BI-RADS update for breast cancer caregivers

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Abstract This review will discuss changes relevant to breast cancer caregivers in the fifth edition of the Breast Imaging Reporting and Data System.

Keywords BI-RADS · Breast imaging · Mammography · MRI · Ultrasound

The fifth edition of the Breast Imaging Reporting and Data System (BI-RADS) impacts not only the breast imaging radiologist and the referring breast care provider, but also the patient. It is incumbent upon all health care workers involved in breast care to understand the changes of the new edition of BI-RADS because it affects how we communicate with one another, how we make management decisions, and how we use this information in research and quality audits to provide future care.

The BI-RADS lexicon, a product of the American College of Radiology, was mandated by the Mammographic Quality and Standard Act of 1992. The Act pertains solely to mammography. The mammography lexicon is a dynamic entity, now in its fifth iteration. Because of the success of the mammography lexicon, the breast ultrasound and breast MRI components were subsequently created. The fifth edition of the BI-RADS mammography lexicon is coupled with the 2nd editions of the breast ultrasound and breast MRI lexicons. In this version, standardization of the lexicon across the different breast imaging modalities was performed to simplify the lexicon for easier integration into everyday use.

The changes in the new edition can be categorized into 3 groups: lexicon, reporting, and management. Changes will be reviewed, and images will be provided to further illustrate the concept. Where available, data will be provided to support the change.

Mammography

Lexicon

The lexicon was originally created by a group of breast imaging experts. Although much of the lexicon continues to rely upon expert opinion, the lexicon is increasingly founded upon evidence. Evidence to support lexicon changes is most robust in the mammography section, largely due to its early creation. The first group of changes was to the words used to describe mammographic findings (“descriptors”). Mammographic findings are grouped into seven categories: masses, calcifications, architectural distortion, asymmetries, intramammary lymph node, skin lesions, and solitary dilated duct. Asymmetries, intramammary lymph node, skin lesions, and solitary dilated duct are newly defined categories. See Figs. 1, 2, 3, and 4. Under masses, the term “lobulated” has been eliminated. In the category of calcifications, three changes were made: the terms “lucent-centered” and “egg shell” were eliminated, and the term “group” exchanged for “cluster” under the subcategory of calcification distribution. A group of calcifications is defined as 5 calcifications within 1 cm area of tissue, but less than 2 cm [1]. A collection of calcifications larger than 2 cm in a non-segmental distribution is called “regional calcifications.” See Figs. 5 and 6.
Reporting

A change in the BI-RADS reporting that will be noticeable for referring clinicians is the elimination of numeric values assigned to breast tissue composition. In an effort to discern breast density from report assessments (both of which used “BI-RADS 1 through 4”), breast density will now be described as BI-RADS A (fatty) through D (extremely dense). Due to significant overlap in radiologists’ assessment of adjacent categories, the former numeric quantification of dense breast tissue (e.g., ≤25 % dense tissue) has been eliminated [1].

Proper characterization of the morphology and distribution of calcifications is fundamental to the usefulness of the lexicon. The PPV (likelihood of malignancy) has been studied which has resulted in changes in this edition of BI-RADS. It has been shown that the PPV of abnormal calcifications on screening mammography of women who were ultimately diagnosed with breast cancer was 19.1 % [2]. Specific descriptors have been studied by multiple investigators, four of which have relevance to BI-RADS: coarse heterogeneous, amorphous, fine pleomorphic, and fine linear branching. Coarse heterogeneous calcifications had PPVs ranging from 7 to 50 % [3, 4]. Amorphous calcifications had PPVs that ranged from 13 to 26 % [3–6]. The PPVs of fine pleomorphic calcifications have been reported to be approximately 28 % [4]. Fine linear branching calcifications have the highest PPVs, ranging from 53 to 81 % [3, 4, 6]. The reporting of BI-RADS 4 (“Findings are suspicious for malignancy, biopsy should be considered”) had been previously subdivided into 4a-c to assist the referring physician in the decision to perform a biopsy. This edition assigns PPVs to the subdivisions: 4a (PPV of >2–10 %), 4b (>10–50 %), 4c (>50 % to <95 %). Although the assignment of the 4a-c subdivisions is still voluntary, greater adoption is expected. For example, fine...
linear branching calcifications should be given a 4c assignment, as the PPVs range from 53 to 81%. See Fig. 7.

Two other changes are relevant to the referring physician. The first is to include the reporting of a specific location of a finding which includes laterality, quadrant, clock face orientation, depth, and distance from the nipple (e.g., “left upper outer quadrant at 2 o’clock, middle depth, 5 cm from the nipple”). Specific location descriptions can be especially helpful in the absence of prior images. Second, a screening mammogram should not be assessed as BI-RADS 3, 4 or 5. Those assessments are reserved for diagnostic modalities only (diagnostic mammography, ultrasound or breast MRI). This recommendation is now one of the Physician Quality Reporting System measures from the Centers of Medicare and Medicaid Services.

Management

A significant, and controversial, change relevant to all breast care providers is the separation of the BI-RADS assessment from management recommendations. Formerly, the BI-RADS assessment directed management (e.g., BI-RADS 3 usually indicated a 6-month follow up). Radiologists, however, have been increasingly faced with the dilemma of a BI-RADS 3 assessment but then performing a biopsy at the request of the patient or referring provider. Since the BI-RADS audit has driven improvement, the
integrity of the audit can be preserved by separating the assessment from the management. Many existing software programs use the assessment categories to perform both the

Fig. 4 a, b Symmetric bilateral skin thickening and parenchymal edema in a patient with congestive heart failure

Fig. 5 Grouped calcifications are a collection of calcifications spanning 2 cm or less

Fig. 6 Regional calcifications are a collection of calcifications that span more than 2 cm of breast tissue
audit and drive appropriate follow up. Future reporting software will have to create algorithms which permit logs for appropriate patient follow up and to perform audits where assessment and management are independent variables.

One controversy involves the use of BI-RADS 0 and problem solving breast MRI. Although the use of breast MRI as a problem solving tool is infrequent, breast MRI can be a valuable tool in patients who have had breast conservation therapy and who perceive changes in the lumpectomy bed. Diagnostic mammography and ultrasound are of little use due to the expected post-operative changes, and breast MRI has been found to be useful to differentiate scar from tumor [7]. The new BI-RADS

Fig. 7 Fine, linear branching calcifications should be given a BI-RADS 4e assessment

Fig. 8 Amorphous calcifications should be given a BI-RADS 4b assessment

Fig. 9a–c Developing asymmetry (arrow). Note the asymmetry development over time

Fig. 10 Intraductal calcifications (arrows)
edition strongly discourages the use of BI-RADS 0 in this circumstance; however, many radiologists are reluctant to assign a BI-RADS assessment to the mammogram without the additional information provided by the breast MRI. Since the use of the BI-RADS lexicon is voluntary, there may be practitioner variation in this patient scenario. It is important to communicate with your local radiologist about how this situation is managed at your facility.

Two biopsy recommendations relevant to referring physicians are the recommendations for biopsy of amorphous calcifications and for a developing asymmetry. As mentioned above, the PPV of a biopsy recommendation of amorphous calcifications ranges between 13 and 26 % [3–6]. Formerly, amorphous calcifications were considered of intermediate suspicion and may have been observed with serial mammograms. Now, they would be assessed as BI-RADS 4b, and biopsy would be recommended. See Fig. 8. A developing asymmetry is a focal asymmetry which is new or has suspicious characteristics (e.g., getting bigger). The PPV is 12.8 %, so the BI-RADS assessment of a developing asymmetry should be BI-RADS 4b [8]. See Fig. 9.

**Ultrasound**

**Lexicon**

Ultrasound findings are grouped into three categories: masses, calcifications, and special cases. In the masses...
category, lesion boundary was eliminated. The posterior acoustic features descriptor was changed to “posterior features.” In the calcifications category, the macrocalcifications descriptor was eliminated, and intraductal (e.g., ductal carcinoma in situ) calcifications descriptor was added. See Fig. 10. Several new Special Cases were added: simple cyst, vascular abnormalities, Mondor disease, postsurgical fluid collection, and fat necrosis. See Figs. 11, 12, 13, 14 and 15.

In this edition, a new sonographic technique was incorporated into BI-RADS: elasticity (as a subset of associated features). Elasticity measures the hardness of a sonographic mass via strain or shear wave. The more stiff the mass, the more likelihood it is a cancer [9]. There is, however, significant overlap between what is benign and what is malignant, so the tool is used to improve the specificity of a biopsy recommendation [9, 10]. See Fig. 16.

**Reporting**

Currently, 19 states have adopted legislation regarding breast density notification to women undergoing mammography. Evidence supporting the use of screening ultrasound in normal risk women is scant. In Connecticut, where insurance coverage for additional screening...
was mandated by law, the PPV for a finding seen only on ultrasound was 6.5% [11]. Due to the increased use of ultrasound as a screening tool, this edition of BI-RADS recommended making a tissue composition assessment: homogeneous background echotexture (fat), homogeneous background echotexture (fibroglandular), and heterogeneous background echotexture. It is unknown how the different echotextures affect the sensitivity or specificity of screening ultrasound, a topic likely to be addressed in the next edition of BI-RADS.
Referring physicians should be aware of changes in the recommended management of probable fibroadenomas and complicated cysts. In prior editions, core needle biopsy or aspiration had been the standard recommendation. For probable fibroadenomas, ample evidence supports a BI-RADS 3 (probably benign) assessment with 6-, 12-, and 24-month follow up ultrasounds \cite{12, 13}.

**Breast magnetic resonance imaging (Breast MRI)**

**Lexicon**

Breast MRI findings are grouped into seven categories for dynamic contrast enhanced breast MRI (DCE-BMRI): focus, mass, nonmass enhancement, intramammary lymph node, skin lesion, non-enhancing findings, and fat-containing lesions. Associated features contain pertinent descriptors for the 7 categories. Multiple descriptors have been eliminated: foci, lobular, enhancing internal septation, central enhancement, ductal enhancement, stippled, punctate, reticular, dendritic, pre-contrast high duct signal, edema, lymphadenopathy, hematoma-blood, and abnormal signal void. Many of these terms were eliminated due to underuse; others were eliminated in order to have homogeneity across the 3 lexicons. For example, mass margins were now characterized as circumscribed (a benign descriptor) versus non-circumscribed (a suspicious descriptor) which is consistent with the mammography and ultrasound lexicons. New descriptors include clustered ring internal enhancement, intramammary lymph node and skin lesions. See Figs. 17, 18 and 19. Finally, nonmass-like enhancement category was simplified to nonmass enhancement.

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**Fig. 17** Clustered ring enhancement (arrow). Sagittal T1 fat saturation dynamic contrast enhanced subtraction image

**Fig. 18** Intramammary lymph node (arrow). Note white fat in center of the mass, a characteristic of an intramammary lymph node. Axial T1 image

**Fig. 19** Benign skin lesion-sebaceous cyst (arrow). Axial STIR image
For the first time, silicone breast implants have been included as a category in the BI-RADS lexicon. (Saline breast implant integrity is a clinical assessment.) Silicone breast implant integrity is assessed without contrast injection. Descriptors include type, location, abnormal implant contour, intracapsular silicone implant findings, extracapsular silicone, water droplets, and peri-implant fluid. See Figs. 20, 21, 22 and 23.

**Reporting**

Breast care health workers will now notice two standard phrases at the beginning of the DCE-BMRI report regarding breast tissue composition and background parenchymal enhancement. Breast tissue composition is divided in the 4 categories, as in mammography. Background parenchymal enhancement (BPE) pattern is also divided into 4 categories (minimal, mild, moderate, marked) and may be symmetric or asymmetric. See Fig. 24. Inclusion of the BPE is important because there is evidence that the degree of BPE may be associated with breast cancer risk, like that of breast density on mammography [14]. Consistent use of the lexicon in the assessment of BPE will allow for further investigation of this observation.

Kinetic assessment reporting has been further defined to emphasize the importance of reporting both the initial and delayed phases of the signal intensity changes over time. Studies have increasingly shown the prediction of malignancy in assessment of the initial phase, and some have advocated fewer delayed contrast sequences to shorten the imaging time [15].

**Management**

The most significant new management recommendation is that any MRI finding that necessitates a second-look ultrasound for biopsy localization should be given a BI-RADS 4 or 5 assessment. In prior years, radiologists would give a BI-RADS 0 assessment to indicate that additional imaging was recommended. The BI-RADS 0 recommendation, however, resulted in patients lost to follow up and inaccurate quality auditing.

In summary, multiple changes have been made in the fifth edition of BI-RADS which impacts our communication, patient management, research, and quality improvement. The lexicon has been simplified and standardized across 3 breast imaging modalities to

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**Fig. 20** a Prepectoral silicone implant. Note the anterior location of the implant (star) relative to the pectoralis major muscle (arrow). Sagittal water saturation image. b Retropectoral silicone implant. Note the posterior location of the implant (star) relative to the pectoralis minor muscle (arrow). Sagittal T1 fat saturation dynamic contrast enhanced image

**Fig. 21** Focal implant bulge (arrow). Axial water saturation image of a silicone breast implant
promote consistent use of the lexicon. Current reporting software programs will need to evolve to accommodate the separation of the BI-RADS assessment and the patient management recommendations to ensure adequate patient follow-up. Frequent communication between breast care providers and breast imaging radiologists is encouraged for better understanding of the lexicon which will foster improved patient care.

Fig. 22  a Intracapsular findings-subcapsular line (arrow). Sagittal water saturation sequence. 
   b Intracapsular findings-radial fold (arrow). Axial STIR sequence.  
   c Intracapsular findings-keyhole (arrow). Axial water saturation sequence. 
   d Intracapsular findings-linguine sign (arrow). Sagittal water saturation sequence.

Fig. 23  a Extracapsular findings-breast (arrow). Sagittal water saturation sequence. 
   b Water droplets (arrow). Axial water saturation sequence.
Conflict of interest  The authors have no financial conflict of interest.

Compliance with Ethical Standards  The authors declare that this review complies with United States’ ethical standards. As this is a review, no human/animal experiments were performed, and no informed consent was needed.

References


Fig. 24 a Background parenchymal enhancement-minimal. Axial fat saturation dynamic contrast enhanced subtraction image. b Background parenchymal enhancement-mild. Axial fat saturation dynamic contrast enhanced subtraction image. c Background parenchymal enhancement-moderate. Axial fat saturation dynamic contrast enhanced subtraction image. d Background parenchymal enhancement-marked. Axial fat saturation dynamic contrast enhanced subtraction image.