

American College of Radiology/Society of Breast Imaging Curriculum for Resident and Fellow Education in Breast Imaging[†]

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The ACR and the Society of Breast Imaging have revised the curriculum for resident and fellow education in breast imaging on the basis of substantial changes in breast imaging practice since the initial curriculum was published in 2000. This curriculum provides guidance to academic chairs, residency program directors, and academic section chiefs in assessing and improving their residency and fellowship training programs and indicates to residents and breast imaging fellows the topics they need to learn and the experience they should try to acquire during their training. Radiologists already in practice also may find the curriculum useful in outlining the material they need to know to remain up to date in the practice of breast imaging.

Key Words: Breast imaging, residency training, fellowship training, education, mammography, breast ultrasound, breast MRI

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Six years ago, the Society of Breast Imaging (SBI) developed a curriculum for resident and fellow education in breast imaging in response to a request from the Curriculum Committee of the Association of Program Directors in Radiology [1]. Since that time, there have been numerous changes in breast imaging practice, including publication by the ACR of the fourth edition of the Breast Imaging Reporting and Data System[®] (BI-RADS[®]), changes in US Food and Drug Administration guidance concerning Mammography Quality Standards Act (MQSA) regulations, and the increased use of breast ultrasound, magnetic resonance imaging (MRI), interventional breast imaging procedures, and full-field digital mammography. The ACR and SBI have revised the training curriculum to incorporate these important changes in practice. The authors of the revised curricu-

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The breast imaging training curriculum has been designed principally (1) to provide guidance to academic chairs, residency program directors, and academic section chiefs in assessing and improving their residency and fellowship training programs and (2) to indicate to residents and breast imaging fellows the topics they need to learn and the experience they should try to acquire during their training. Radiologists already in practice also may find the curriculum useful in outlining the material they need to know to remain up-to-date in the practice of breast imaging.

The curriculum consists of bulleted lists, in outline format, covering many areas pertinent to breast imaging practice. These revised lists have been shortened somewhat from those provided in the initial curriculum to produce a more concise document. It is assumed that the academic section chiefs who are directly responsible for providing breast imaging training will expand and elaborate the abbreviated list items as appropriate. Several of the listed items involve aspects of breast imaging practice that are not universally available in either academic or community practice, for example, full-field digital mammography, computer-aided detection, and breast MRI. If a training program finds it impractical to provide hands-on experience with a given list item, either on site or at a cooperating neighbor institution, then instruction should be provided in lecture, conference, syllabus, videotape, or another format. The curriculum also includes several specific documents with which residents and fellows should become familiar, for example, the most recent edition of BI-RADS[®] [2]. The selection of specific textbooks and other learning materials is left to the discretion of both trainers and trainees, with the understanding that learning is most effective when a variety of educational materials are studied. Unlike its predecessor, the revised curriculum omits recommendations concerning the number of specific breast imaging examinations and procedures that residents and fellows should perform during their training. Clearly, more is better, but local institutional conditions (eg, several residents and fellows on service simultaneously) may preclude the achievement of a specific target number for a given infrequently performed procedure, especially as concerns every resident in training. Academic section chiefs should consider the volume requirements for initial and continuing experience of MQSA and the several ACR accreditation programs as desirable minimum volume goals for their resi-

dent trainees and to expect their fellow trainees to far exceed these volume goals.

The ultimate goal of a residency training program in breast imaging should be for resident graduates to be fully prepared to assume the role of interpreting physician in any breast imaging facility, without the need for additional training. Residency training must involve a minimum of 12 full-time-equivalent weeks of clinical training in breast imaging during the entire 4-year residency. It is recommended that the initial month of breast imaging training be given in the first or second year of residency, to expose residents to the practice of breast imaging before they are expected to make subspecialty career choices. It also is recommended that the last month of breast imaging training be given in the last 6 months of residency, because in case board certification is not achieved by the end of residency, the MQSA initial-experience requirement for the direct supervision of at least 240 mammography interpretations must be met within 6 months (rather than 2 years) of beginning independent interpretation of mammography examinations.

The ultimate goal of a fellowship program in breast imaging should be for fellow graduates to be fully prepared to assume the role of lead interpreting physician in any breast imaging facility, without the need for additional training. To this end, a breast imaging fellowship should involve a minimum of 6 full-time-equivalent months of training after the completion of residency; 12 months is recommended.

Breast imaging has undergone considerable growth and change in recent years, and this trend is expected to continue. Therefore, the residency and fellowship training curriculum likely will require periodic additional updates.

BREAST IMAGING RESIDENCY TRAINING CURRICULUM

By means of lectures, conferences, textbooks, syllabi, journal reprints, videotapes, teaching files, and other teaching materials, a resident should become familiar with and understand the following topics in breast disease:

Breast anatomy, physiology, and pathology

- Breast development
- Normal breast anatomy and histology; alteration with age, pregnancy, menstrual cycle, and hormonal effects; male breast anatomy
- Pathologic appearance and clinical significance of
 - Benign breast lesions
 - Atypical ductal hyperplasia, atypical lobular hyperplasia, lobular carcinoma in situ, and other histologic risk factors

- Ductal carcinoma in situ, including its histologic subtypes
- Invasive ductal carcinoma not otherwise specified; subtypes of invasive ductal carcinoma (mucinous, medullary, papillary, tubular); invasive lobular carcinoma
- Other types of breast cancer, such as Paget's disease and inflammatory carcinoma
- Other malignancies involving the breast, including phyllodes tumor, lymphoma, leukemia, sarcomas, and metastases
- Histologic grading
- Pathologic staging
- Multifocal and multicentric carcinoma
- Margin analysis for specimens containing malignancy

Epidemiology

- Risk factors for breast cancer
 - Indications for genetic screening
- Breast cancer incidence and mortality, including longitudinal trends
- Breast cancer staging and survival rates by stage

Mammographic equipment and technique

- Both screen-film and full-field digital mammography
 - Features of dedicated mammographic units, including target, filtration, automatic exposure control, and grids
 - Factors affecting optical density, contrast, sharpness, and noise
 - Selection of technique factors, including effects of milliampere-seconds, kilovolt peak, target and filter material choice, and density settings on image quality and radiation dose
 - Effect of breast thickness and composition on technique, image quality, and radiation dose
 - Mammographic positioning for craniocaudal and mediolateral oblique views
 - Mammographic positioning for women with breast implants
 - Rationale for breast compression
 - Clinical image assessment for proper breast positioning, compression, exposure, contrast, sharpness, and noise
- Screen-film mammography
 - Characteristics of mammographic screen-film systems
 - Film processing
 - Effect of screen-film speed, optical density, and film processing on radiation dose
 - High-intensity view boxes, view box masking
- Full-field digital mammography
 - Characteristics of full-field digital mammographic systems, including advantages and limitations

- Effects of postprocessing on the digital mammographic image
- Effect of signal-to-noise ratio on radiation dose
- Dedicated high-luminance, high-resolution viewing monitors
- ACR Practice Guideline for the Performance of Whole Breast Digital Mammography [3]

Mammography quality assurance

- Familiarity with content in the ACR *Mammography Quality Control Manual* [4]
- Purpose and frequency of performance of quality control tests performed by the technologist and physicist
- Demonstrate proficiency in recognizing the mammographic appearance of artifacts for both screen-film and digital mammography
- Regulation
 - Equipment, quality control, and personnel (radiologist, technologist, physicist) requirements for ACR accreditation and MQSA certification
 - Responsibilities of the lead interpreting physician
- Medical audit
 - Audit definitions as provided by BI-RADS®
 - Desirable goals and benchmarks for standard outcome parameters, for both screening and diagnostic mammography [5–7]
 - Auditing requirements for MQSA certification

Mammographic interpretation

- Optimal viewing conditions, including a low ambient light environment
- Demonstrate proficiency in
 - Recognizing normal mammographic anatomy
 - Recognizing the mammographic features of characteristically benign and suspicious breast calcifications
 - Recognizing the mammographic features of characteristically benign and suspicious breast masses
 - Recognizing the mammographic appearance of indirect signs of malignancy (architectural distortion, asymmetries, etc)
 - Recognizing the mammographic features of the surgically altered breast, including implants
 - Recognizing the mammographic features of probably benign (BI-RADS® category 3) lesions
- Principles, methods, strengths, and pitfalls of computer-aided detection and double reading

Screening mammography

- Randomized clinical trials, case-control studies, service-screening studies: purpose, methods, results
- Pitfalls in evaluating screening results: lead-time bias, length-bias sampling, selection bias, prevalence vs incidence screening, interval cancer rate, survival rates

- Relative screening efficacy of clinical breast examination, breast self-examination, and mammography
- Benefit-risk assessment, including radiation risk and false-positive results
- Cost-effectiveness
- Controversies regarding screening women aged 40 to 49 years; younger than age 40
 - Screening guidelines of the ACR, the American Cancer Society, the National Cancer Institute, the US Preventive Services Task Force, and others
- Logistics and throughput issues in the performance and interpretation of screening mammography examinations
- ACR Practice Guideline for the Performance of Screening Mammography [3]

Diagnostic (problem-solving) mammography

- Techniques and indications for and value of supplementary mammographic views
- Demonstrate proficiency in
 - Performing the workup of lesions seen on only 1 standard (mediolateral oblique or craniocaudal) screening view
 - Three-dimensional lesion localization
 - Correlation of palpable with imaging findings
 - Evaluation and management of a palpable mass (or other focal symptoms) when there are no associated mammographic findings
 - Assessment of extent of disease for suspicious and for known-malignant lesions
- ACR Practice Guideline for the Performance of Diagnostic Mammography [3]

Breast ultrasound

- Equipment and physical principles
- Techniques
- Indications
- Demonstrate proficiency in
 - Scanning the breast
 - Recognizing normal sonographic anatomy
 - Recognizing features of simple cysts, complicated cysts, complex masses
 - Recognizing differential features of benign and malignant solid masses
 - Correlation with findings at mammography and clinical breast examination
- Limitations in the detection and assessment of microcalcifications
- Controversies regarding the role of screening whole-breast ultrasound examination
- ACR Practice Guideline for the Performance of a Breast Ultrasound Examination [3]
- ACR Breast Ultrasound Accreditation Program

Breast MRI

- Equipment and physical principles
- Techniques
- Indications
- Strengths and limitations of kinetic and morphologic analysis
- Demonstrate proficiency in
 - Recognizing normal MRI anatomy
 - Recognizing differential features of benign and malignant masses
 - Recognizing differential features of benign and malignant non-mass-like enhancement
 - Evaluating implant integrity
 - Correlation with findings at mammography, ultrasound, and clinical breast examination
- Limitations in the detection and assessment of lesions presenting as microcalcifications
- Controversies regarding the role of screening breast MRI examination
- ACR Practice Guideline for the Performance of MRI of the Breast [3]

Reporting and medicolegal aspects of breast imaging

- Demonstrate proficiency in producing breast imaging reports, including
 - ACR BI-RADS® lexicon terms for mammography, ultrasound, and MRI
 - Lesion location
 - Categorization of breast composition (BI-RADS® breast density descriptors)
 - Final assessment categories (ACR BI-RADS®; MQSA regulatory requirements)
 - Management recommendations
 - Concordance between lesion descriptors and assessment categories
 - Concordance between assessment categories and management recommendations
- MQSA regulatory requirements for reporting mammography results to referring clinician and patient
- Medicolegal aspects of all breast imaging and interventional procedures
 - Understanding the supervisory responsibility for approving the technical quality of a given examination
 - Communication issues and follow-up of abnormal findings
 - Informed consent for invasive procedures

Interventional procedures

- Principles, indications and contraindications, equipment, preparation, technique, advantages, disadvantages, accuracy, and auditing for

- Needle-wire localization guided by mammography and ultrasound
- Ultrasound-guided core biopsy (also fine-needle aspiration, if available)
- Stereotactically guided core biopsy (also fine-needle aspiration, if available)
- Ultrasound-guided cyst aspiration
- Second-look ultrasound to substitute ultrasound guidance for MRI guidance
- MRI-guided core biopsy and needle-wire localization
- Use and limitations of using markers to indicate the site of percutaneous biopsy
- Specimen radiography, including paraffin block radiography
- Galactography
- Assessment of imaging-pathologic concordance
- Postprocedure follow-up imaging
- ACR Practice Guideline for the Performance of Ultrasound-Guided Breast Interventional Procedures [3]
- ACR Practice Guideline for the Performance of Stereotactically Guided Breast Interventional Procedures [3]
- ACR Ultrasound-Guided Breast Biopsy Accreditation Module (part of the ACR Breast Ultrasound Accreditation Program)
- ACR Stereotactic Breast Biopsy Accreditation Program

Therapeutic and management considerations

- Basic understanding of breast cancer treatment options
- Role of breast imaging in planning and monitoring of breast cancer treatment and posttreatment follow-up
- ACR Practice Guideline for the Management of Ductal Carcinoma In-Situ of the Breast [3]
- ACR Practice Guideline for Breast Conservation Therapy in the Management of Invasive Breast Carcinoma [3]
- ACR Appropriateness Criteria™ for breast microcalcifications, nonpalpable breast masses, palpable breast masses, stage I breast carcinoma [8]

Economics of breast imaging practice

- Basic understanding of coding and billing
- Revenue positive, revenue neutral, and revenue negative breast imaging examinations
- Strategies to improve the profitability of a breast imaging practice

Other recommendations

- Minimum of 12 full-time-equivalent weeks of clinical training in breast imaging during 4-year residency; it is

recommended that the initial month of breast imaging training be given in the first or second year of residency, to expose residents to the practice of breast imaging before they are expected to make subspecialty career choices

- Active participation in screening and diagnostic mammography interpretation
- Hands-on performance of breast ultrasound examinations
- Hands-on performance of all interventional breast imaging procedures, especially needle-wire localization and ultrasound-guided core biopsy
- Active participation in breast MRI interpretation
- Formal teaching conferences (lectures, case presentations)
- Imaging-pathologic correlation conferences; also multidisciplinary breast cancer case conferences, if practical
- Direct observation or videotape of mammographic positioning for routine and supplementary views
- Review of teaching file materials (film or digital images), especially using computer-based interactive formats
- Breast imaging textbooks available in department or breast imaging section library
- Reprint file or reference library including breast imaging materials
- Log of numbers of mammograms and sonograms interpreted and of procedures performed by each resident

BREAST IMAGING FELLOWSHIP TRAINING CURRICULUM

- Minimum of 6 full-time-equivalent months training after completion of residency; 12 months is recommended
- The fellow should acquire much deeper knowledge of all topics for which the resident should have familiarity and understanding (as listed in the Breast Imaging Residency Training Curriculum)
- Fellows should interpret many more examinations and perform many more interventional procedures than residents
- Demonstrate proficiency in performing all types of interventional breast imaging procedures performed at the training institution; when the number of a given interventional procedure is severely limited, these procedures should be performed by the fellow and observed by residents; if a particular interventional procedure listed above is not performed at all at the training institution, hands-on experience with this procedure should be arranged at a nearby institution, if practical
- Demonstrate proficiency in interacting with patients, including how to recommend biopsy, how to explain a

cancer diagnosis, and how to develop sensitivity to patients' emotional needs

- Experience interacting with surgeons, pathologists, medical oncologists, and radiation oncologists in providing multidisciplinary patient care
- Familiarity with radionuclide breast scanning
- Familiarity with performing a medical audit
- Teaching medical students and residents
- Encourage participation in research projects
- Familiarity with performing breast positioning and setting techniques for mammographic examination
- Familiarity with performing technologists' quality control tests for screen-film and digital mammography
- Knowledge of quality control tests performed by medical physicists
- Observation of pathology, breast surgery, and radiation therapy practice

SUMMARY

The ACR and SBI have revised the breast imaging training curriculum to incorporate recent growth and changes in breast imaging practice, including publication of the fourth edition of BI-RADS[®], changes in Food and Drug Administration guidance concerning MQSA regulations, and the increased use of breast ultrasound, breast MRI, interventional breast imaging procedures, and full-field digital mammography. By adhering to the revised

curriculum, residency training programs should produce graduates who are fully prepared to assume the role of interpreting physician in any breast imaging facility without the need for additional training, and fellowship training programs should produce graduates who are fully prepared to assume the role of lead interpreting physician in any breast imaging facility without the need for additional training.

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