Breast Sonography

The purpose of the ~~breast sonography~~ examination requirement is to assess whether individuals have obtained the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required ~~of breast sonographers~~ of the staff technologist at entry into the profession.

ARRT determined the tasks that entry-level breast sonographers typically perform by administering a comprehensive practice analysis survey to a nationwide sample of breast sonographers. The Task Inventory for Breast Sonography is on ARRT's website (www.arrt.org).

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

This document is not intended to serve as a curriculum guide. Although ARRT programs for certification and registration and educational programs may have related purposes, their functions are clearly different. Educational programs are generally broader in scope and address the subject matter that is included in the content outline, but do not limit themselves to only this content.

The table below presents the major content categories and subcategories that ~~covered on~~ the examination covers. The table lists t~~T~~he number of test questions in each category in bold ~~are listed in bold~~ and the number of test questions in each subcategory in parentheses. The content outline, which makes up the remaining pages of this document, addresses specific topics within each category.

Content Category	**Number of Scored Questions[2]**
Patient Care	~~18~~16
Patient Interactions and Management (~~18~~16)	
Image Production	~~102~~105
Basic Principles of Ultrasound (~~37~~32)	
Image Formation (~~32~~37)	
Evaluation and Selection of Representative Images (~~33~~36)	
Procedures	~~65~~64
Anatomical Layers and Breast Tissues ~~Anatomy and Physiology~~ (~~15~~17)	
Pathology (~~35~~32)	
Breast Interventions and Other Imaging (15)	
Total	**185**

[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 40 unscored (pilot) questions.**

Patient Care

1. Patient Interactions and Management

A. Patient Communication
1. explanation of procedure
   a. diagnostic ultrasound
   b. screening ultrasound
2. patient assessment
   a. external appearance ~~physical observations~~ and ~~symptoms (*e.g., breast changes, palpation findings, scarring,, skin)~~
      1. normal findings (*e.g. hemangioma, skin tags/moles, tattoos, scarring)
      2. abnormal findings (e.g., nipple retraction, skin changes)
   b. patient symptoms/clinical indications
      1. nipple discharge/changes
      2. palpable lump
      3. focal pain
   c. medical history ~~and clinical indications~~
      1. previous surgery
      2. previous imaging
      3. family history
      4. breast trauma
3. review and respond to inquiries regarding benefits and limitations of breast imaging studies
   a. breast sonography
   b. automated whole breast ultrasound
   c. mammography (2D, DBT)
   d. breast MRI
   e. ~~nuclear medicine (e.g., BSGI, PET/CT)~~
   ~~f. CT~~
4. patient positioning
5. explanation of findings and follow-up recommendations (ACR guidelines)
   a. ACR BI-RADS®
   b. breast density (tissue composition)

B. Facility Requirements ~~Accreditation of Ultrasound ies and Personnel Certification~~
   1. breast imaging center accreditation
   2. ultrasound personnel qualifications (e.g., training, education)

C. Verification of Requested Examination
1. determination of appropriate sequence of imaging studies
2. correlation of imaging request to clinical indications for appropriateness
3. correlation of other imaging with breast ultrasound
   a. mammography
      1. quadrant (triangulation)
      2. depth
      3. size
      4. margin
   b. breast MR
      1. quadrant
      2. depth
      3. size
      4. margin
   c. CT
   d. positron emission tomography (PET/CT)
   e. automated whole breast ultrasound

D. Breast Cancer
1. epidemiology
   a. incidence
   b. inherent risk factors
      1. female sex assigned at birth (e.g., menarche, menopause, nulliparity, primiparity)
      2. age
      3. personal history of cancer (e.g., breast, ovarian, lung)
      4. genetic risk (e.g., family history, gene mutations)
      5. previous chest radiation
      6. breast tissue density (tissue composition)
   c. social risk factors
      1. lifestyle (e.g., tobacco use, body weight, excessive alcohol use)
      2. access to care/health disparity hormone use (e.g., HRT, birth control, gender transition)

E. Communication of Imaging to Supervising Physician (radiologist, surgeon)
1. description of findings using appropriate terminology (e.g., echo patterns, size/shape, vascularity, location ~~anechoic, hypoechoic, hyperechoic, isoechoic~~)
2. review of findings (e.g., in person, remote, teleradiology)

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

Image Production

1. Basic Principles of Ultrasound

A. Generation of Signal
   1. console
   2. monitors
   3. transducers
      a. piezoelectric effect
      b. components
      c. resonance frequency
      d. beam characteristics (e.g., near zone/field, far zone)
      e. focusing (e.g., electronic, beam)
      f. types (e.g., curved, linear)

B. Ultrasound Wave Characteristics
   1. speed of sound (propagation speed)
   2. frequency
   3. reflection and refraction
   4. intensity of signal
   5. acoustic impedance
   6. attenuation coefficient
   7. pulsed
   8. Doppler
   9. ~~specular reflectors~~scatter (specular/nonspecular reflection)
   10. amplitude

C. Fundamentals
   1. relationship between speed of sound, frequency, and wavelength
   2. image resolution
      a. axial
      b. lateral
      c. elevational
      d. temporal
      e. contrast (soft tissue)
   3. range equation
   4. dynamic range
   5. acoustic transmission media (e.g., gel)

[1] Operator ergonomics is referenced in the "Industry Standards for the Prevention of Work Related Musculoskeletal Disorders in Sonography."

2. Image Formation

A. Selection and Adjustment of Technical Factors
   1. power
   2. focal zone
   3. field of view (depth)
   4. time-gain compensation (TGC)
   5. overall gain
   6. dynamic range
   7. harmonic imaging
   8. spatial compounding

B. Safety
   1. sonographer ergonomics[1]
      a. equipment (e.g., monitor level, table height)
      b. work environment (e.g., lighting, placement of accessories)
      c. ~~sonographer~~ body mechanics (e.g., transducer contact pressure, posture)
   2. patient bioeffects

C Image Orientation and Transducer Manipulation
   1. superior and inferior
   2. lateral and medial

D. Image Documentation (ACR Practice Parameters ~~Guidelines~~)
   1. manual or automated annotation
      a. patient identification
      b. laterality
      c. transducer orientation (e.g., radial or antiradial, transverse or longitudinal)
      d. clock position
      e. distance from the nipple
   2. lesion measurement

E. Image Optimization ~~Other Imaging Tools~~
   1. manual image optimization
      a. Doppler
         1.color
         2.power
      b. fremitus
      c. panoramic imaging (extended field of view)
      d. stand-off pad
      e. cine loop
      f. beam steering
      g. static elastography (mechanical compression)
   2. automated imaging optimization (e.g., automated technical factor selection)

(Image Production continues on the following page.)

Image Production (continued)

3. Evaluation and Selection of Representative Images

A. Criteria for Diagnostic Quality
   1. demonstration of anatomic structure
   2. demonstration of pathologic conditions
   3. use of calipers
   4. improvement of suboptimal images

B. Artifact Recognition (diagnostic versus non-diagnostic value)
   1. posterior shadowing
   2. edge shadowing
   3. posterior enhancement
   4. reverberation
   5. color Doppler flash
   6. speed propagation
   7. mirror artifact
   8. implant rupture artifacts (e.g., snowstorm, stepladder)
   ~~7. ring-down~~

C. Image Display and Storage
   1. post-processing
      a. cine loop
      b. overall gain
      ~~a. dynamic range~~
      ~~d. annotations and measurements~~
   2. PACS (MIMPS)

D. Maintenance ~~Evaluation~~ of Sonographic Equipment and Accessories
   ~~1. equipment quality control~~
   1. sonographer quality assurance tasks
      a. clean filters
      d. visual check (e.g., cords, transducer)
      c. infection control (e.g., exam table, transducer disinfection[2])
      d. console cleanliness (e.g., gel build up, dust)
   2. recognition of equipment malfunctions (e.g., transducer dropout, track ball)
   ~~sensitivity (e.g., contrast resolution, detection of lesion, dead zone)~~
   ~~b. vertical and horizontal distance accuracy~~
   ~~c. focal zone~~
   ~~d. resolution (e.g., lateral, axial)~~
   ~~e. TGC characteristics~~
   ~~f. overall gain~~
   ~~g. dynamic range~~

[2] Transducer infection control is referenced in the "Guidelines for Infection Prevention and Control in Sonography: Reprocessing the Ultrasound Transducer."

Procedures

1. Anatomical Layers and Breast Tissues ~~y and Physiology~~

A. Breast Anatomy
1. skin
2. fat
3. fibroglandular tissue
4. pectoralis muscle
5. ribs

B. Fascia
1. superficial fascia
2. deep fascia

C. Nipple
1. areola~~r~~
   a. Montgomery glands
   b. Morgagni tubercles
   c. lactiferous sinus

D. Blood Flow ~~Vascular System~~
a. normal blood flow
b. artery versus vein

E. Lymph Nodes ~~Lymphatic System~~
1. axillary
2. ~~regional lymph nodes~~internal mammary
3. intramammary
4. supraclavicular

F. Other Breast Components
1. ducts
2. lobules
3. Cooper ligaments

2. Pathology and Sonographic Features[1]

A. Benign Conditions ~~and Sonographic Features (e.g., echogenicity, posterior acoustic features)~~
1. cyst (e.g., simple, complex, complicated)
~~2. galactocele~~
2. sebaceous cyst
3. fibroadenoma
4. papilloma
5. lipoma
6. hamartoma
7. abscess and inflammation
8. ~~traumatic changes~~hematoma
9. oil cyst
10. fat necrosis
11. duct~~al~~ ectasia
12. edema
13. diabetic mastopathy
14. pseudoangiomatous stromal hyperplasia (PASH)

~~15. phyllodes tumor~~
15. gynecomastia
16. lymph nodes
17. pregnancy induced changes (e.g., galactocele, prominent ducts, lactating adenoma)
18. pseudoaneurysm

B. Benign with Upgrade Potential ~~High Risk Conditions and Sonographic Features (e.g., echogenicity, posterior acoustic features)~~
1. lobular carcinoma in situ (LCIS)
2. atypical ductal hyperplasia (ADH)
3. atypical lobular hyperplasia (ALH)
4. papilloma with atypia
5. radial scar
6. phyllodes tumor

C. Malignant Conditions ~~and Sonographic Features (e.g., echogenicity, posterior acoustic features)~~
1. ductal carcinoma in situ (DCIS)
2. invasive ductal carcinoma
   a. medullary carcinoma
   b. mucinous (colloid) carcinoma
   c. papillary carcinoma
   d. tubular carcinoma
3. invasive lobular carcinoma
4. inflammatory carcinoma
5. Paget disease
6. lymphoma
7. metastasis
8. metastatic lymph nodes

[1]The breast sonographer is expected to describe sonographic and pathologic features according to the ACR BI-RADS lexicon manual including shape, orientation, margin, echo pattern, and posterior features.

(Procedures continues on the following page.)

3. Breast Interventions and Other Imaging

A. Surgical Procedures*
   1. lumpectomy (e.g. benign surgical excision, breast conservation surgery)
   2. axillary dissection
   3. mastectomy (with/without reconstruction)
   4. augmentation
   5. reduction

B. Postoperative Breast Changes
   1. hematoma
   2. seroma
   3. surgical ~~scarring~~changes (e.g., fat necrosis, oil cysts, lumpectomy scaring)

C. Therapeutic Treatment Changes*
   1. chemotherapy (neoadjuvant and adjuvant)
   2. hormonal therapy (e.g., antiestrogen therapy)
   3. post-radiation changes

D. Other Breast Ultrasound Imaging
   1. whole breast ultrasound (implant integrity)
   2. supplemental screening for dense tissue
   3. identification of multifocal/multicentric disease (post breast cancer diagnosis)
   4. second look following MRI

*The breast sonographer is expected to have basic knowledge of these procedures and treatment changes.

Procedures (continued)

D. Image-Guided Breast Procedures

1. Fluid Aspiration (e.g., abscess, seroma, cyst)
2. Fine Needle Aspiration ~~Biopsy~~
3. Needle Core Biopsy (e.g., spring-loaded)
4. Vacuum-Assisted Core Biopsy
5. Clip Placement
6. Needle~~/Wire~~ Localization
   a. wire
   b. non-wire (radar/radiofrequency, magnetic, radioactive seed)

FOCUS OF QUESTIONS

Questions about each of the procedures listed on the left may focus on any of the following factors:

A. Explain Procedure, Risks, and Benefits

B. Consent (e.g., informed, oral, implied)

C. Select and Prepare Equipment

D. Perform Time Out Procedure

E. Position Patient

F. Practice Infection Control and Prevention

1. aseptic technique
2. sharps disposal
3. biohazard disposal (OSHA Guidelines)

G. Assist with Procedure

H. Communicate with Performing Physician

I. Provide Post-Procedural Care and Instructions

J. Hemostasis