American College of Radiology
ACR Appropriateness Criteria®
Female Breast Cancer Screening

Variant 1: **Adult female. Breast cancer screening. Average risk.**

Procedure	Appropriateness Category	Relative Radiation Level
Digital breast tomosynthesis screening	Usually Appropriate	☢☢
Mammography screening	Usually Appropriate	☢☢
US breast	May Be Appropriate	O
MRI breast without and with IV contrast	May Be Appropriate	O
MRI breast without and with IV contrast abbreviated	May Be Appropriate	O
Mammography with IV contrast	Usually Not Appropriate	☢☢
MRI breast without IV contrast	Usually Not Appropriate	O
MRI breast without IV contrast abbreviated	Usually Not Appropriate	O
Sestamibi MBI	Usually Not Appropriate	☢☢☢

Variant 2: **Adult female. Breast cancer screening. Intermediate risk.**

Procedure	Appropriateness Category	Relative Radiation Level
Digital breast tomosynthesis screening	Usually Appropriate	☢☢
Mammography screening	Usually Appropriate	☢☢
US breast	May Be Appropriate	O
Mammography with IV contrast	May Be Appropriate	☢☢
MRI breast without and with IV contrast	May Be Appropriate	O
MRI breast without and with IV contrast abbreviated	May Be Appropriate	O
MRI breast without IV contrast	Usually Not Appropriate	O
MRI breast without IV contrast abbreviated	Usually Not Appropriate	O
Sestamibi MBI	Usually Not Appropriate	☢☢☢

Variant 3: **Adult female. Breast cancer screening. High risk.**

Procedure	Appropriateness Category	Relative Radiation Level
Digital breast tomosynthesis screening	Usually Appropriate	☢☢
Mammography screening	Usually Appropriate	☢☢
MRI breast without and with IV contrast	Usually Appropriate	O
MRI breast without and with IV contrast abbreviated	Usually Appropriate	O
US breast	May Be Appropriate (Disagreement)	O
Mammography with IV contrast	May Be Appropriate (Disagreement)	☢☢
MRI breast without IV contrast	Usually Not Appropriate	O
MRI breast without IV contrast abbreviated	Usually Not Appropriate	O
Sestamibi MBI	Usually Not Appropriate	☢☢☢

FEMALE BREAST CANCER SCREENING

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Summary of Literature Review

Introduction/Background

Breast cancer is the most common nonskin cancer diagnosis in women and is second only to lung cancer with respect to cancer deaths. Early detection of breast cancer from regular screening substantially reduces breast cancer mortality [1]. Because regular screening identifies tumors when they are smaller and with fewer nodal metastases, patients with screen-detected breast cancers are less likely to require mastectomy or chemotherapy, thereby also decreasing morbidity [2].

Breast cancer risk is frequently divided into 3 major categories: average, intermediate, and high risk. Numerous factors contribute to breast cancer risk, so no single method or definition is used to classify each woman into a specific risk category [3,4]. The use of validated statistical models based largely upon family history, which also incorporate additional risk factors, represents one mechanism to estimate risk. Currently, risk categories are most frequently defined by estimated lifetime risk; however, different time horizons, such as 5 or 10 year risk, may also be valuable for guideline development and informed decision-making [3]. Women at average risk are typically defined as those with <15% estimated lifetime risk for developing breast cancer, whereas intermediate-risk women are generally defined as those with a 15% to 20% estimated lifetime risk. The high-risk category typically includes women who have a >20 to 25% estimated lifetime risk: women who carry a deleterious genetic mutation that increases breast cancer risk, as well as untested first-degree relatives of patients with these mutations and women who have received radiation therapy to the thorax or upper abdomen at an early age (<30 years). Some women with a personal history of high-risk breast lesions, a personal history of breast cancer, dense breast tissue, or a family history of breast cancer may fit into the intermediate- or high-risk categories, depending upon their specific risk factors or combination of factors [3]. Elevated risk is sometimes used to refer to women in both the intermediate- and high-risk categories [3].

Breast cancer screening guidelines vary across medical professional organizations, although published guidelines agree that regular breast cancer screening decreases morbidity and breast cancer mortality [5-7]. Medical professional organizations may also define breast cancer risk categories using different methodologies. Although screening guidelines for high-risk patients have typically been similar, discrepant recommendations for average- and intermediate-risk women have sparked controversy and confusion. In part due to differences in screening guidelines, use of breast cancer screening modalities remains suboptimal in women of all risk categories. The ACR encourages patients to undergo breast cancer risk assessment by 25 years of age, so elevated-risk patients have the opportunity to benefit from earlier and more aggressive breast cancer screening regimens, when appropriate [3]. The ACR recommends that both the benefits and risks of breast cancer screening and supplemental screening be considered to assist patients in making informed decisions regarding their health care [8].

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Although all patients are at risk for developing breast cancer, this document addresses breast cancer screening in cisgender females (birth assigned female with a female gender identity). For breast cancer screening in transgender and gender diverse patients, please reference the ACR Appropriateness Criteria® topic on "Transgender Breast Cancer Screening" [9]. Additional ACR Appropriateness Criteria® topics on "Supplemental Breast Cancer Screening Based on Breast Density" [10], "Imaging after Mastectomy and Breast Reconstruction" [11], "Imaging after Breast Surgery" [12], and "Breast Imaging of Pregnant and Lactating Women" [13] can be referenced in the appropriate clinical context.

Discussion of Procedures by Variant

Variant 1: Adult female. Breast cancer screening. Average risk.

Digital Breast Tomosynthesis Screening

Digital breast tomosynthesis (DBT) displays reconstructed stacked images of the breast in combination with digital mammographic views, which may be synthetic mammograms reconstructed from the acquired tomosynthesis data set or full-field digital mammograms (FFDM). Compared to FFDM or synthetic mammograms alone, most studies demonstrate that DBT increases cancer detection rate (CDR) and decreases recall rate [14-22]; although some studies have not reached statistical significance [23] or have found less compelling results in subsets of women, such as those with extremely dense breasts [24,25]. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Compared to average breast density (near the threshold between heterogeneously dense and scattered areas of fibroglandular density), the relative risks for developing breast cancer are 1.2 for heterogeneously dense and 2.1 for extremely dense breasts [28]. Some health care providers may therefore consider women with extremely dense breasts to no longer be average risk. Irrespective of risk category, meta-analyses have demonstrated an incremental increase in CDR of 1.6 to 3.2 per 1,000 screening DBT examinations and a 2.2% pooled decrease in recall rate compared to digital mammography [18,29,30].

The degree of breast cancer mortality reduction from screening mammography varies with different screening regimens. Mortality reduction is greater when screening begins at 40 years of age rather than 45 or 50 years of age and when screening is done more frequently (annually rather than biennially) [8,31]. Beginning screening at an earlier age and more frequent screening result in a greater number of imaging studies performed, so these screening regimens may also increase the number of false-positive examinations and biopsies [8,32]. To maximize the benefits, the ACR recommends screening DBT in average-risk women each year beginning at 40 years of age. Although randomized controlled trials of screening mammography did not enroll women >74 years of age, observational studies demonstrate that some women ≥75 years of age may continue to benefit from screening mammography [8,32]. There is no upper age limit agreed upon for screening mammography [5,6,8,32]. Because mortality reduction from screening mammography requires years before being fully attained, screening recommendations should be based upon life expectancy and competing comorbidities, rather than age alone [8,32-34]. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8].

Because screening mammography decreases breast cancer mortality, screening mammography or screening DBT is still performed in women undergoing supplemental screening studies [3,8,35].

Mammography Screening

To date, mammography is the only screening modality shown to decrease breast cancer mortality. Multiple randomized controlled trials demonstrate that invitation to screening mammography results in at least a 22% reduction in breast cancer mortality [35]. For example, after 29 years of follow-up, the Swedish Two-County trial demonstrated a 27% to 31% reduction in breast cancer mortality in 133,065 women 40 to 74 years of age invited to screening despite use of single view mammography and the 24 to 33 month interval between subsequent screenings [1]. Randomized controlled trials of screening mammography in which advanced stage breast cancers decreased by 20% or more demonstrate even greater reductions in breast cancer mortality [8]. Observational studies, including those from population-based service screening programs, also demonstrate larger reductions in breast cancer mortality (≥40%) in women who were actually screened [8,35].

In addition to mortality reduction, screening mammography decreases treatment morbidity, because screen-detected tumors are typically lower stage (eg, smaller and more likely to be node-negative), compared to breast cancers detected by palpation [2,8]. Despite these benefits, screening mammograms also have risks. The most common perceived risks include false-positive recalls and biopsies, overdiagnosis, and patient anxiety [5,7,32]. Approximately 10% of screening mammograms result in a recall for additional imaging, although <2% result in a recommendation for percutaneous biopsy following additional imaging [8]. Overdiagnosis refers to breast cancers that are detected by screening that would not have otherwise become apparent during the patient's lifetime. The reported frequency of overdiagnosis varies widely in the published literature due to important underlying differences in study methodology. Overdiagnosis estimates that do not account for breast cancer risk, trends in breast cancer incidence, or lead time bias range from 0% to 54%, whereas adjusted estimates range from 1% to 10% [36,37]. Overdiagnosis estimates increase with age at screening [36,37]. Although the risks of screening may impact uptake and adherence to screening mammography, prior research has shown that women value early detection of breast cancer over false-positives and screening-related anxiety [8].

Despite the established mortality benefit, published guidelines differ in their recommendations for screening mammography due to variations in the perceptions of the relative risks and benefits [5,38]. The degree of breast cancer mortality reduction from screening mammography varies with different screening regimens. Mortality reduction is greater when screening begins at 40 years of age rather than 45 or 50 years of age and when screening is done more frequently (annually rather than biennially) [8,31]. Annual screening mammography for women 40 to 84 years of age decreases mortality by 40% (12 lives per 1,000 women screened), whereas biennial screening mammography for women 50 to 74 years of age only decreases mortality by 23% (7 lives per 1,000 women screened) [32]. Earlier initiation of screening and more frequent screening result in a greater number of imaging studies performed, so these screening regimens also increase the number of false-positive examinations and biopsies [8,32]. Although randomized controlled trials of screening mammography did not enroll women >74 years of age, observational studies demonstrate that women ≥75 years of age may continue to benefit from screening mammography [8,32]. There is no upper age limit agreed upon for screening mammography [5,6,8,32]. Because mortality reduction from screening mammography requires years before being fully attained, screening recommendations should be based upon life expectancy and competing comorbidities, rather than age alone [8,32-34]. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8].

For women 40 to 49 years of age, randomized controlled trials and observational studies demonstrate that screening mammography decreases breast cancer mortality by 15% to 50% [1,8,32,33,39]. Results from the Cancer Intervention and Surveillance Modeling Network (CISNET) suggest that annual screening mammography in women 40 to 49 years of age saves 42% more lives and life-years than biennial screening due to faster growing tumors in younger women [31]. Women screened between 40 and 49 years of age are also less likely to require mastectomy or chemotherapy than women diagnosed with palpable tumors [2].

Non-Hispanic Black, Hispanic Black, and Hispanic White women have higher breast cancer mortality than non-Hispanic White women, and minority women often present at younger ages with more aggressive tumor subtypes [3,8]. Therefore, decreasing access to screening mammography, especially in women 40 to 49 years of age, may disproportionately impact minority women.

Annual screening mammography results in a greater reduction in mortality compared to biennial screening [8]. In women 40 to 84 years of age, annual screening reduces mortality by 40%, compared to a 32% reduction for biennial screening [32]. With regular screening, interval breast cancers do occur with a higher frequency in women undergoing biennial or triennial screening compared to annual screening. The sensitivity of mammography is decreased in some groups of women, including those with dense breasts [40]. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Compared to average breast density (near the threshold between heterogeneously dense and scattered areas of fibroglandular density), the relative risks for developing breast cancer are 1.2 for heterogeneously dense and 2.1 for extremely dense breasts [28]. Some health care providers may therefore consider women with extremely dense breasts to no longer be average risk. Given the limitations of mammography and to minimize interval cancers, supplemental screening modalities have been investigated in women at average risk.

Because screening mammography decreases breast cancer mortality, screening mammography or screening DBT is still performed in women undergoing supplemental screening studies [3,8,35]. Rather than supplementing screening mammography with additional imaging modalities, some have suggested limiting women offered screening mammography based upon individual patient risk assessed by various risk models, breast density, or genetic information such as single-nucleotide polymorphism. However, the randomized controlled trials demonstrating mortality reduction and most large-scale observational studies enrolled women based upon geographic location and age, not other individual patient risk factors. In one observational study in women <50 years of age, restricting screening to women with a first-degree family history, extremely dense breast tissue, or both, would cause 66% of potentially screen-detected cancers to be missed [41].

To maximize the benefits, the ACR recommends screening mammography in average-risk women each year beginning at 40 years of age. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8].

Mammography With IV Contrast
Data are limited regarding the use of mammography with intravenous (IV) contrast for screening women at average risk. Most published studies evaluated mammography with IV contrast in women with dense breasts and elevated risk, so results specific to women at average risk, especially those without dense breasts, are not currently available. For supplemental screening recommendations based upon breast density, please refer to the ACR Appropriateness Criteria® topic on "Supplemental Breast Cancer Screening Based on Breast Density" [10].

MRI Breast Without and With IV Contrast
Although data are limited regarding the use of breast MRI without and with IV contrast for screening women at average risk, one study has demonstrated that breast MRI demonstrates incremental cancer detection (15-16 cancers per 1,000 breast MRI examinations) over screening mammography with or without screening ultrasound (US) in average-risk women irrespective of breast density [42]. Breast MRI also decreases interval cancers [42,43]. In the DENSE trial, breast MRI significantly reduced interval cancers within women with extremely dense breast tissue and normal mammography, so the European Society of Breast Imaging now recommends screening breast MRI every 2 to 4 years in women 50 to 70 years of age with extremely dense breasts [43,44]. Compared to average breast density (near the threshold between heterogeneously dense and scattered areas of fibroglandular density), the relative risks for developing breast cancer are 1.2 for heterogeneously dense and 2.1 for extremely dense breasts [28]. Some health care providers may therefore consider women with extremely dense breasts to no longer be average risk.

For supplemental screening recommendations based upon breast density, please refer to the ACR Appropriateness Criteria® topic on "Supplemental Breast Cancer Screening Based on Breast Density" [10].

MRI Breast Without and With IV Contrast Abbreviated
Data are limited regarding the use of abbreviated breast MRI without and with IV contrast for screening women at average risk. The ECOG-ACRIN abbreviated MRI trial demonstrated a significantly higher CDR for abbreviated breast MRI without and with IV contrast (15 cancers per 1,000) compared with DBT (6 cancers per 1,000), although the study recruited women with dense breasts [45]. In addition to dense breasts, women enrolled in the trial had variable 5 and 10 year risk profiles based upon the Breast Cancer Surveillance Consortium risk calculator and 19% reported 1 or more first degree relatives with breast cancer [45]. Compared to average breast density (near the threshold between heterogeneously dense and scattered areas of fibroglandular density), the relative risks for developing breast cancer are 1.2 for heterogeneously dense and 2.1 for extremely dense breasts [28]. Some health care providers may therefore consider women with extremely dense breasts to no longer be average risk.

For supplemental screening recommendations based upon breast density, please refer to the ACR Appropriateness Criteria® topic on "Supplemental Breast Cancer Screening Based on Breast Density" [10].

MRI Breast Without IV Contrast
There is no relevant literature to support the use of MRI without IV contrast for screening women at average risk.

MRI Breast Without IV Contrast Abbreviated
There is no relevant literature to support the use of abbreviated MRI without IV contrast for screening women at average risk.

Sestamibi MBI
Data are limited regarding the use of sestamibi molecular breast imaging (MBI) for screening women at average risk. Most studies have focused upon women with dense breasts and variable risk profiles. One of the larger studies published to date of 1,696 women with recent negative or benign mammographic examinations showed that sestamibi MBI yielded an incremental CDR of 7.7 cancers per 1,000 examinations; however, all 13 cancers were detected in women with dense breasts [46]. Although 92% of the women within the study had <20% estimated lifetime risk, the estimates ranged from 6.1% to 17.2% [46]. Additional retrospective and prospective studies have demonstrated similar incremental CDR for sestamibi MBI of 6.5 to 9 per 1,000 over mammography [40,47].

Sestamibi MBI demonstrates similar sensitivity, better specificity, and lower recall rate compared to supplemental screening US in women with dense breasts [47,48].

US Breast

Most studies evaluating the utility of screening with breast US have focused on women with dense breast tissue with or without other risk factors. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Screening breast US in women with mammographically dense breasts, including those with risk factors placing them at increased breast cancer risk, identifies mammographically occult, small, node-negative invasive tumors with an increased CDR of 1.8 to 4.6 cancers per 1,000 women screened [40,49]. Although supplemental screening US in women with dense breasts results in an increased CDR, US also increases recall rate, false-positive examinations, and false-positive biopsies [26,49-55].

For supplemental screening recommendations based upon breast density, please refer to the ACR Appropriateness Criteria® topic on "Supplemental Breast Cancer Screening Based on Breast Density" [10].

Data regarding supplemental screening US in average-risk women with nondense breasts is less compelling. In a study of 1,526 average-risk women without mammographic abnormalities, screening with US demonstrated an overall incremental CDR of 3.3 per 1,000, with 5.1 per 1,000 examinations in dense breasts and 0 per 1,000 in nondense breasts compared to digital mammography [56]. In another study of 1,003 average-risk women, US yielded an overall incremental CDR of 3.2 per 1,000 examinations, with 0 per 1,000 in nondense breasts, compared to DBT with or without digital mammography [53].

Variant 2: Adult female. Breast cancer screening. Intermediate risk.

Evidence-based screening recommendations for intermediate-risk women are complicated by different methodologies for risk assessment using variable time spans (eg, lifetime, 5 year, 10 year), as well as the interplay between breast density and additional risk factors [40]. Compared to average breast density (near the threshold between heterogeneously dense and scattered areas of fibroglandular density), the relative risks for developing breast cancer are 1.2 for heterogeneously dense and 2.1 for extremely dense breasts [28]. Some health care providers may therefore consider women with extremely dense breasts to be at increased risk. Published data are primarily from observational studies, which have been largely retrospective with variable risk assessment methods resulting in heterogeneous patient groups. In a subset of the literature, intermediate-risk women have been grouped with high-risk women or average-risk women without stratified analyses. The absence of high-quality prospective studies of various supplemental imaging modalities specific to intermediate-risk patients creates challenges when developing guidelines [40]. Depending upon family and personal history of breast cancer, prior biopsies yielding high-risk lesions, and other risk factors, certain intermediate-risk women may benefit from screening starting at <40 years of age, as well as more intensive screening regimens with supplemental imaging modalities [3].

Please reference the ACR Appropriateness Criteria® topics on "Transgender Breast Cancer Screening" [9], "Supplemental Breast Cancer Screening Based on Breast Density" [10], "Imaging after Mastectomy and Breast Reconstruction" [11], "Imaging after Breast Surgery" [12], and "Breast Imaging of Pregnant and Lactating Women" [13] in the appropriate clinical context.

Digital Breast Tomosynthesis Screening

DBT displays reconstructed stacked images of the breast in combination with digital mammographic views, which may be synthetic mammograms reconstructed from the acquired tomosynthesis dataset or FFDM. Compared to FFDM or synthetic mammograms alone, most studies demonstrate that DBT increases CDR and decreases recall rate [14-22]; although, some studies have not reached statistical significance [23] or have found less compelling results in subsets of women, such as those with extremely dense breasts [24,25]. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Compared to average breast density (near the threshold between heterogeneously dense and scattered areas of fibroglandular density), the relative risks for developing breast cancer are 1.2 for heterogeneously dense and 2.1 for extremely dense breasts [28]. Some health care providers may therefore consider women with extremely dense breasts to no longer be average risk. Irrespective of risk category, meta-analyses have demonstrated an incremental increase in CDR of 1.6 to 3.2 per 1,000 screening DBT examinations and a 2.2% pooled decrease in recall rate compared to digital mammography [18,29,30].

The degree of breast cancer mortality reduction from screening mammography varies with different screening regimens. Mortality reduction is greater when screening begins at 40 years of age rather than 45 or 50 years of age and when screening is done more frequently (annually rather than biennially) [8,31]. Beginning screening at an earlier age and more frequent screening, result in a greater number of imaging studies performed, so these screening regimens also increase the number of false-positive examinations and biopsies [8,32]. Although randomized controlled trials of screening mammography did not enroll women >74 years of age, observational studies demonstrate that some women ≥75 years of age may continue to benefit from screening mammography [8,32]. There is no upper age limit agreed upon for screening mammography [5,6,8,32]. Because mortality reduction from screening mammography requires years before being fully attained, screening recommendations should be based upon life expectancy and competing comorbidities, rather than age alone [8,32-34]. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8].

Within the limited studies of women at elevated risk due to personal and/or family history of breast cancer, DBT decreased recall rate without a significant increase in CDR compared to FFDM; however, small sample sizes restrict analyses [3,40].

Because screening mammography decreases breast cancer mortality, screening mammography or screening DBT is still performed in women undergoing supplemental screening studies [3,8,35]. The ACR recommends annual screening mammography beginning no later than 40 years of age for women at intermediate risk [3]. For those with a family history of breast cancer, mammography should begin earlier if familial breast cancer occurred at a young age, typically 10 years prior to the youngest age at presentation but generally not before age 30 [6]. For women who have lobular neoplasia or atypical hyperplasia diagnosed prior to 40 years of age, annual screening mammography should be performed from time of diagnosis but generally not prior to 30 years of age [38]. Early detection of second breast cancers improves survival, so patients with a personal history of breast cancer should undergo annual mammography or DBT for surveillance following breast conservation therapy [3].

Mammography Screening

To date, mammography is the only screening modality shown to decrease breast cancer mortality. Multiple randomized controlled trials demonstrate that invitation to screening mammography results in at least a 22% reduction in breast cancer mortality [35]. For example, after 29 years of follow-up, the Swedish Two-County trial demonstrated a 27% to 31% reduction in breast cancer mortality in 133,065 women 40 to 74 years of age invited to screening despite use of single view mammography and the 24 to 33 month interval between subsequent screenings [1]. Randomized controlled trials of screening mammography in which advanced stage breast cancers decreased by 20% or more demonstrate even greater reductions in breast cancer mortality [8]. Observational studies, including those from population-based service screening programs, also demonstrate larger reductions in breast cancer mortality (≥40%) in women who were actually screened [8,35].

In addition to mortality reduction, screening mammography decreases treatment morbidity, because screen-detected tumors are typically lower stage (eg, smaller and more likely to be node-negative) compared to breast cancers detected by palpation [2,8]. Despite these benefits, screening mammograms also have risks. The most common perceived risks include false-positive recalls and biopsies, overdiagnosis [5,7,32], and patient anxiety. Approximately 10% of screening mammograms result in a recall for additional imaging, although <2% result in a recommendation for percutaneous biopsy following additional imaging [8]. Overdiagnosis refers to breast cancers that are detected by screening that would not have otherwise become apparent during the patient's lifetime. The reported frequency of overdiagnosis varies widely in the published literature, due to important underlying differences in study methodology. Overdiagnosis estimates that do not account for breast cancer risk, trends in breast cancer incidence, or lead time bias range from 0% to 54%, whereas adjusted estimates range from 1% to 10% [36,37]. Overdiagnosis estimates increase with age at screening [36,37]. Although the risks of screening may impact uptake and adherence to screening mammography, prior research has shown that women value early detection of breast cancer over false-positives and screening-related anxiety [8].

Despite the established mortality benefit, published guidelines differ in their recommendations for screening mammography due to variations in the perceptions of the relative risks and benefits [5,38]. The degree of breast cancer mortality reduction from screening mammography varies with different screening regimens. Mortality reduction is greater when screening begins 40 years of age rather than 45 or 50 years of age and when screening is done more frequently (annually rather than biennially) [8,31]. Annual screening mammography for women 40 to 84 years of age decreases mortality by 40% (12 lives per 1,000 women screened), whereas biennial screening mammography for women 50 to 74 years of age only decreases mortality by 23% (7 lives per 1,000 women screened) [32]. Earlier initiation of screening and more frequent screening result in a greater number of imaging studies performed, so these screening regimens also increase the number of false-positive examinations and biopsies [8,32]. Although randomized controlled trials of screening mammography did not enroll women >74 years of age, observational studies demonstrate that women ≥75 years of age may continue to benefit from screening mammography [8,32]. There is no upper age limit agreed upon for screening mammography [5,6,8,32]. Because mortality reduction from screening mammography requires years before being fully attained, screening recommendations should be based upon life expectancy and competing comorbidities, rather than age alone [8,32-34]. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8].

For women 40 to 49 years of age, randomized controlled trials and observational studies demonstrate that screening mammography decreases breast cancer mortality by 15% to 50% [1,8,32,33,39]. Results from the CISNET suggest that annual screening mammography in women 40 to 49 years of age saves 42% more lives and life-years than biennial screening due to faster growing tumors in younger women [31]. Women screened between 40 and 49 years of age are also less likely to require mastectomy or chemotherapy than women diagnosed with palpable tumors [2].

Non-Hispanic black women, Hispanic black, and Hispanic white women have higher breast cancer mortality than non-Hispanic white women, and minority women often present at younger ages with more aggressive tumor subtypes [3,8]. Therefore, decreasing access to screening mammography, especially in women 40 to 49 years of age, may disproportionately impact minority women.

Annual screening mammography results in a greater reduction in mortality compared to biennial screening [8]. In women 40 to 84 years of age, annual screening reduces mortality by 40%, compared to a 32% reduction for biennial screening [32]. With regular screening, interval breast cancers do occur with a higher frequency in women undergoing biennial or triennial screening compared to annual screening. The sensitivity of mammography is decreased in some groups of women, including those with dense breasts [40]. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Compared to average breast density (near the threshold between heterogeneously dense and scattered areas of fibroglandular density), the relative risks for developing breast cancer are 1.2 for heterogeneously dense and 2.1 for extremely dense breasts [28]. Some health care providers may therefore consider women with extremely dense breasts to no longer be average risk. Given the limitations of mammography and to minimize interval cancers, supplemental screening modalities have been investigated in women at intermediate risk.

Because screening mammography decreases breast cancer mortality, screening mammography or screening DBT is still performed in women undergoing supplemental screening studies [3,8,35]. Rather than supplementing screening mammography with additional imaging modalities, some have suggested limiting women offered screening mammography based upon individual patient risk assessed by various risk models, breast density, or genetic information such as single-nucleotide polymorphisms. However, the randomized controlled trials demonstrating mortality reduction and most large-scale observational studies enrolled women based upon age and geographic location, not individual patient risk factors. In one observational study in women <50 years of age, restricting screening to women with a first-degree family history, extremely dense breast tissue, or both, would cause 66% of potentially screen-detected cancers to be missed [41].

To maximize the benefits, the ACR recommends annual screening mammography beginning no later than 40 years of age for women at intermediate risk [3]. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8]. For those with a family history of breast cancer, mammography should begin earlier if familial breast cancer occurred at a young age, typically 10 years prior to the youngest age at presentation but generally not before 30 years of age [6]. For women who have lobular neoplasia or atypical hyperplasia diagnosed prior to 40 years of age, annual screening mammography should be performed from time of diagnosis but generally not prior to 30 years of age [38]. Early detection of second breast cancers improves survival, so patients with a personal history of breast cancer should undergo annual mammography or DBT for surveillance following breast conservation therapy [3].

Mammography With IV Contrast

Data are limited regarding the use of mammography with IV contrast for breast cancer screening in intermediate-risk women. To date, published studies have predominantly included women with dense breasts and other risk factors resulting in intermediate- or high-risk profiles. Compared to mammography alone, mammography with IV contrast increases cancer detection (incremental CDR = 6.6-13 per 1,000) in women at elevated risk [57-60].

MRI Breast Without and With IV Contrast

MRI has a higher CDR than mammography alone, DBT, or mammography/DBT combined with US [61-64]. The incremental CDR of MRI in elevated-risk women ranges from 8 to 29 per 1,000 women, with lower CDR estimates in intermediate-risk women compared to high-risk BRCA mutation carriers [61-63,65,66]. In one study, breast MRI CDR was 15 per 1,000 in women with a prior biopsy demonstrating a high-risk lesion compared to 8 per 1,000 in women reporting a family history [65]. In women with a personal history of breast cancer, a meta-analysis estimated a CDR of 9 to 15 per 1,000 breast MRI [67]. Breast MRI detects small, node-negative invasive cancers at earlier tumor stages compared to mammography, as well as ductal carcinoma in situ [68,69]. Screening MRI also reduces interval cancers [69]. However, breast MRI has a higher recall rate than mammography (15.1% versus 6.4%) [70], higher frequency of BI-RADS category 3 assessment than mammography (14.8% versus 11.8%), and greater frequency of image-guided biopsies than mammography (11.8% versus 2.4%) [63].

MRI Breast Without and With IV Contrast Abbreviated

Data are limited regarding the use of abbreviated breast MRI without and with IV contrast in intermediate-risk women. In one cohort of women deemed at “mildly to moderately increased risk” abbreviated breast MRI demonstrated an incremental cancer detection yield of 18 cancers per 1,000 and a high negative predictive value [71,72]. In intermediate-risk women, abbreviated breast MRI yields a lower CDR (7 per 1,000) compared to high-risk women (29 per 1,000) [53]. Multiple studies have demonstrated similar diagnostic accuracy for abbreviated protocol MRI compared to conventional full protocol breast MRI [73-75]. The ECOG-ACRIN abbreviated MRI trial demonstrated a significantly higher CDR for abbreviated breast MRI without and with IV contrast (15 cancers per 1,000) compared with DBT (6 cancers per 1,000) in women with dense breasts [45]. In addition to dense breasts, women enrolled in the trial had variable 5 and 10 year risk profiles based upon the Breast Cancer Surveillance Consortium risk calculator, and 19% reported 1 or more first degree relatives with breast cancer [45].

MRI Breast Without IV Contrast

There is no relevant literature to support the use of breast MRI without IV contrast for screening women at intermediate risk.

MRI Breast Without IV Contrast Abbreviated

There is no relevant literature to support the use of abbreviated breast MRI without IV contrast for screening women at intermediate risk.

Sestamibi MBI

Data are limited regarding the use of sestamibi MBI for screening women at intermediate risk. Most studies have focused upon women with dense breasts and variable risk profiles. Retrospective and prospective studies have demonstrated similar incremental CDR for sestamibi MBI of 6.5 to 9 over mammography, with a study demonstrating an incremental CDR of 16.5 per 1,000 in women at increased risk primarily due to family or personal history of breast cancer [40,47]. Sestamibi MBI demonstrates similar sensitivity, better specificity, and lower recall rate compared to supplemental screening US in women with dense breasts [47,48].

US Breast

Most studies evaluating the utility of screening with breast US have focused on women with dense breast tissue with or without other risk factors. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Screening breast US in women with mammographically dense breasts, including those with risk factors placing them at increased breast cancer risk, identifies predominantly mammographically occult, small, node-negative invasive tumors with an increased CDR of 1.8 to 4.6 cancers per 1,000 women screened [40,49]. Although supplemental screening US in women with dense breasts results in an increased CDR, US also increases recall rate, false-positive examinations, and false-positive biopsies [26,49-55]. In women undergoing annual mammography plus annual supplemental screening MRI, the addition of supplemental screening with US does not identify additional cancers and is therefore not routinely performed.

For supplemental screening recommendations based upon breast density, please refer to the ACR Appropriateness Criteria® topic on “Supplemental Breast Cancer Screening Based on Breast Density” [10].

The ACRIN 6666 trial enrolled women with dense breast tissue and at least one other breast cancer risk factor [61]. Compared to mammography alone, screening US detected 5.3 cancers per 1,000 in year 1, 3.7 cancers per 1,000 in years 2 and 3, and resulted in a larger number of false-positive examinations and false-positive biopsies each year [61]. In a prospective study limited to intermediate-risk women, sensitivity of mammography was 57%, US was 24.5%, and mammography combined with biannual US demonstrated 80.4% sensitivity [76]. In women with a personal history of breast cancer, supplemental US screening results in an incremental CDR of 2.4 to 2.9 cancers per 1,000 examinations over mammography alone; however, US screening has lower specificity [10,66].

Variant 3: Adult female. Breast cancer screening. High risk.

Women considered high risk for breast cancer include those with a >20% to 25% estimated lifetime risk for developing breast cancer using a validated statistical model. Other groups of high-risk women include those carrying a pathogenic mutation within certain genes (eg, BRCA1, BRCA2, p53, ATM, CHEK2, PALB2 [77]), first-degree relatives of these mutation carriers who remain untested themselves, and women with a history of thoracic or upper abdominal radiation therapy at an early age (<30 years) [78]. Some women with a personal history of breast cancer may also fit into the high-risk category [3]. Since 2007, published guidelines have recommended that high-risk women undergo more intensive breast cancer screening regimens, typically beginning at younger ages [4].

Please reference the ACR Appropriateness Criteria® topics on "Transgender Breast Cancer Screening" [9], "Supplemental Breast Cancer Screening Based on Breast Density" [10], "Imaging after Mastectomy and Breast Reconstruction" [11], "Imaging after Breast Surgery" [12], and "Breast Imaging of Pregnant and Lactating Women" [13] in the appropriate clinical context.

Digital Breast Tomosynthesis Screening

DBT displays reconstructed stacked images of the breast in combination with digital mammographic views, which may be synthetic mammograms reconstructed from the acquired tomosynthesis data set or FFDM. Compared to FFDM or synthetic mammograms alone, most studies demonstrate that DBT increases CDR and decreases recall rate [14-22]; although, some studies have not reached statistical significance [23] or have found less compelling results in subsets of women, such as those with extremely dense breasts [24,25]. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Irrespective of risk category, meta-analyses have demonstrated an incremental increase in CDR of 1.6 to 3.2 per 1,000 screening DBT examinations and a 2.2% pooled decrease in recall rate compared to digital mammography [18,29,30].

The degree of breast cancer mortality reduction from screening mammography varies with different screening regimens. Mortality reduction is greater when screening begins at 40 years of age rather than 45 or 50 years of age and when screening is done more frequently (annually rather than biennially) [8,31]. Beginning screening at an earlier age and more frequent screening result in a greater number of imaging studies performed, so these screening regimens also increase the number of false-positive examinations and biopsies [8,32]. Although randomized controlled trials of screening mammography did not enroll women >74 years of age, observational studies demonstrate that some women ≥75 years of age may continue to benefit from screening mammography [8,32]. There is no upper age limit agreed upon for screening mammography [5,6,8,32]. Because mortality reduction from screening mammography requires years before being fully attained, screening recommendations should be based upon life expectancy and competing comorbidities, rather than age alone [8,32-34]. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8].

Within the limited studies of women at elevated risk due to personal and/or family history of breast cancer, DBT decreased recall rate without a significant increase in CDR compared to FFDM; however, small sample sizes restrict analyses [3,40].

High-risk women should begin annual screening mammography at 30 years of age or 10 years prior to the youngest family member who had breast cancer, but generally not before 30 years of age [3]. Approximately one-third of breast cancers may only be detected on mammography in BRCA2 mutation carriers who are <40 years of age [79]. In some mutation carriers, some referring providers use mammography or DBT beginning at 40 years of age if patients undergo annual MRI [80]. Women who underwent thoracic or upper abdominal radiation therapy at an early age (<30 years) should begin screening mammography 8 years after radiation therapy but not before 25 years of age [3].

Because screening mammography decreases breast cancer mortality, screening mammography or screening DBT is still performed in women undergoing supplemental screening studies [3,8,35].

Mammography Screening

To date, mammography is the only screening modality shown to decrease breast cancer mortality. Multiple randomized controlled trials demonstrate that invitation to screening mammography results in at least a 22%

reduction in breast cancer mortality [35]. For example, after 29 years of follow-up, the Swedish Two-County trial demonstrated a 27% to 31% reduction in breast cancer mortality in 133,065 women 40 to 74 years of age invited to screening despite use of single view mammography and the 24 to 33 month interval between subsequent screenings [1]. Randomized controlled trials of screening mammography in which advanced stage breast cancers decreased by 20% or more demonstrate even greater reductions in breast cancer mortality [8]. Observational studies, including those from population-based service screening programs, also demonstrate larger reductions in breast cancer mortality (≥40%) in women who were actually screened [8,35].

In addition to mortality reduction, screening mammography decreases treatment morbidity, because screen-detected tumors are typically lower stage (eg, smaller and more likely to be node-negative), compared to breast cancers detected by palpation [2,8]. Despite these benefits, screening mammograms also have risks. The most common perceived risks include false-positive recalls and biopsies, overdiagnosis [5,7,32], and patient anxiety. Approximately 10% of screening mammograms result in a recall for additional imaging, although <2% result in a recommendation for percutaneous biopsy following additional imaging [8]. Overdiagnosis refers to breast cancers that are detected by screening that would not have otherwise become apparent during the patient’s lifetime. The reported frequency of overdiagnosis varies widely in the published literature due to important underlying differences in study methodology. Overdiagnosis estimates that do not account for breast cancer risk, trends in breast cancer incidence, or lead time bias range from 0% to 54%, whereas adjusted estimates range from 1% to 10% [36,37]. Overdiagnosis estimates increase with age at screening [36,37]. Although the risks of screening may impact uptake and adherence to screening mammography, prior research has shown that women value early detection of breast cancer over false-positives and screening-related anxiety [8].

Despite the established mortality benefit, published guidelines differ in their recommendations for screening mammography due to variations in the perceptions of the relative risks and benefits [5,38]. The degree of breast cancer mortality reduction from screening mammography varies with different screening regimens. Mortality reduction is greater when screening begins 40 years of age rather than 45 or 50 years of age and when screening is done more frequently (annually rather than biennially) [8,31]. Annual screening mammography for women 40 to 84 years of age decreases mortality by 40% (12 lives per 1,000 women screened), whereas biennial screening mammography for women 50 to 74 years of age only decreases mortality by 23% (7 lives per 1,000 women screened) [32]. Earlier initiation of screening and more frequent screening, result in a greater number of imaging studies performed, so these screening regimens also increase the number of false-positive examinations and biopsies [8,32]. Although randomized controlled trials of screening mammography did not enroll women >74 years of age, observational studies demonstrate that women ≥75 years of age may continue to benefit from screening mammography [8,32]. There is no upper age limit agreed upon for screening mammography [5,6,8,32]. Because mortality reduction from screening mammography requires years before being fully attained, screening recommendations should be based upon life expectancy and competing comorbidities, rather than age alone [8,32-34]. Women should continue screening mammography as long as they remain in overall good health and are willing to undergo the examination and subsequent testing or biopsy, if an abnormality is identified [5,8].

For women 40 to 49 years of age, randomized controlled trials and observational studies demonstrate that screening mammography decreases breast cancer mortality by 15% to 50% [1,8,32,33,39]. Results from the CISNET suggest that annual screening mammography in women 40 to 49 years of age saves 42% more lives and life-years than biennial screening due to faster growing tumors in younger women [31]. Women screened between 40 and 49 years of age are also less likely to require mastectomy or chemotherapy than women diagnosed with palpable tumors [2].

Non-Hispanic Black, Hispanic Black, and Hispanic White women have higher breast cancer mortality than non-Hispanic White women, and minority women often present at younger ages with more aggressive tumor subtypes [3,8]. Therefore, decreasing access to screening mammography, especially in women 40 to 49 years of age, may disproportionately impact minority women.

Annual screening mammography results in a greater reduction in mortality compared to biennial screening [8]. In women 40 to 84 years of age, annual screening reduces mortality by 40%, compared to a 32% reduction for biennial screening [32]. With regular screening, interval breast cancers do occur with a higher frequency in women undergoing biennial or triennial screening compared to annual screening. The sensitivity of mammography is decreased in some groups of women, including those with dense breasts [40]. Dense breast tissue decreases the sensitivity of mammography [26] and is an independent risk factor for developing breast cancer [27]. Given the limitations of mammography and to minimize interval cancers, supplemental screening modalities have been investigated in women at high risk. Because screening mammography decreases breast cancer mortality, screening mammography or screening DBT is still performed in women undergoing supplemental screening studies [3,8,35]. Rather than supplementing screening mammography with additional imaging modalities, some have suggested limiting women offered screening mammography based upon individual patient risk assessed by various risk models, breast density, or genetic information such as single-nucleotide polymorphism. However, the randomized controlled trials demonstrating mortality reduction and most large-scale observational studies enrolled women based upon age and geographic location, not individual patient risk factors. In one observational study in women <50 years of age, restricting screening to women with a first-degree family history, extremely dense breast tissue, or both, would cause 66% of potentially screen-detected cancers to be missed [41].

Numerous studies in high-risk women have evaluated the performance of mammography and supplemental screening modalities, such as US and MRI. Mammography consistently demonstrates lower sensitivity (25%-69%) than US or MRI, and high-risk women experience higher interval cancer rates than the general population [3,40]. The combination of mammography with MRI yields the highest sensitivity across high-risk groups of women (91%-98%) [3,40,81]. Because screening mammography decreases breast cancer mortality, screening mammography or screening DBT is still performed in women undergoing supplemental screening studies [3,8,35]. High-risk women should begin annual screening mammography at 30 years of age or 10 years prior to the youngest family member who had breast cancer, but generally not before 30 years of age [3]. Approximately one-third of breast cancers may only be detected on mammography in BRCA2 mutation carriers who are <40 years of age [79]. In some mutation carriers, some referring providers use mammography or DBT beginning at 40 years of age if patients undergo annual MRI [80]. Women who underwent thoracic or upper abdominal radiation therapy at an early age (<30 years) should begin screening mammography 8 years after radiation therapy but not before 25 years of age [3].

Mammography With IV Contrast

Data are limited regarding the use of mammography with IV contrast for breast cancer screening in high-risk women. To date, published studies have predominantly included women with dense breasts and other risk factors resulting in intermediate or high-risk profiles. Compared to mammography alone, mammography with IV contrast increases sensitivity and cancer detection (incremental CDR = 6.6-13 per 1,000) in women at elevated risk [57-60]. Mammography with IV contrast may be useful in high-risk women as an alternative to MRI.

MRI Breast Without and With IV Contrast

MRI has a higher CDR than mammography alone, DBT, or mammography/DBT combined with US [61-64]. In high-risk women, supplemental screening MRI combined with mammography yields a 91% to 98% sensitivity, although the reported specificity of MRI is typically lower than mammography [40,81]. The incremental CDR of MRI in elevated-risk women ranges from 8 to 29 per 1,000 women, with higher CDR (26 per 1,000) in BRCA mutation carriers [61-63,65,66]. Breast MRI detects small, node-negative invasive cancers at earlier tumor stages compared to mammography, as well as ductal carcinoma in situ [68,69]. Screening MRI also reduces interval cancers [69]. However, breast MRI has a higher recall rate than mammography (15.1% versus 6.4%) [70], higher frequency of BI-RADS category 3 assessment than mammography (14.8% versus 11.8%), and a greater frequency of image-guided biopsies than mammography (11.8 versus 2.4%) [63].

In women with a personal history of breast cancer, early detection of second breast cancers improves survival; however, mammographic sensitivity is lower, and interval cancer rates are higher, prompting investigations into supplemental screening regimens in breast cancer survivors [3,40,66]. In women previously diagnosed with breast cancer [3], a recent meta-analysis estimated a CDR of 9 to 15 per 1,000 breast MRI [67]. Due to heterogeneity in the risk of second breast cancer diagnoses, recommendations for supplemental screening MRI vary. Based upon limited modeling data, women with a personal history of breast cancer who were diagnosed before <50 years of age or women with a personal history of breast cancer and dense breast tissue may have a >20% estimated lifetime risk of a subsequent breast cancer diagnosis and may therefore be considered high risk, warranting supplemental screening breast MRI on an annual basis [3]. In a prospective observational study of women ≤50 years of age who had undergone breast conservation therapy, supplemental screening MRI increased CDR (8.2 versus 4.4 per 1,000) but had decreased specificity, compared to mammography [66].

Since 2007, the American Cancer Society has recommended annual breast MRI for breast cancer screening in high-risk women [4]. The ACR recommends annual breast MRI in high-risk women beginning as early as 25 years of age [3].

MRI Breast Without and With IV Contrast Abbreviated
Data are limited regarding the use of abbreviated breast MRI without and with IV contrast for screening in high-risk women. Following the publication of the American Cancer Society guidelines for supplemental screening breast MRI in 2007, high-risk women have traditionally undergone conventional full protocol breast MRI without and with IV contrast [3,4]. However, multiple studies have demonstrated similar diagnostic accuracy for abbreviated protocol MRI compared to conventional full protocol breast MRI [73-75]. In a study evaluating 3,037 abbreviated breast MRI in 1,975 high-risk women, the CDR was 29 per 1,000, the interval cancer rate was 0.66 per 1,000, and all cancers missed by abbreviated breast MRI were node negative early-stage invasive malignancies [72].

MRI Breast Without IV Contrast
There is no relevant literature to support the use of MRI without IV contrast for screening women at high risk.

MRI Breast Without IV Contrast Abbreviated
There is no relevant literature to support the use of abbreviated breast MRI without IV contrast for screening women at high risk.

Sestamibi MBI
Data are limited regarding the use of sestamibi MBI for screening women at high risk. Most studies have focused upon women with dense breasts and variable risk profiles. Retrospective and prospective studies have demonstrated similar incremental CDR for sestamibi MBI of 6.5 to 9 over mammography, with one study demonstrating an incremental CDR of 16.5 per 1,000 in women at increased risk primarily due to family or personal history of breast cancer [40,47]. Sestamibi MBI demonstrates similar sensitivity, better specificity, and lower recall rate compared to supplemental screening US in women with dense breasts [47,48].

US Breast
In high-risk women undergoing annual mammography plus annual supplemental screening MRI, the addition of supplemental screening with US does not identify additional cancers and is therefore not routinely performed. Screening US may be useful in high-risk patients as an alternative to MRI. However, high-risk women who do not undergo supplemental screening MRI should be counseled that the CDR of US is inferior to MRI. MRI has a higher CDR than mammography, DBT, or mammography/DBT combined with US [61-64]. The ACRIN 6666 trial enrolled women with elevated breast cancer risk [61]. Compared to mammography alone, screening US detected 5.3 cancers per 1,000 in year 1 and 3.7 cancers per 1,000 in years 2 and 3 and resulted in a larger number of false-positive examinations and false-positive biopsies each year [61]. After 3 consecutive rounds of mammography plus US, the incremental CDR of MRI was 14.7 per 1,000, although false-positive examinations also increased [61]. In a prospective multicenter study of 687 high-risk women who underwent clinical breast examination, mammography, US, and MRI for screening, the combination of MRI plus mammography maximized the breast cancers detected [62]. Mammography identified 5 cancers per 1,000 compared to 6 per 1,000 for US, 7.7 per 1,000 for mammography plus US, 14.9 per 1,000 for MRI, 14.9 per 1,000 for MRI plus US, 16 per 1,000 for mammography plus MRI, and 16 per 1,000 for mammography plus US plus MRI [62].

In a prospective study of BRCA mutation carriers and high-risk women, sensitivity of mammography was 25% and 66% whereas US was 23% and 34%, respectively [76]. In the high-risk group, mammography combined with biannual US demonstrated 100% sensitivity [76]; however, MRI was not performed. In a subset analysis of BRCA mutation carriers, MRI sensitivity was 94% [76]. In another study of 529 high-risk women suspected or proven to carry a deleterious BRCA mutation, the performance of US was also inferior to MRI [82]. The sensitivity of mammography was 33%, US was 40%, mammography plus US was 49%, and MRI was 91% [82].

In women with a personal history of breast cancer, supplemental US screening results in an incremental CDR of 2.4 to 2.9 cancers per 1,000 examinations over mammography alone; however, US screening has lower specificity [10,66].

Summary of Recommendations

- **Variant 1**: DBT screening and mammography screening are usually appropriate for breast cancer screening in an adult woman at average risk. These procedures are alternatives.
- **Variant 2**: DBT screening and mammography screening are usually appropriate for breast cancer screening in an adult woman at intermediate risk. These procedures are alternatives.

- **Variant 3**: DBT screening, mammography screening, MRI breast without and with IV contrast, and abbreviated MRI breast without and with IV contrast are usually appropriate for breast cancer screening in an adult woman at high risk. DBT screening and mammography screening are alternatives. MRI breast without and with IV contrast and abbreviated MRI breast without and with IV contrast are alternatives. DBT screening and mammography screening are complementary to MRI breast without and with IV contrast and abbreviated MRI breast without and with IV contrast. In adult women at high risk, breast cancer detection on imaging is maximized with the use of these 2 complementary screening examinations. The panel did not agree on the recommendation for US breast or mammography with IV contrast, because those imaging modalities should be reserved for adult women at high risk who cannot undergo MRI screening.

Supporting Documents

The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

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, because of both 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 with 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 [83].

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."		

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