American College of Radiology
ACR Appropriateness Criteria®

Clinical Condition: **Breast Cancer Screening**

Variant 1: **High-risk women: women with a BRCA gene mutation and their untested first-degree relatives, women with a history of chest irradiation between the ages of 10-30, women with 20% or greater lifetime risk of breast cancer.**

Radiologic Procedure	Rating	Comments	RRL*
Mammography screening	9	Beginning at age 25-30 or 10 years before age of first-degree relative with breast cancer or 8 years after radiation therapy, but not before age of 25. Mammography and MRI are complementary examinations, both should be performed.	☢☢
MRI breast without and with contrast	9	Mammography and MRI are complementary examinations, both should be performed. See statement regarding contrast in text under "Anticipated Exceptions."	O
US breast	6	If patient cannot have MRI.	O
FDG-PEM	2		☢☢☢☢
Tc-99m sestamibi BSGI	2		☢☢☢☢
MRI breast without contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Variant 2: **Intermediate-risk women: women with personal history of breast cancer, lobular neoplasia, atypical ductal hyperplasia, or 15%-20% lifetime risk of breast cancer.**

Radiologic Procedure	Rating	Comments	RRL*
Mammography screening	9		☢☢
MRI breast without and with contrast	7	See statement regarding contrast in text under "Anticipated Exceptions."	O
US breast	5		O
FDG-PEM	2		☢☢☢☢
Tc-99m sestamibi BSGI	2		☢☢☢☢
MRI breast without contrast	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

Clinical Condition: **Breast Cancer Screening**

Variant 3: **Average-risk women: women with <15% lifetime risk of breast cancer, breasts not dense.**

Radiologic Procedure	Rating	Comments	RRL*
Mammography screening	9		☢ ☢
MRI breast without and with contrast	3		O
US breast	2		O
MRI breast without contrast	1		O
FDG-PEM	1		☢ ☢ ☢ ☢
Tc-99m sestamibi BSGI	1		☢ ☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			***Relative Radiation Level**

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Summary of Literature Review

Mammography

Mammography is the only method of screening for breast cancer shown to decrease mortality [1-4]. Annual screening mammography is recommended starting at: 1) age 40 for general population; 2) age 25-30 for BRCA (BReast CAncer 1) carriers and untested relatives of BRCA carriers; 3) age 25-30 or 10 years earlier than the age of the affected relative at diagnosis (whichever is later) for women with a first-degree relative with premenopausal breast cancer or for women with a lifetime risk of breast cancer ≥20% on the basis of family history; 4) 8 years after radiation therapy but not before age 25 for women who received mantle radiation between the ages of 10-30; and 5) any age for women with biopsy-proven lobular neoplasia, atypical ductal hyperplasia (ADH), ductal carcinoma in situ (DCIS), or invasive breast cancer [5]. However, mammography alone does not perform as well as mammography plus supplemental screening in certain subsets of women, particularly those with a genetic predisposition to the disease and those with dense breasts [6-11]. Therefore, supplemental screening is recommended in selected high-risk populations.

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Magnetic Resonance Imaging

Breast magnetic resonance imaging (MRI) in high-risk women has been shown to have a higher sensitivity than mammography, and the combination of mammography and MRI in this population has the highest sensitivity [12-19]. In a high-risk population, MRI and mammography combined have a higher sensitivity (92.7%) than ultrasound (US) and mammography combined (52%) [6]. Therefore, in high-risk women for whom supplemental screening is indicated, MRI is recommended when possible.

Screening high-risk women with breast MRI is cost-effective [20,21] and the cost-effectiveness of screening MRI increases with increasing breast cancer risk. The American Cancer Society recommends screening breast MRI in certain high-risk women [22], and the ACR and Society of Breast Imaging endorse those recommendations [5]. Screening MRI is recommended in women with BRCA gene mutations and their untested first-degree relatives as well as women with a lifetime risk of breast cancer of ~20% or greater. Also included in this high-risk group are women who have received radiation therapy to the chest between the ages of 10-30 as well as women with other genetic syndromes that increase the risk of breast cancer (eg, Li Fraumeni syndrome). For other women with an intermediate risk of breast cancer, such as those with a lifetime risk of 15%-20%, a personal history of breast cancer, or a history of lobular neoplasia or ADH, the use of screening MRI is an area of ongoing investigation [5,22]. However, recent literature supports the use of screening MRI in addition to mammography in patients with a personal history of breast cancer [23] and lobular neoplasia [24].

Ultrasound

Screening US is indicated in high-risk patients who cannot tolerate MRI. Supplemental screening with US for women with intermediate risk and dense breasts is an option to increase cancer detection. However, hand-held US screening by the radiologist has a high false-positive rate and is time-consuming [25]. Therefore, this may not be a cost-effective practice. The balance between cancer detection and the risk of a false positive result should be considered by women and their health care providers when considering the use of screening US or other ancillary screening examinations.

Other Imaging Modalities

There is insufficient evidence to support the use of other imaging modalities such as thermography, breast specific gamma imaging (BSGI), positron emission mammography (PEM), or optical imaging for breast cancer screening [5]. Radiation dose from BSGI and PEM are 15-30 times higher than the dose of a digital mammogram [26,27], and they are not indicated for screening in their present form.

Summary

- For high-risk women, annual screening mammography and contrast-enhanced MRI are both indicated. US can be used for patients with contraindications to MRI.
- For intermediate-risk women, annual screening mammography is indicated. Contrast-enhanced MRI may be indicated in some patients.
- For average-risk women, annual screening mammography is indicated.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m^2. For more information, please see the ACR *Manual on Contrast Media* [28].

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document.

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢ ☢	0.1-1 mSv	0.03-0.3 mSv
☢ ☢ ☢	1-10 mSv	0.3-3 mSv
☢ ☢ ☢ ☢	10-30 mSv	3-10 mSv
☢ ☢ ☢ ☢ ☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

Supporting Document(s)

- ACR Appropriateness Criteria® Overview
- Procedure Information
- Evidence Table

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