



Mammography

The purpose of the ~~mammography~~ examination ~~requirement~~ is to assess ~~whether individuals have obtained~~ the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required ~~of in mammographers-mammography~~ at entry ~~into the profession level~~. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of mammographers.¹ The *Task Inventory for Mammography* may be found on the ARRT's website (www.arrt.org).

The *Examination Content Specifications for Mammography* and attached content outline ~~identifies-identify~~ the knowledge areas underlying performance of the tasks on the *Task Inventory for Mammography*. Every content category can be linked to one or more tasks on the task inventory.

The table below presents the major content categories ~~and subcategories~~ covered on the examination. The number of test questions in each category are listed in bold and number of test questions in each subcategory in parentheses. Specific topics within each category are addressed in the content outline, which makes up the remaining pages of this document.

Content Category	Number of Scored Questions ²
Patient Care	4420
<i>Patient Interactions and Management (4420)</i>	
Image Production	3330
<i>Image Acquisition and Quality Assurance (3330)</i>	
Procedures	6865
<i>Anatomy, Physiology, and Pathology (26)</i>	
<i>Mammographic Positioning, Special Needs,</i>	
<i>and Imaging Procedures (4239)</i>	
Total	115

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

² The exam includes an additional 30 25 unscored (pilot) questions.



Patient Care

1. Patient Interactions and Management

A. Patient Communication

1. pre-exam instructions
(*e.g., removal of deodorant, clothing)
2. explanation of mammographic procedure/imaging
 - a. establish patient rapport
 - b. provide psychological and emotional support (e.g., anxiety, modesty)
 - c. address physical and mental limitations/needs
 - d. explain need for repeat imaging (e.g., motion, artifact)
3. patient education
 - a. American Cancer Society (ACS) and American College of Radiology (ACR) guidelines for mammography screening
 - b. ACS recommendations for breast self-examination (BSE)
 - c. ACS recommendations for clinical breast examination (CBE)
 - d. typical patient dose
 - e. breast imaging modalities (e.g., DBT/3D, 2D, ultrasound)
4. patient results
 - a. process for receiving results (e.g., telephone, mail, electronic chart access)
 - b. reason(s) for additional imaging
 - c. clinician's role in explaining results and findings (e.g., breast density reporting, diagnostic mammogram)

B. Patient Assessment (risks for breast cancer; implication for imaging)

1. epidemiology of breast cancer
 - a. incidence
 - b. risk factors
 1. female gender/sex
 2. advancing age
 3. personal history of breast cancer
 4. personal history of other cancers
 5. family history of breast cancer
 6. genetic predisposition
 7. race
 8. abnormal breast biopsy
 9. early menarche
 10. late menopause
 11. nulliparity
 12. late age at primiparity
 13. previous breast/chest radiation
 14. obesity
 15. hormone replacement therapy (HRT)
 16. breast tissue density (tissue composition)

* The abbreviation "e.g.," is used to indicate that examples are listed in parentheses, but that it is not a complete list of all possibilities.

(Patient Interactions and Management Continues on the following page)



2. signs and symptoms

- a. pain
 - b. lump
 - c. ~~thickening~~
 - d. nipple discharge
 - e. skin changes
 1. thickening
 2. erythema
 3. dimpling
 - f. nipple and areolar changes
 - g. edema
 - h. ~~erythema~~
 - i. ~~dimpling~~
3. documentation of medical history and ~~clinical~~ physical findings
- a. previous breast surgery (e.g., lumpectomy, augmentation)
 - b. clinical findings (e.g., lumps, scars, moles, tattoos, abnormalities)
 - c. gender affirmation (e.g., surgery, hormonal therapy)
4. previous mammograms
- a. importance of having prior images available
 - b. review prior to exam
 - b. ~~importance of having prior images available~~

C. Breast Cancer Treatment Options¹

1. surgical options
 - a. lumpectomy/breast-conserving surgery
 - b. ~~sentinel axillary node dissection~~
 - c. simple (total) mastectomy
 - d. modified radical mastectomy
 - e. prophylactic mastectomy
2. nonsurgical options
 - a. radiation therapy
 - b. chemotherapy
 - c. hormone therapy (antiestrogen therapy)
 1. hormone receptor status (ER+/-)
 2. hormone receptor status (PR+/-)
 3. anti-HER2/neu therapy
3. implant reconstruction
 - a. ~~implant~~
 - b. ~~TRAM flap~~
 - c. ~~latissimus dorsi flap~~

¹ The mammographer is expected to understand the definitions and basic descriptions of these terms.



Image Production

1. Image Acquisition and Quality Assurance

- A. Design Characteristics of Mammography Units
 1. kVp range
 2. mammography tube (e.g., anode, filtration, window, focal spot)
 3. compression paddles
 - a. fixed
 - b. flexed
 - c. curved
 - d. implant
 - e. spot
 4. grids
 5. system geometry (e.g., SID, OID, magnification)
- B. Digital Acquisition, Display, and Informatics
 1. acquisition type
 - a. full field digital mammography-direct radiography (FFDM-DR/2D)
 - b. digital breast tomosynthesis (DBT/3D)
 - c. synthesized imaging
 2. image receptors
 3. monitors
 - a. acquisition workstation
 - b. radiologist interpretation workstation
 4. digital image display and informatics
 - a. medical record
 1. HIS/RIS
 2. EMR
 - a. workflow (e.g., appropriate documentation, matching images, merging patient data)
 - b. PACS
 1. storage and retrieval of data
 2. backup and archive
 3. troubleshooting
 5. computer-aided detection (CAD)
- C. Quality Assurance and Evaluation
 1. accreditation and certification
 - a. agencies (ACR, FDA)
 - b. purpose
 - c. process
 - d. frequency
 2. MQSA regulations
 - a. personnel requirements
 - b. record keeping (e.g., assessment categories, image ID and labeling, maintenance of images and reports, communication of results to providers and patient)
 - c. medical outcomes audit
 - d. required policies (e.g., infection control, consumer complaint)
 - e. Enhancing Quality Using the Inspection Program (EQUIP)
 1. quality assurance (clinical image corrective action)
 2. clinical image quality
 3. quality control oversight
 - f. breast density reporting requirements

(Image Production continues on the following page.)



Image Production (continued)

D. Quality Control²

1. mammographer tests
 - a. phantom image
 1. quality
 2. artifact
 - b. compression thickness
 - c. visual checklist
 - d. acquisition and radiologist workstation monitors
 1. monitor cleanliness
 2. monitor calibration and test pattern (e.g., SMPTE, TG18)
 - e. repeat analysis
 - f. viewing conditions
 - g. compression force
 - h. manufacturer detector calibration

FOCUS OF QUESTIONS

- Purpose
- Frequency
- Equipment and Procedure
- Performance Criteria
- Evaluation and Documentation
- Corrective Action

2. medical physicist tests
 - a. mammographic equipment evaluation
 - b. collimation assessment
 - c. system resolution tests
 1. spatial resolution
 2. modulation transfer function (MTF)
 - d. low contrast performance tests
 1. signal-to-noise (SNR)
 2. contrast-to-noise (CNR)
 - e. automatic exposure control system performance
 - f. artifact evaluation
 - g. phantom image quality evaluation
 - h. kVp accuracy and reproducibility
 - i. beam quality assessment (half-value layer)
 - j. average glandular dose
 - k. room illuminance
 - l. evaluation of technologist's quality control program
 - m. application of compression
 - n. compression paddle alignment
 - o. acquisition and radiologist interpretation workstation QC

FOCUS OF QUESTIONS

- Purpose
- Frequency

² The Quality Control (QC) tests for the mammographer and the medical physicist tests listed are referenced in the 2018 ACR Digital Mammography Quality Control Manual. The mammographer is expected to have a detailed understanding of all the mammographer QC tests and a basic understanding of the medical physicist QC tests.



(Image Production continues on the following page.)

Image Production (continued)

E. Mammographic Technique and Image Evaluation

1. technical factors
 - a. kVp
 - b. mAs
 - c. automatic exposure
 - d. manual exposure
 - e. compression thickness
 - f. target/filter
 - g. focal spot
 - h. grids
 - i. magnification
 - j. labeling
2. evaluation of image quality
 - a. positioning
 - b. compression
 - c. exposure
 - d. contrast
 - e. sharpness
 - f. noise
 - g. artifacts
 - h. collimation
 - i. motion

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Procedures

1. Anatomy, Physiology, and Pathology

- A. Localization Terminology
 - 1. clock position
 - 2. quadrants (LOQ, LIQ, UOQ, UIQ)
 - 3. triangulation
- B. External Anatomy
 - 1. breast margins
 - 2. nipple
 - 3. areola
 - a. Morgagni tubercles
 - b. Montgomery glands
 - 4. angle of pectoral muscle
 - 5. skin
 - a. sebaceous glands
 - b. sweat glands
 - c. hair follicles
 - 6. axillary tail
 - 7. inframammary fold
- C. Internal Anatomy
 - 1. fascial layers
 - 2. retroglandular mammary space
 - 3. fibrous tissues
 - 4. glandular tissues
 - a. lobules
 - b. terminal ductal lobular unit (TDLU)
 - 1. extralobular terminal duct
 - 2. intralobular terminal duct
 - 3. acinus (ductal sinus)
 - 5. adipose tissues
 - 6. Cooper ligaments
 - 7. pectoral muscle
 - 8. vascular system
 - 9. lymphatic system
- D. Cytology
 - 1. epithelial cells
 - 2. myoepithelial cells
 - 3. basement membrane
- E. Pathology
 - 1. mammographic appearance and reporting terminology (BI-RADS®)
 - a. architectural distortion
 - b. asymmetry and focal asymmetry
 - c. characteristics of masses
 - 1. shape (e.g., round, irregular)
 - 2. margin (e.g., circumscribed, indistinct, spiculated)
 - 3. density
 - d. characteristics of calcifications
 - 1. typically benign (e.g., skin, vascular, coarse, milk-of-calcium layering, dystrophic)
 - 2. suspicious morphology (e.g., amorphous, heterogenous, fine pleomorphic)
 - 3. distribution (e.g., diffuse, grouped, linear)
 - e. BI-RADS® categories
 - 1. mammographic assessment
 - 2. breast composition density (e.g., entirely fatty, heterogeneously dense)
 - f. recommendations
- 2. benign pathology and mammographic appearance
 - a. cyst
 - b. galactocele
 - c. fibroadenoma
 - d. lipoma
 - e. hamartoma
 - f. papilloma
 - g. ductal ectasia
 - h. hematoma
 - i. abscess and inflammation
 - j. fat necrosis
 - k. lymph nodes
 - l. gynecomastia
 - ~~m. radial scar~~
 - m. edema
 - n. phyllodes tumor
 - o. seroma
- 3. high risk benign with upgrade potential pathology and mammographic appearance
 - a. lobular carcinoma in situ (LCIS)
 - b. atypical ductal hyperplasia (ADH)
 - c. atypical lobular hyperplasia (ALH)
 - d. papilloma with atypia
 - e. flat epithelial atypia
 - ~~f. radial scar~~
- 4. malignant pathology and mammographic appearance
 - a. ductal carcinoma in situ (DCIS)
 - b. invasive/infiltrating ductal carcinoma (IDC)
 - c. invasive lobular carcinoma
 - d. inflammatory carcinoma
 - e. Paget disease of the breast
 - f. sarcoma
 - g. lymphoma
 - h. metastatic lesions



Procedures (continued)

2. Mammographic Positioning³, **Special Needs,** and **Imaging Procedures**

A. Views

1. craniocaudal (CC)
2. mediolateral oblique (MLO)
3. mediolateral (ML)
4. lateromedial (LM)
5. exaggerated craniocaudal (XCCL, XCCM)
6. cleavage (CV)
7. axillary tail (AT)
8. tangential (TAN)
9. rolled (RL, RM, RS, RI)
10. implant displaced (ID)
11. nipple in profile
12. anterior compression
13. spot compression
14. magnification

B. **Special-Patient Situations** Variance

1. chest wall variations (e.g., pectus excavatum, pectus carinatum)
2. irradiated breast
3. reduction mammoplasty
4. postsurgical breast
5. male **sex** patients
6. kyphotic/lordotic patients
7. protruding abdomen
8. implanted devices (e.g., pacemaker, port)
9. breast augmentation (e.g., **implants, injections**)
10. lactating breast
11. extremely large/small breast (e.g., **mosaic, tiling, paddle selection**)

C. Imaging Examinations

1. mammography
 - a. screening
 1. ~~2D~~
 2. ~~digital breast tomosynthesis (DBT/3D)~~
 - b. diagnostic
2. breast ultrasound⁴
3. breast MRI⁴
4. ~~sentinel node mapping~~⁴

D. Interventional Procedures⁴

1. ~~informed consent~~ patient preparation
 - a. pertinent history (e.g., anticoagulation, allergies)
 - b. informed consent
 - c. time-out procedure
 - d. procedure set-up
 - e. ~~postprocedure instructions~~
2. procedures **and associated imaging**
 - a. biopsy ~~with clip placement~~
 1. ~~ultrasound core biopsy~~
 1. stereotactic (upright or prone) ~~core biopsy~~
 2. ultrasound
 - b. ~~cyst aspiration~~
 - c. ~~fine needle aspiration biopsy~~
 - b. needle localization (wire)
3. procedure associated **Interventional imaging**
 - a. ~~surgical specimen~~
 - b. ~~stereotactic specimen~~
 1. intraprocedural (real time)
 2. ~~post core needle biopsy (e.g., stereotactic, surgical)~~
 - c. localization
 - d. clip ~~placement~~
4. handling and disposing of biohazardous materials
 - a. biopsy specimens
 - b. ~~cyst aspirate~~ body fluids
 - c. sharps and biopsy supplies

³ The mammographer is expected to know positioning as presented in the ACR *Mammography Quality Control Manual-Clinical Image Quality* (1999). Approximately six items in this section will cover the standard views (CC and MLO).

⁴ The mammographer is expected to have the basic knowledge of these examinations and procedures.