held.
4. **Maintain Your Records:** Applicants must keep the Clinical Experience Documentation Form for at least 24 months after the application for examination is submitted. The ARRT conducts audits of some applications for examination. Applications 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.

*\* These clinical experience requirements are to be used for applications submitted after January 1, 2002. The ARRT periodically updates the clinical experience requirements, and future requirements may be different from those specified in this document. Candidates are responsible for meeting the requirements in force at the time of application.*

## **A. MAMMOGRAPHY TRAINING / EDUCATION REQUIREMENT**

The applicant must complete and document 40 hours of training / education specific to mammography under the supervision of a qualified instructor. These requirements must be completed within 24 months immediately before application for examination. The hours of documented training shall include, but not necessarily be limited to:

1. Training in breast anatomy and physiology, positioning and compression, quality assurance/ quality control techniques, imaging of patients with breast implants;
2. The performance of a minimum of 25 examinations under the direct supervision of an ARRT registered technologist or radiologist (12.5 hours maximum);
3. At least 8 hours of training in each mammography modality to be used by the technologist in performing mammography exams.

## **B. EXPERIENCE REQUIREMENT FOR MAMMOGRAPHIC EXAMINATIONS**

The applicant must perform mammographic examinations (screening and/or diagnostic) on an additional 75 patients addressing the following tasks in each examination. These 75 examinations, plus the 25 examinations performed under the direct supervision of an individual qualified (as defined by MQSA) to perform mammography, total 100 required mammographic examinations. All examinations must be performed on patients (not phantoms or simulated patients).

### **Patient Preparation / Education**

- Provide for patient comfort and cooperation by familiarizing patient with the equipment and procedure, stressing the need for compression, and by providing general psychological support.
- Solicit and record patient clinical history relevant to the performance and interpretation of the mammographic examination.
- Document location of lumps, scars, moles, etc. by means of radiopaque markers on breast and/or diagram on clinical information sheet.
- Respond to patient questions on BSE, ACS guidelines for screening mammography, patient dosage, possible need for additional projections and other breast imaging procedures.

### **Mammographic Procedure**

- Select equipment appropriate to the patient and the examination to be performed (e.g., platforms, grids, compression plates, cassettes).
- Select and record exposure factors based upon breast tissue density, patient's age, numerical compression scale and equipment characteristics.
- Place radiopaque markers on film receptor to document breast imaged and projection used.
- Position patient and equipment to provide projections specified by department protocol or requisition form.
- Evaluate the images to assure that they contain proper identification and are of diagnostic quality.

### **C. EXPERIENCE REQUIREMENT FOR QUALITY CONTROL**

The applicant must participate<sup>1</sup> in the performance, evaluation and recording of the following QC tests. QC tests are described in the Mammography Quality Control Manual (1999) published by the American College of Radiology.

- Darkroom cleanliness (at least 25 times)
- Processor QC (at least 25 times)
- Screen cleanliness (at least 4 times)
- Phantom images (at least 4 times)
- Darkroom fog (at least 2 times)
- Screen-film contact (on at least 8 cassettes)
- Compression (at least 2 times)
- Repeat analysis (at least 2 times)
- Viewboxes and viewing conditions (at least 4 times)
- Analysis of fixer retention in film (at least 2 times)
- Visual checklist (at least 2 times)
- Review medical physicist's annual survey report (1 time)

### **D. EXPERIENCE REQUIREMENT FOR INTERVENTIONAL / SPECIAL EXAMINATIONS**

The applicant must observe, assist with, or participate<sup>1</sup> in at least four of the following procedures:

- Needle localization
- Breast MRI
- Breast ultrasound: imaging, biopsy, or fine needle aspiration
- Stereotactic procedure
- Breast implant imaging
- Ductography
- Diagnostic work-up (for example, magnification, XCCL, LM, implant imaging)

### **E. EXPERIENCE REQUIREMENT FOR RADIOGRAPHIC CRITIQUE / INTERPRETATION**

The applicant must review at least 20 mammographic examinations with a radiologist to evaluate radiographic technique, breast anatomy, and pathology.

<sup>1</sup> "Participate" means being actively involved in the performance of the procedure even though the applicant may not have primary responsibility for performing the procedure.













**PHANTOM IMAGES**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

**DARKROOM FOG**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____

**SCREEN-FILM CONTACT**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

**COMPRESSION**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____

**REPEAT ANALYSIS**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____

**VIEWBOXES AND VIEWING CONDITIONS**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

**ANALYSIS OF FIXER RETENTION IN FILM**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____

**VISUAL CHECKLIST**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____
_____	_____	_____

**REVIEW MEDICAL PHYSICIST'S ANNUAL SURVEY REPORT**

Date Performed	Facility Name	Verified By (Initials)
_____	_____	_____

**D. EXPERIENCE REQUIREMENT FOR INTERVENTIONAL / SPECIAL EXAMINATIONS**

Applicant must observe or participate in at least four of the following:

<b>INTERVENTIONAL / SPECIAL EXAMINATIONS</b>				
<b>Procedure</b>	<b>Date Performed</b>	<b>Time of Day</b>	<b>Facility Name</b>	<b>Verified By (Initials)</b>
Needle Localization	_____	_____	_____	_____
Breast MRI	_____	_____	_____	_____
Breast Ultrasound: Imaging, Biopsy, or FNA	_____	_____	_____	_____
Stereotactic Procedure	_____	_____	_____	_____
Breast Implant Imaging	_____	_____	_____	_____
Ductography	_____	_____	_____	_____
Diagnostic Work-up	_____	_____	_____	_____

ASRT





## DIRECTIONS

The *Mammography Clinical Experience Documentation Form* requires only that the initials of the person verifying performance of a procedure be listed. The full name and mailing address must be supplied below to completely identify each person whose initials appear on the form.

Verified By (Initials)	Mailing Address					
	Printed Name	ARRT ID#	Street	City	State	Zip
_____	_____	_____	_____	_____	_____	_____
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_____	_____	_____	_____	_____	_____	_____

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