18th Annual
Breast Imaging and Interventions Update

Hotel Del Coronado • Coronado, California

Friday, October 21, 2016
<table>
<thead>
<tr>
<th>Topic</th>
<th>Author(s)</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening for Breast Cancer</td>
<td>Mohammad Eghtedari, M.D., Ph.D.</td>
<td>1</td>
</tr>
<tr>
<td>Multimodality Image Guided Interventions</td>
<td>Mohammad Eghtedari, M.D., Ph.D.</td>
<td>11</td>
</tr>
<tr>
<td>Hereditary Breast Cancer</td>
<td>Lisa Madlensky, Ph.D.</td>
<td>21</td>
</tr>
<tr>
<td>What is New in BI-RADS® 5th Edition</td>
<td>Haydee Ojeda-Fournier, M.D.</td>
<td>33</td>
</tr>
<tr>
<td>MRI Case Review</td>
<td>Haydee Ojeda-Fournier, M.D.</td>
<td>47</td>
</tr>
</tbody>
</table>
SCREENING FOR
BREAST CANCER

Mohammad Eghtedari, M.D., Ph.D.
Assistant Professor of Radiology
Breast Imaging
University of California, San Diego
Breast Cancer Screening

- What is breast cancer
- Facts and figures about breast cancer
- Controversies of breast cancer screening
- Latest recommendations for breast cancer screening

Majority of cancers originate from TDLU

- ~80% ductal (positive staining for E-Cadherin)
  - ADH, DCIS, IDC
- ~10% lobular (negative staining for E-cadherin)
  - ALH, LCIS, ILC

As a comparison, ~61,000 cases of DCIS are expected in 2016

<table>
<thead>
<tr>
<th>Type</th>
<th>Expected Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>ILC</td>
<td>~1</td>
</tr>
<tr>
<td>DCIS</td>
<td>~2</td>
</tr>
<tr>
<td>IDC</td>
<td>~8</td>
</tr>
</tbody>
</table>

Risk of male breast cancer is 1% of women

Breast Cancer Incidence has been stable from 2003 to 2012 while mortality has declined by 1.9%

Breast cancer incidence incidences 4 times from age 40s to 60s
Most common symptom of breast cancer: Painless lump

Male breast cancer
- 2016 estimates
  - 2600 new cases
  - 440 deaths
- For each 100 female breast cancer, we see one male cancer

Breast lesions
- Benign (may need imaging follow up)
  - FA, cyst, papilloma, fibrosis, apocrine metaplasia, PASH, Adenosis, etc.
- High risk (need surgical excision)
  - ADH (less than DCIS)
  - FEA (flat epithelial atypia)
  - ALH (Less than LCIS)
  - LCIS (less than ILC)
- Malignant
  - IDC (70% of cancers)
  - ILC (8% of cancers)
  - DCIS (20% of cancers)
- Miscellaneous

Breast Cancer Risk Calculators
- Gail model
  - Personal and 1st degree
- Claus
  - More family history
- Tyrer-Cuzick
  - Both personal and family

Average risk = 12.5%
High risk >20%

Breast cancer survival rate by stage

Our role:
- Find the cancer at early stages
- Determine the type and extent of disease (staging)
- Plan for surgery

Signs and Symptoms of Breast Cancer
- Breast lump
- Nipple discharge
  - New and spontaneous
  - Unilateral
  - Serosanguinous
  - Serous and copious
- Nipple inversion
- Skin retraction
- Peau d’orange
- Nothing: detected at screening
Breast Imaging

Screening

Diagnostic

Interventions (biopsy, localizations)

Breast Imaging

Breast Screening

• Screening mammography is for asymptomatic patients only
• At least eight large population-based trials were conducted to evaluate the benefits of screening mammograms to reduce mortality.
  – Seven of eight studies showed an average 24% reduction in mortality by screening
  – Canadian trial did not show any benefit

Screening v. Diagnostic

• Screening
  – Asymptomatic women
  – CC and MLO

• Diagnostic
  – Symptomatic women or mammographic abnormality
  – Additional mammograms tailored to the problem
  – With or without breast ultrasound

Screening Basics

• Dedicated mammographic equipment
• Highly skilled technologists
  – position the breast to maximize the visualized tissue
• Proper processing of the image
  – enhance soft-tissue contrast and preserve high resolution
• Quality control program to guarantee that these elements remain constant
  – MQSA

Mammography quality standards act

• Congress passed this act on October 27, 1992, to establish national quality standards for mammography.
• All facilities must be accredited by FDA
• Involves equipment, QA, QC, personnel, medical records, medical audit.

Screening

• Read between 40-50 batch screening mammograms in 2 hr period
• Recall rate 10% or less
• Average of 5 cancers found per 1,000 women screened
  – PPV1 5-10% (chance of cancer when screening is abnormal)
  – PPV2 at least 25% (chance of cancer when biopsy is done)
• 1000 screening ⇒ 100 recall ⇒ 20 biopsies ⇒ 5 cancers

Goal of screening is to pick up invasive breast cancer when it is at T1 stage (≤2 cm or less) to obtain an excellent outcome
Harms of mammography

- Average radiation dose 1.86 mGy per view (more in younger patients or with large breasts)
  - Simulations have shown that Annual screening in 100,000 women age 40-74 causes maximum 16 deaths but will saves 968 deaths by early detection (not a single death has been recorded yet!)

- Over-diagnosis of DCIS
  - 20-50% of DCIS turns into invasive after 10 years

- False positive → Anxiety/biopsy

Harms of 1000 mammograms per USPSTF

<table>
<thead>
<tr>
<th>Age</th>
<th>False-positive mammography</th>
<th>Additional imaging</th>
<th>Biopsy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>60-64</td>
<td>65-69</td>
<td>70+</td>
</tr>
<tr>
<td>55-59</td>
<td>50.3</td>
<td>29.5</td>
<td>18.7</td>
</tr>
<tr>
<td>60-64</td>
<td>32.0</td>
<td>20.5</td>
<td>16.0</td>
</tr>
</tbody>
</table>

*Number per 1,000 screened women at screening round

From meta-analysis of screening trials using two different methods of case ascertainment, long case a group from EUROSCREEN has been based on 13 studies overall and 3 studies adjusted for breast cancer rate per 100,000 screening women.

Table of Contents
2016 Recommendations for breast cancer screening

Recent changes to breast screening

• Up to 2015, recommendation was for annual screening mammography starting at age 40
• American Cancer Society released its new recommendations on October 20th, 2015 for average risk person:
  – Annual screening mammography at age 45 to 54
  – Every other year mammography starting at 55
  – No clinical breast exam by physician!

ACR disagreed with ACS

• ACR still recommends annual screening mammography at age 40 (no change)
• Screening should be continued while the patient is in good health condition
• High-risk: start screening at age 30
• Mother with early breast cancer: start 10 years earlier than the age of mother at diagnosis

A few things to remember about new ACS guidelines

• Only for average risk: no personal Hx of breast CA, no genetic factor, no radiation to chest
• It still shows that over ALL age groups, screening is associated with 28-36% reduced mortality
• Women should have the opportunity to select annual scan before age 45
• No clinical breast exam by physician, continue self exam
• Maximum detection is achieved by annual starting at 40

Digital Mammography

Tomosynthesis will replace 2D mammograms

One tomosynthesis have equal or higher dose than conventional 2D
However, it requires less recalls and eventually will decrease the dose to patient
Mammographic findings of Breast Cancer
- Pleomorphic calcifications
- Spiculated mass
- Round mass
- Architectural distortion
- Asymmetry, focal or global
- Breast edema
- Lymphadenopathy
- Nothing (10-15% of all cancers are false negatives on mammography)

Structured Reports
- Indication
- Comparison to previous
- Breast composition
- Findings
- Overall assessment
- Recommendation

Location

Assessment Categories
- BI-RADS-0: assessment incomplete, recall for diagnostic study, priors, or technical repeats
- BI-RADS-1: negative
- BI-RADS-2: benign finding(s)
- BI-RADS-3: probably benign, short interval follow-up (<2% risk of malignancy)
- BI-RADS-4: suspicious, needs biopsy (A, B, C)
- BI-RADS-5: Needs biopsy and surgery for sure (>95% probability of being cancer)
- BI-RADS-6: Completed workup of cancer

A few things to remember
- On screening mammography
  - We can only use BI-RADS 1, 2, or 0
- On diagnostic mammograms
  - We do not want to use BI-RADS 0; We have to make a decision
- Usually we don’t rely on MRI to complete a diagnostic workup. Make decision based on mammo + Ultrasound

meghtedari@ucsd.edu
Multimodality Image Guided Interventions

Mohammad Eghtedari, M.D., Ph.D.
Assistant Professor of Radiology
Breast Imaging
University of California, San Diego
Currently used procedures in Breast Imaging

- Biopsies:
  - Ultrasound-guided
  - Stereotactic Biopsy
  - MRI-guided
- Pre-operative localization
  - Ultrasound-guided
  - Mammography-guided
  - MRI-guided
  - Stereotactic-guided
- Ductography

Preparation

- Review images prior to the day of procedure
- Plan for your approach, type of needle, clip, time needed
- Anticoagulation is not a contraindication
- Consent
  - Explain the procedure to your patient
  - Risks (pain, bleeding, infection, implant rupture)
  - Clip placement
  - Alternatives (may be too late to discuss!)

Time out

- Before starting the procedure ask the patient to:
  - Identify self (First and Last names) + (DOB or MRN)
  - State the procedure
  - State the location and side
  - Check allergy

Anesthetic

- Blocks voltage-dependent sodium channels in nerves
  - Amides (example: Lidocaine)
  - Esters (example: procaine, usually cause more allergy)
- Dermal and subdermal Lidocaine
  - 5 cc (maximum dose 300 mg ≈ 30 cc of 1%)
  - Buffered
- Deep Lidocaine with Epinephrine
  - Total dose can be 50 cc
- Watch for the maximum allowed dose if you are doing multiple procedures/sites for your patient

Core needle biopsy

- Removal of small pieces of tissue using needles that range from 18 gauge to as large as 7 gauge
- Less trauma than a surgical incision and biopsy
- Less expensive than surgery
- Less bleeding and hematoma
  - FNA is even less traumatic than core biopsy but the sample needs to be read by an expert cytologist
Setup your table in a logical order

- Skin prep ➔ local anesthetic ➔ scalpel ➔ Biopsy needle ➔ clip
- Separate sterile components from clean components
- Keep the needle part of the biopsy needle and clip covered until the last minute
- You need to reach all of the items on your table using only one hand when needed
- Position the patient and the height of the bed so you can reach the target easily

US-guided biopsy: positioning is very important

- Align the transducer to point to your shoulder
  - Find your target first and place it at the center of your ultrasound image
  - Then, turn your transducer on the target until the long axis of the transducer points toward your shoulder
  - This will allow you to move the biopsy needle along the longitudinal axis of transducer without any need to bend your wrist.

Evaluate the depth of your target

- Shallow target: enter the skin within 5 mm of transducer
- Deep target: enter the skin within 1-2 cm of transducer

Currently used procedures in Breast Imaging

- Practice to operate the needle with ONE hand
- Demonstrate the clicking noise to patient after injecting anesthetic when you are waiting for medicine to work
- After each core, you will need to unload the specimen and get ready for the next core

What is wrong with this picture?

Table of Contents
FNA (axillary node, FA, papilloma, or satellite masses)

Tips to remember

- The skin is the most sensitive area
- If you run into large venous bleeding, continue with your biopsy to get it done fast, no need to clean the field
- If you run into arterial bleeding, stop biopsy and hold pressure
- Do not change the angle of the needle when the needle is inside tissue
- Excess pressure on transducer will interfere with the cutting mechanism \( \Rightarrow \) poor sampling
- Unlock the needle tip etc. before starting the biopsy
- Do not re-cap the needle
- See the entire length of needle before firing
- Leave marker clip after each biopsy
- If the target is small or hard to see by ultrasound, be ready to insert the clip immediately after the first core

Stereotactic Biopsy

- Larger needle size, vacuum-assisted
- If the target is small, mark your target using mammographic guidance right before stereotactic biopsy
- You probably need both plain/buffered lidocaine as well as lidocaine mixed with epinephrine to minimize bleeding

Select the proper thickness at the beginning

Reference point for calibration
\( X=0, Y=0, Z=0 \)

Table of Contents
A few Tips

- Inject around the target to avoid displacing your target.
- Do not change the angle of the needle that is inside tissue.
- Consider re-targeting if needed (pull back the needle before re-targeting but leave the needle tip in the skin).
- X-ray of the specimen if the target is calcification separate cores.
- If the target is asymmetry and/or hard to be seen on pair images, then replace one of the side images with scout to at least avoid X and Y error (note that z error less than 10 mm is tolerable).
- The clip may migrate along the path of needle (most common on cc approach from below).

MRI-guided biopsy

- Used for MRI findings that do not have mammographic or sonographic correlate
- Limited access, only from lateral or medial of breasts (not superior or inferior)
- If bilateral biopsies, only lateral approach for each breast regardless of the location of the target
- Always vacuum assisted (like stereotactic biopsy, unlike ultrasound biopsy)
- Use same amount of contrast as original MRI; early phase imaging if the target had washout on delayed images
- May need subtraction; acquire pre-contrast T1 fat saturated
- May use axial, sagittal, or a combination to find your target
- Software or manual targeting

General sequence of events for MRI Biopsy

- Cleaning the skin, inserting the grid/compression, place the fiducial marker
- Acquire images following injection of contrast
- Locate the target on images
- Apply anesthetic, skin incision, insert trocar, advance to the target, remove trocar and insert the obturator
- Repeat imaging to see the target and the tip of the obturator that will determine the center of the aperture of the biopsy needle, adjust if needed
- Take obturator out, insert biopsy needle and obtain the sample, leave a marker clip
- May image post procedure to confirm adequate sampling (will see the biopsy cavity and small hematoma)
- Mammograms for clip check

Table of Contents
Needle Localization

- To guide the surgeon
- Bracketing for targets that are more than 2 cm apart from each other
- Select the modality for guidance in advance
- Select your approach, usually the shortest distance
- Note that the needle/wire needs to pass the target by 1 cm

Target clip in medial approach of right breast

Local anesthetic
- Insert the needle vertically using the shadow
- Advance needle (full length of the needle in tissue)
Perpendicular view of the clip/needle

Wire deployed

Thank you for your attention

“The important thing is to figure out whether a lesion needs to be biopsied or not; after that, you can even have a monkey do the biopsy”

Mark J. Dryden, M.D.
HEREDITARY BREAST CANCER

Lisa Madlensky, Ph.D.
Associate Professor
Moores UCSD Cancer Center
Family Cancer Genetics Program
University of California, San Diego
Identification and Management of women at increased breast cancer risk

Lisa Madlensky, PhD, CGC
Director, Family Cancer Genetics Program

UC San Diego Moores Cancer Center

Why is risk assessment important?
- Screening recommendations
  - Mammo start age/frequency
  - Is MRI screening appropriate? High risk clinic?
- Genetic counseling and testing
- Managing risk for other cancers
- Identifying family members at risk

Risk assessment for breast cancer

Goals of breast cancer risk assessment:
- Identify women with hereditary cancer syndromes
- Identify women with “familial risk”
- Personalize screening recommendations
  - Mammogram, or mammogram + MRI?
  - Identify women who can consider tamoxifen
- Am I at increased risk? What can I do about it??

The shift in current testing
- Can still order just BRCA1/2, but panel testing is a “new normal”
- Panels more appropriate for women with breast cancer
- Insurance coverage is inconsistent
- Wide variety of genes
  - Some mimic BRCA1/2 (e.g. PALB2)
  - Some have known cancer syndromes (p53, PTEN)
  - Some are associated with other types of cancer
  - Can now order custom panels
  - Now $250 panel test available commercially, kit sent to home address, reported directly to patient

Clinical vs. genetic diagnosis

Clinical presentation
- Young age of dx
- Cancer features
- Family history

Targeted genetic testing
- 1 or 2 genes; “obvious”
- Clear clinical guidelines
- Clinical utility

“Generic” genetic testing
- Direct to consumer
- Whole exome/genome
- SNP panels

Management
- What is the risk level?
- Appropriate for intervention?
- Identify relatives?

Helping patients (and providers) understand the increasing complexity of genetic test offerings

Table of Contents
Your genome is like a library of 20,000 genes

BRCA1 and BRCA2 are two of the 20,000 books in the library...

Genetic testing is (mostly) like spellchecking the whole book to find one spelling mistake

But what if a whole chapter is missing from the book? The spellchecker won’t work...

Another technology is needed to find missing chapters:
“BART” testing or Large rearrangement testing

FYI– the three common mutations in the Ashkenazi Jewish population:

1) Book BRCA1; chapter 2, page 187– “AG” is missing

2) Book BRCA1; chapter 20, page 5385– an extra “C” is present

3) Book BRCA2; chapter 11, page 6174– a “T” is missing

Panel tests:
5-40+ books at the same time
They found that the polygenic risk score could put women into risk categories. Compared to women with an average polygenic risk score:

- Women with the highest 1% of scores were 3 times more likely to develop breast cancer
- Women with the lowest 1% of scores had a 70% lower risk of developing breast cancer

- Won’t change risk assignment for most women
- For very high or very low, it may change risk assignment
- Opportunities to learn about SNP scores across race/ethnicity

Identifying patients who are appropriate for a genetic workup:

- Cancer patient
- Family hx of cancer
- Probable to test: Consider age of dx, types of cancer in family
- No/minimal family hx of cancer
- May be appropriate for testing: young, large family, triple negative
- If possible, a relative with cancer should undergo testing first
- No/minimal family hx of cancer
- Not appropriate for testing

Whole genome sequencing....

Table of Contents
Results from panel testing:
• “Hit rate” of about 8-10%, depending on who is tested
• 20-30% “Variant of Uncertain Significance”
  – Spelling change, but can’t tell if it’s benign or a true mutation
• **Most are negative**
• Most hits in BRCA1/2, TP53, ATM, PALB2, CHEK2

Genetic Counseling & Testing
• Overview of the family history
  – Bring records if possible
• Personal & family risk assessment
• Will genetic testing be possible?
  – What will be recommended if positive?
  – If negative?
  – Explain chance of a VUS; best testing approach
• Identify family members at risk
• Address family communication
• Insurance issues

So what do we do with the results?
• BRCA1/2, TP53: Follow guidelines for management
• PTEN, CDH1 (STK11): rare, but there are management guidelines
• ATM, CHEK2, PALB2, RAD51C/D, etc
  – No guidelines yet, consult with cancer genetics specialist for personalized plan

Hereditary Breast/Ovarian Cancer Syndrome (BRCA1/2)
• **Multiple cases of early onset breast cancer**
• **Ovarian cancer (invasive)**
• Bilateral breast cancer; breast & ovarian
• Pancreas cancer
• Male breast cancer
• Aggressive prostate cancer

Choices for a BRCA Mutation-Positive Patient:

<table>
<thead>
<tr>
<th>Who? How?</th>
<th>Possible testing for other adult relatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased surveillance</td>
<td>Lifestyle changes</td>
</tr>
<tr>
<td>Early detection</td>
<td>No evidence</td>
</tr>
</tbody>
</table>

Positive BRCA1 or BRCA2 test result

Personalized risk assessment for carriers


Table of Contents
Cumulative incidence of early-stage (stages 0 to I) breast cancer in magnetic resonance imaging (MRI) –screened cohort and comparison group (competing risk model).

Warner E et al. JCO 2011;29:1664-1669

©2011 by American Society of Clinical Oncology

Cumulative incidence of stages II to IV breast cancer in magnetic resonance imaging (MRI) –screened cohort and comparison group (competing risk model).

Warner E et al. JCO 2011;29:1664-1669

©2011 by American Society of Clinical Oncology

Choices for BRCA+ women:

http://brcatool.stanford.edu

Management for BRCA1/2:Summary

- Options: Early detection or risk reduction
- Both are acceptable; data backs up MRI, tamoxifen, and mastectomy
- Personal choice
- Often driven by family history (daughters of BC pts)
  - Actual risks (short- and long-term) are complex
  - Breast cancer genetic counseling is strongly recommended
- Resources for BRCA1/2 families:
  - www.facingourrisk.org
  - www.bebrightpink.org
  - http://brcatool.stanford.edu

Management for ATM, CHEK2, PALB2

- Consult with cancer genetics specialist for personalized, age-specific risk assessment
- Risk of breast cancer is dependent on family history, thorough pedigree (with verification of ages, pathology) if at all possible
- Recommend participation in national/international registries to track penetrance, surveillance outcomes
- Prepare for gene-related risks to change; integration into risk models is evolving

Table of Contents
Management for ATM, CHEK2, PALB2

For most women:

Annual mammograms:
Start at age 30 (PALB2) or 40 (ATM, CHEK2)

Consider annual MRI
In cases with very strong family history/risk profile, can consider risk reducing mastectomy

Family history of breast cancer? Ages of dx?
Other risk/protective factors?

Management for other syndromes:

- Li Fraumeni (TP53 mutations): very high risk of all cancers
  - Breast MRI age 20-29
  - MRI and mammogram age 30-75 (as appropriate)
- PTEN Hamartoma syndrome ("Cowden syndrome")
  - MRI and mammogram age 30+ (or younger if family hx indicates)
- Hereditary Diffuse Gastric Cancer (CDH1)
  - Increased risk of diffuse gastric cancer, lobular breast cancer
  - Some families are "breast cancer dominant"
- Peutz-Jeghers syndrome (STK11)
  - MRI and mammogram age 25+
  - Rare; ideally followed at specialty clinic for high risk patients.
  - NCCN guidelines for management

Stopping screening…

- Dependent on risk, age, and comorbidities
- No data yet for risks of breast cancer in 70+ women for many panel genes
- Genetic risk is typically strongest prior to menopause (greater relative risks)

- Individual risk/benefit discussion
- Generally, woman with BRCA mutation who is 70+ is likely to be more at risk of a “sporadic” breast cancer than a BRCA-related breast cancer
  - (tumor profiling will provide important data)

Personalized risk assessment for carriers

Data from 653 Young Breast Cancer Patients aged ≤ 50

- Initial list from UCSD Cancer Registry 2011-15
- Includes DCIS/Invasive BC

- How many pts were referred to genetics?
  - If not, why not?
- How many referred pts made an appointment?
  - If not, why not?
- What (if any) testing was offered? Did testing occur?
- What was the yield of testing in this age group?

Genetic testing in young breast cancer patients
Attendance: Who actually made an appointment and attended?

74% of patients referred to genetics came to an appointment. 26% did not. Why?
• 42%: no response
• 18%: declined
• 17%: getting care elsewhere
• 5% palliative care

Of 386 referred patients, 287 attended an appointment.

Results: Genetic testing (BRCA or panel)

15.4% of tested patients were had a positive result

BRCA test only:
• 11.7% positive
• 4.4% VUS

Panel test:
• 16.9% positive
• 19.3% VUS

Conclusions:

• It’s not just “a test”, it’s a process: Referral → Appointment → Decision-making
• Young BC patients have a 13% positive rate overall; as high as 34% in those 30 or less
• Most positive results are BRCA1/2
• Likely many women who have a mutation, but were not referred, didn’t attend appointment, declined testing, or have had limited testing: opportunities to improve + respect personal choice

Summary:
• Panel testing now widely available
  – Picks up more high risk families
  • But, more VUSs = more confusion
  • And, lower penetrance genes with little data
• BRCA1/2 still most common cause of hereditary BC risk
• Utilize cancer genetics experts for help with risk assessment
• Young BC patients- special population

Thank you
Resources

- USPSTF guidelines for BRCA workup
- American Cancer Society
  - Multi-Society Task Force guidelines for colorectal cancer screening
- NCCN guidelines for Detection, Prevention and Risk Reduction
  - Hereditary breast cancer & GI Cancer syndromes
  - NCCN.org
- GeneReviews.org
  - Clinical summary of genetic diseases, including cancer syndromes
  - Helpful differentials
  - Includes management recommendations

Resources

- Genetic counselors near you:
  - NSGC.org “Find a counselor” tool; specify cancer
  - ABGC.net Directory of all board-certified genetic counselors

- For BRCA1/2 and high risk women:
  - Facing Our Risk of Cancer Empowered (FORCE)
  - FacingOurRisk.org
  - Be Bright Pink (for younger BRCA+ women)
  - Brightpink.org
What is New in 
BI-RADS® 5th Edition

Haydee Ojeda-Fournier, M.D.
Associate Professor of Radiology
Medical Director, Breast Imaging
University of California, San Diego

Table of Contents
What is new in BI-RADS® 5th Edition

Haydee Ojeda-Fournier, MD
Associate Professor of Clinical Radiology
UC San Diego Health
Moores Cancer Center
hojeda@ucsd.edu

Then and now

Educational goals

1. Understand the changes to the BI-RADS 5th edition
2. Review those changes with imaging correlation on
   a. Mammography
   b. US
   c. Breast MRI

History of BI-RADS

• Prior to the initiation of BI-RADS, mammography reports used ambiguous and often unintelligible descriptions that made management difficult for referring physicians
• The first edition of BI-RADS was released by the ACR in 1993 with the goal of standardizing mammography reporting using a specific lexicon of imaging features
• Lexicon descriptors were designed to predict both benign and malignant disease, eliminate ambiguity, allow automated data collection and help facilitate communication with referring physicians

Background information

• Standardized terminology, report organization and assessment structure allow radiologists to communicate breast imaging findings with referring physicians in a clear and succinct manner
• The much anticipated American College of Radiology Breast Imaging Reporting and Data System (BI-RADS) Atlas 5th edition was released in February 2014
• Since the 4th edition was released more than 10 years ago, it may be difficult to learn all the specific changes in the 5th edition
• While the majority of changes represent re-organization and consolidation of terms, there are also new descriptors in the lexicon
BI-RADS ®

- Breast Imaging Reporting And Data System
  - Lexicon
  - Reporting
  - Data collection and audit system

- 5th Ed. changes
  - Corrects errors
  - Resolve inconsistencies between modalities
  - Consolidates, revise, expand lexicon terms

Summary of changes

<table>
<thead>
<tr>
<th>Section</th>
<th>Descriptor</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>General</td>
<td>Documentation</td>
<td></td>
</tr>
<tr>
<td>Mammogram</td>
<td>Breast density</td>
<td>Eliminate percent ranges for breast density</td>
</tr>
<tr>
<td></td>
<td>Mass: Oval and lobular</td>
<td>Rim</td>
</tr>
<tr>
<td></td>
<td>Califications:</td>
<td>Round and punctate</td>
</tr>
<tr>
<td></td>
<td>Lucent center and eggshell</td>
<td>Round</td>
</tr>
<tr>
<td></td>
<td>Higher probability of malignancy</td>
<td>Suspicious</td>
</tr>
<tr>
<td>US</td>
<td>Breast tissue composition</td>
<td>Visual assessment</td>
</tr>
<tr>
<td></td>
<td>Complex mass</td>
<td>Complex cystic and solid mass</td>
</tr>
<tr>
<td>MRI</td>
<td>Elastography descriptors</td>
<td>New</td>
</tr>
<tr>
<td></td>
<td>Includes FGT, BPE, implants</td>
<td>Most dramatic change</td>
</tr>
</tbody>
</table>

BI-RADS 5th ed: Mammography revisions

<table>
<thead>
<tr>
<th>Section</th>
<th>Revision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Percentiles eliminated</td>
</tr>
<tr>
<td>Masses</td>
<td>Consolidated shapes to match US and MRI</td>
</tr>
<tr>
<td></td>
<td>descriptors by eliminating lobular</td>
</tr>
<tr>
<td>Califications</td>
<td>• Simplified distributions by eliminating scattered and clustered</td>
</tr>
<tr>
<td></td>
<td>• Combined intermediate and higher probability of malignancy categories into suspicious morphology</td>
</tr>
<tr>
<td></td>
<td>• Consolidated several calcification types</td>
</tr>
<tr>
<td></td>
<td>• Eliminated number</td>
</tr>
<tr>
<td>Asymmetries</td>
<td>Added developing asymmetry descriptor</td>
</tr>
<tr>
<td>Special cases</td>
<td>Moved asymmetric tubular structure from asymmetries and to renamed solitary dilated duct</td>
</tr>
</tbody>
</table>
Mammography: Shape for masses

<table>
<thead>
<tr>
<th>Density*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>60% chance of malignancy</td>
</tr>
<tr>
<td>Equal</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>22% chance of malignancy</td>
</tr>
<tr>
<td>Fat containing</td>
<td>Radiolucent eliminated 0% chance of malignancy</td>
</tr>
</tbody>
</table>

*In reference to equal volume of fibroglandular tissue

Masses – Margins (no change)

<table>
<thead>
<tr>
<th>Margin</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circumscribed</td>
<td></td>
</tr>
<tr>
<td>Obscured</td>
<td></td>
</tr>
<tr>
<td>Indistinct</td>
<td></td>
</tr>
<tr>
<td>Spiculated</td>
<td></td>
</tr>
<tr>
<td>Microlobulated</td>
<td></td>
</tr>
</tbody>
</table>

Calcifications

<table>
<thead>
<tr>
<th>Changes</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rim to encompass both eggshell and lucent-centered calcifications</td>
<td></td>
</tr>
<tr>
<td>Round to encompass both round and punctate calcifications</td>
<td></td>
</tr>
<tr>
<td>Amorphous preferred over indistinct</td>
<td></td>
</tr>
<tr>
<td>Grouped preferred over clustered and includes at least 5 calcifications within a 1 cm distance as opposed to 1 cubic cm</td>
<td></td>
</tr>
<tr>
<td>Diffuse preferred over scattered</td>
<td></td>
</tr>
</tbody>
</table>

Typically benign calcifications

<table>
<thead>
<tr>
<th>Comments</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin</td>
<td></td>
</tr>
<tr>
<td>Vascular</td>
<td></td>
</tr>
<tr>
<td>Coarse, popcorn</td>
<td></td>
</tr>
<tr>
<td>Large rod-like</td>
<td></td>
</tr>
<tr>
<td>Round</td>
<td>To encompass both round &gt;0.5 mm and punctate &lt; 0.5 mm</td>
</tr>
<tr>
<td>Rim</td>
<td>To replace lucent-centered and eggshell</td>
</tr>
<tr>
<td>Dystrophic</td>
<td></td>
</tr>
<tr>
<td>Milk of Calcium</td>
<td></td>
</tr>
<tr>
<td>Suture</td>
<td></td>
</tr>
<tr>
<td>Suspicious*</td>
<td>Comments</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Coarse, heterogeneous</td>
<td></td>
</tr>
<tr>
<td>Amorphous</td>
<td>preferred over indistinct</td>
</tr>
<tr>
<td>Fine pleomorphic</td>
<td></td>
</tr>
<tr>
<td>Fine linear</td>
<td></td>
</tr>
<tr>
<td>Fine linear</td>
<td>branching</td>
</tr>
</tbody>
</table>

*replace intermediate and higher probability of malignancy

Liberman AJR 1998,
Berg Radiology 2001,
Burnside Radiology 2007,
Bent Radiology 2010

**Calcifications – Morphology**

- Coarse heterogeneous
- Amorphous
- Fine pleomorphic
- Fine linear
Calcifications – Morphology
Fine linear branching

Calcifications

<table>
<thead>
<tr>
<th>Distribution</th>
<th>Comment</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diffuse</td>
<td>preferred over scattered</td>
<td>0%</td>
</tr>
<tr>
<td>Regional</td>
<td>preferred over clustered</td>
<td>26%</td>
</tr>
<tr>
<td>Grouped</td>
<td>preferred over clustered - now 5 calcifications in 1 cm distance as opposed to 1 cubic cm; clustered with history of being suspicious but now can be benign or suspicious/malignant</td>
<td>31%</td>
</tr>
<tr>
<td>Linear</td>
<td></td>
<td>60%</td>
</tr>
<tr>
<td>Segmental</td>
<td></td>
<td>74%</td>
</tr>
</tbody>
</table>


Diffuse Regional Grouped

Architectural distortion
• Suspicious for malignancy unless scar
• Benign causes of architectural distortion
  – Surgery/prior biopsy
  – Radial scar
  – Sclerosing adenosis
  – Stromal fibrosis

Asymmetry changes

<table>
<thead>
<tr>
<th>BI-RADS 3rd Ed.</th>
<th>BI-RADS 4th Ed.</th>
<th>BI-RADS 5th Ed.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>Asymmetry</td>
<td>Asymmetry</td>
</tr>
<tr>
<td>Asymmetric breast tissue</td>
<td>Global asymmetry</td>
<td>Global asymmetry</td>
</tr>
<tr>
<td>Focal asymmetric density</td>
<td>Focal asymmetry</td>
<td>Focal asymmetry</td>
</tr>
</tbody>
</table>

Developing asymmetry*

*new, larger or denser, focal asymmetry

Table of Contents
Asymmetry

• Normal variant
• Super-imposed tissue
• Surgery
• Hormone replacement
• Fibrocystic changes
• Developing cancer

Global asymmetry

Focal asymmetry

Focal asymmetry

Developing asymmetry

Developing asymmetry

Table of Contents
Developing asymmetry

Management of asymmetries

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>BI-RADS 1</td>
<td>Asymmetry at screening → overlapping tissue Dx</td>
</tr>
<tr>
<td>BI-RADS 2</td>
<td>Non palpable global asymmetry or stable focal asymmetry</td>
</tr>
<tr>
<td>BI-RADS 3</td>
<td>Baseline non palpable asymmetry</td>
</tr>
<tr>
<td>BI-RADS 4</td>
<td>Palpable focal asymmetry or non palpable with suspicious features Developing asymmetry (&gt;2% chance of malignancy)</td>
</tr>
</tbody>
</table>

Associated features

<table>
<thead>
<tr>
<th>Associated features</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skin retraction</td>
<td></td>
</tr>
<tr>
<td>Nipple retraction</td>
<td></td>
</tr>
<tr>
<td>Skin thickening</td>
<td>Infection, radiation, malignancy, lymphatic obstruction, fluid overload</td>
</tr>
<tr>
<td>Trabecular thickening</td>
<td>Bilateral v. unilateral</td>
</tr>
<tr>
<td>Axillary adenopathy</td>
<td></td>
</tr>
<tr>
<td>Architectural distortion</td>
<td>Either primary or associated</td>
</tr>
<tr>
<td>Calcifications</td>
<td></td>
</tr>
</tbody>
</table>

Others

<table>
<thead>
<tr>
<th>Others</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Architectural distortion</td>
<td></td>
</tr>
<tr>
<td>Skin lesions</td>
<td>Previously an associated feature</td>
</tr>
<tr>
<td>Intramammary lymph node</td>
<td></td>
</tr>
<tr>
<td>Solitary dilated duct</td>
<td></td>
</tr>
</tbody>
</table>

Associated features

<table>
<thead>
<tr>
<th>Associated features</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nipple retraction</td>
<td>Skin retraction</td>
<td>Skin and trabecular thickening</td>
</tr>
</tbody>
</table>

Implant findings

- Normal implants
- Asymmetric implants
- Calcified implants
- Distorted implants
- Silicone-laden lymph nodes
- Free silicone
- Herniated implant
- Ruptured implant
- Explant

Table of Contents
Ductography findings
- Normal
- Intraluminal filling defect
- Duct ectasia
- Multiple filling defects
- Abrupt duct termination
- Extravasation
- Duct narrowing
- Cyst fill

<table>
<thead>
<tr>
<th>Masses</th>
<th>Descriptors</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shape</td>
<td>Oval</td>
<td>2-3 undulations</td>
</tr>
<tr>
<td></td>
<td>Round</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td>Irregular</td>
<td>Neithor round or oval</td>
</tr>
<tr>
<td>Orientation</td>
<td>Parallel</td>
<td>To skin</td>
</tr>
<tr>
<td></td>
<td>Not parallel</td>
<td>Taller than wide</td>
</tr>
<tr>
<td>Margin</td>
<td>Circumscribed</td>
<td>&quot;Eliminated abrupt interface echogenic halo&quot;</td>
</tr>
<tr>
<td></td>
<td>Not circumscribed</td>
<td></td>
</tr>
<tr>
<td>Echo pattern</td>
<td>Anechoic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hyperechoic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complex cystic and solid</td>
<td>Replaces complicated mass</td>
</tr>
<tr>
<td></td>
<td>Hypoechoic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Isoechoic</td>
<td>&quot;In reference to mammary fat&quot;</td>
</tr>
<tr>
<td>Posterior acoustic features</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enhancement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shadowing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td></td>
</tr>
</tbody>
</table>

Changes
- Complex cystic and solid mass
- Heterogeneous echo pattern

Ultrasound: Calcifications
- 4th edition
- 5th edition

Table of Contents
### Special cases

<table>
<thead>
<tr>
<th>Special cases*</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple cyst</td>
<td>No further descriptors needed</td>
</tr>
<tr>
<td>Cluster microcyst</td>
<td></td>
</tr>
<tr>
<td>Complicated cysts</td>
<td></td>
</tr>
<tr>
<td>Mass in or on skin</td>
<td></td>
</tr>
<tr>
<td>Foreign body</td>
<td>Includes implants</td>
</tr>
<tr>
<td>Lymph nodes</td>
<td>Intramammary Axillary</td>
</tr>
<tr>
<td>Vascular anomalies</td>
<td>AVM, Mondor’s</td>
</tr>
<tr>
<td>Post surgical fluid collections</td>
<td></td>
</tr>
<tr>
<td>Fat necrosis</td>
<td></td>
</tr>
</tbody>
</table>

* Unique diagnosis

### Ultrasound: New special cases

- **Simple cyst**
- **Post-surgical fluid collection**
- **Fat necrosis**
- **AVM**
- **Mondor disease**

### Overview of BI-RADS 5th edition:

**MRI revisions**

- New sections
  - Amount of fibroglandular tissue (FGT)
  - Background parenchymal enhancement (BPE)
- Diffuse lori now considered background enhancement
- Masses
  - Shapes/Margins
    - Irregular used for shape and margin
    - Lobular eliminated
    - Smooth is now circumferential
  - Internal enhancement characteristics
    - Eliminated central enhancement and increasing internal septations
- Kinetic curve assessment
  - Rapid changed to fast

- Non-mass enhancement (NME) replaces non-mass-like
  - Distribution
  - Eliminated ductal
  - Internal enhancement patterns
  - Eliminated stippled/punctate
  - Reticular/dendritic is now clustered/flopping
- Associated findings section from the 4th edition has been expanded and subcategorized into an additional section
  - Intramammary lymph nodes
  - Skin lesion
  - Non-enhancing findings (7 items)
  - Associated features (6 items)
  - Fat-containing lesions (4 items)
  - Implants

### MRI BI-RADS

**Amount of fibroglandular tissue**

- Almost entirely fat
- Scattered fibroglandular tissue
- Heterogeneous fibroglandular tissue
- Extreme fibroglandular tissue

### Background parenchymal enhancement

- Visual estimation of normal enhancement in the first post contrast sequence
  - Minimal
  - Mild
  - Moderate
  - Marked
- Enhancement is either symmetric or asymmetric
- No significant difference in cancer detection rate or biopsy rates among the different BPE categories

**Table of Contents**
MRI: Kinetic curve assessment

- Initial (within first two minutes or when curve starts to change)
  - Slow
  - Medium
  - Fast (previously rapid)
- Delayed (after 2 min or after curve starts to change)
  - Persistent
  - Plateau
  - Washout

BI-RADS management

<table>
<thead>
<tr>
<th>Category</th>
<th>Term</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Incomplete</td>
<td>Additional imaging or prior mammograms for comparison</td>
</tr>
<tr>
<td>1</td>
<td>Negative</td>
<td>Routine screening</td>
</tr>
<tr>
<td>2</td>
<td>Benign</td>
<td>Routine screening</td>
</tr>
<tr>
<td>3</td>
<td>Probably benign</td>
<td>Short interval follow up</td>
</tr>
<tr>
<td>4</td>
<td>Suspicious</td>
<td>Tissue diagnosis</td>
</tr>
<tr>
<td></td>
<td>Low suspicion</td>
<td><em>Not for MRI</em></td>
</tr>
<tr>
<td></td>
<td>Moderate suspicion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High suspicion</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Highly suggestive</td>
<td>Tissue diagnosis</td>
</tr>
<tr>
<td></td>
<td>of malignancy</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Known biopsy proven</td>
<td>Surgical excision when clinically appropriate</td>
</tr>
<tr>
<td></td>
<td>malignancy</td>
<td></td>
</tr>
</tbody>
</table>

Guidance sub-section

- Offers practical explanations of changes in the BI-RADS lexicon and gives answers to frequently asked questions
- Examples include:
  - Reasons for simplifying the lexicon for mammography and ultrasound
  - Report organization suggestions
  - Surveillance algorithms
  - BI-RADS assessment category explanations
  - FAQ: What should the BI-RADS final assessment be for axillary adenopathy with no suspicious findings in the breasts?

Guidance

- BI-RADS cat 3 never to be used at screening
- BI-RADS cat 4 and 5 should not be used at screening
- BI-RADS cat 4 A, B, and C not to be used for MRI
- BI-RADS cat 3 emerging data for use in MRI

Conclusion

- BI-RADS predicts both benign and malignant disease, eliminates ambiguity, allows automated data collection and facilitates concise communication with referring physicians as well as radiologists across facilities
- The current 5th edition reorganizes and consolidates terminology from the 4th edition and significantly expands the MRI lexicon
- As a living document, BI-RADS allows for updates as future research and data inevitably change practice patterns
- We expect to see future editions of the BI-RADS in years to come

Thank you!
MRI CASE REVIEW

Haydee Ojeda-Fournier, M.D.
Associate Professor of Radiology
Medical Director, Breast Imaging
University of California, San Diego
Breast MR Case Review

Haydee Ojeda-Fournier, MD
Associate Professor of Clinical Radiology
UCSD Moores Cancer Center
hojeda@ucsd.edu

Case 1: Matching
A. Aliasing
B. Coil off
C. No contrast
D. RF
E. Subtraction error

Case 2: 28 yo with palpable finding

Case 3: 29 yo rapidly growing mass

Case 4: What is the diagnosis?

Case 5: Palpable finding right breast, what would you do next?

T2 T1 Sub
MIP What is the most likely diagnosis?

T2 T1 post T1 non fat sat
T1 post T1 in fl T2

What is the most likely diagnosis?
Case 6: Which side is normal?

Case 7: Which side is normal?

Case 8: Diagnosis?

Case 9: Neoadjuvant chemotherapy

Case 10: What would help with this case other than clinical history?

Case 11: What useful information does the surgeon need to know?

This patient has had a:
A. Complete response
B. Partial response
C. No response
Case 12: What BI-RADS category would you give this case?

Case 13: Would you biopsy this lesion?

Case 14: Breast MR T2 sequence, what is the finding?

Case 15: 38 yo axillary node mets

Why did the surgeon order this test?

Case 16: 35 yo triple negative cancer

Case 17: Rim enhancement differential

What does the surgeon need to know?
Case 18. Post surgical breast

Case 19: BI-RADS?

A. BI-RADS 0
B. BI-RADS 1
C. BI-RADS 2
D. BI-RADS 5
E. BI-RADS 6

Case 20: What is the best descriptor for extent of disease