Abbreviated Breast MRI Screening

Gillian M. Newstead MD, FACR
University of Chicago

Disclosures
1. Advisory Board Bayer AG: Breast MRI
2. Consultant Bracco Health Care

Should we expand the use of MRI for Breast Cancer Screening?

- Objectives
  - To review the challenges and efficacy of screening with mammography and ultrasound
  - To review the techniques and challenges associated with expansion of the use of breast MRI screening
  - To discuss the future direction of AB-MRI breast screening and the probable impact on clinical practice

Screening trials using mammography

<table>
<thead>
<tr>
<th>Trial</th>
<th>Screen Interval (months)</th>
<th>Age (years)</th>
<th># Invited women</th>
<th>RR death from breast cancer (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York</td>
<td>12</td>
<td>40-64</td>
<td>31,000</td>
<td>0.71 (0.55-0.91)</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>24</td>
<td>45-64</td>
<td>23,000</td>
<td>0.85 (0.65-1.12)</td>
</tr>
<tr>
<td>Sweden-2 county</td>
<td>24, 33</td>
<td>40-74</td>
<td>77,000</td>
<td>0.78 (0.65-0.93)</td>
</tr>
<tr>
<td>Malmö</td>
<td>28-21</td>
<td>45-70</td>
<td>21,000</td>
<td>0.81 (0.62-1.07)</td>
</tr>
<tr>
<td>Stockholm</td>
<td>28</td>
<td>40-65</td>
<td>39,000</td>
<td>0.76 (0.50-1.14)</td>
</tr>
<tr>
<td>Göteborg</td>
<td>18</td>
<td>40-59</td>
<td>21,000</td>
<td>0.81 (0.50-1.29)</td>
</tr>
<tr>
<td>Swedish overview</td>
<td></td>
<td></td>
<td></td>
<td>0.77 (0.67-0.88)</td>
</tr>
<tr>
<td>All Trials</td>
<td></td>
<td></td>
<td>212,000</td>
<td>0.78 (0.77-0.87)</td>
</tr>
</tbody>
</table>

On Average: 22% mortality reduction

Mammography screening overview

The mammography screening trials were designed to show **The effect of early cancer detection on mortality rates**
High-quality evidence from several RCTs, United States and Europe
- Nearly 500,000 subjects
- All but one showed statistically significant reduction in breast cancer mortality among those invited for screening
None were specifically designed to study women at varying levels of risk

Observed stage shifts with organized mammography screening

<table>
<thead>
<tr>
<th>Cancer</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>T0 In-situ</td>
<td>&lt;5%</td>
<td>25%</td>
</tr>
<tr>
<td>T1 &lt;15 mm</td>
<td>&lt;5%</td>
<td>25%</td>
</tr>
<tr>
<td>T2 15-25 mm</td>
<td>20%</td>
<td>30%</td>
</tr>
<tr>
<td>&gt; 25 mm</td>
<td>70%</td>
<td>20%</td>
</tr>
</tbody>
</table>
Mammographic sensitivity

Sensitivity 88%
Specificity 97%

Sensitivity 62%
Specificity 90%


Limitations of mammography screening

General population

Individual and combined effects of age, breast density, and hormone replacement therapy use on the accuracy of screening mammography

- 7 US population-based Registries
- 2,223 Breast Cancers Diagnosed
  - 62.9% Adj. Sensitivity for Extremely Dense Breasts
  - 87.0% Adj. Sensitivity for Entirely Fatty Breasts
  - 89.1% Adj. Specificity for Extremely Dense Breasts
  - 96.9% Adj. Specificity for Entirely Fatty Breasts


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Limitations of mammography screening

General population

- DMIST trial compared digital with film mammography for breast cancer screening in 49,528 women with a 2-year followup for validation of negative results
  - 41% overall sensitivity for trial participants
  - 38% sensitivity in women with dense breasts
- Breast tumor characteristics as predictors of mammographic detection
  - 17% interval cancer rate
  - Interval cancers with higher grade histology

DMIST trial compared digital with film mammography for breast cancer screening in 49,528 women with a 2-year followup for validation of negative results

- 41% overall sensitivity for trial participants
- 38% sensitivity in women with dense breasts
- Breast tumor characteristics as predictors of mammographic detection
- 17% interval cancer rate
- Interval cancers with higher grade histology

Breast cancer mortality rates are declining worldwide
Mammography screening accounts for a 22% mortality decrease

- 30% cancers in current screening programs are interval cancers
- Mammography has a technology-inherent bias toward detection of slow-growing cancers
- Length-time bias may contribute to "over-diagnosis"
- Mammography has a limited sensitivity for detection of non-calcified prognostically important cancers, those not visible in dense breast tissue


Why should we search for improved screening methods?

Shortcomings of mammography has led to passage of breast density legislation in many states
- Laws recommend that women with dense breasts consider supplemental screening
- Type of supplemental screening not specified


48% of states have passed density laws
http://areyoudenseadvocacy.org/dense/
If you have dense breasts, please talk to your doctor. Together, you can decide which, if any, additional screening exams are right for you.

Risk estimation

<table>
<thead>
<tr>
<th>Factors</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal history</td>
<td>3–4X</td>
</tr>
<tr>
<td>2 or more family members</td>
<td>3X</td>
</tr>
<tr>
<td>Mother dx'd before age 50</td>
<td>2.4X</td>
</tr>
<tr>
<td>Sister dx'd before age 50</td>
<td>3.2X</td>
</tr>
<tr>
<td>LCIS</td>
<td>8–12X</td>
</tr>
<tr>
<td>ADH</td>
<td>4–5X</td>
</tr>
<tr>
<td>ALH</td>
<td>3X</td>
</tr>
<tr>
<td>Dense breasts</td>
<td>4–6X</td>
</tr>
</tbody>
</table>

How do we assess breast density?

- a) The breasts are almost entirely fatty
  - <25% glandular: 10% population
- b) There are scattered areas of fibroglandular density
  - 25%-50% glandular: 40% population
- c) The breasts are heterogeneously dense, which may obscure detection of small masses
  - 51%-75% glandular: 40% population
- d) The breasts are extremely dense, which lowers the sensitivity of mammography
  - >75% glandular: 10% population

ACR BI-RADS Atlas 5.0, 2013

How do we assess breast density?

- Quantitative Measurement of Mammographic Density
  - Mammmography (digital)
    - Planimetry = direct measurement of the area of dense tissue
    - Semi-automated feature: interactive thresholding (Jaffe et al.)
    - Analyzing mammographic patterns: correlation with risk
  - Volumetric density assessment
    - Number of target cells is proportional to the fractional volume of dense tissue
    - For example: "Quantra" from Hologic, "Volpara" ....
    - Dual energy X-ray absorptiometry

Yaffe M. http://breast-cancer-research.com/content/10/3/2009

Risk Estimation Models

Garrett et al. Breast Cancer can be a Tool to Determine well enough to produce or delay screening. Model discrimination must be considerably improved to make a risk-based screening model program reasonable.

BOADICEA


J Harvey: JACR 2015 Issue 2, Page 21

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Candidate additional screening methods

- Digital Breast Tomosynthesis (DBT)
- Contrast-enhanced digital mammography (CE-DM)
- Hand-held ultrasound (HH-US)
- Automated breast ultrasonography (AB-US)
- Magnetic resonance imaging (MRI)

Digital breast tomosynthesis (DBT)

A Better Mammogram
- Detects cancer which may be obscured by overlapping breast tissue
- Improves lesion detection and characterization and reduces recall rates
- Rapidly becoming integrated into clinical practice
- C View: 2D images generated from the tomosynthesis data eliminates the need for additional 2D exposures. FDA approved 2013
- 1 GB of data for 4-view DBT examination
- Doubling of interpretation time


Contrast-enhanced Digital Mammography (CEDM)

Contrast-enhanced mammography can improve the sensitivity of digital mammography

- Dual-energy technique: bolus of nonionic iodinated contrast administered at 1.5 mL/kg.
- 15 seconds per view, imaging time within 5 minutes
- Can be combined with tomosynthesis, CE-DBT
- Studied only in patients with known cancer or other clinical/imaging findings.
- Screening trials are underway


Implementation of Abbreviated Breast MRI Protocols

March 10, 2016

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## Ultrasound for Screening

<table>
<thead>
<tr>
<th>Method</th>
<th>Author</th>
<th>Participants</th>
<th>Additional Cancer yield</th>
<th>DCIS lesions</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>HH-US</td>
<td>Gordon</td>
<td>12,706</td>
<td>44 (3.5/1000)</td>
<td>0 (0%)</td>
<td>16%</td>
</tr>
<tr>
<td>HH-US</td>
<td>Buchberger</td>
<td>8,103</td>
<td>62 (7.9/1000)</td>
<td>5 (13%)</td>
<td>9%</td>
</tr>
<tr>
<td>HH-US</td>
<td>Crystal</td>
<td>1,517</td>
<td>7 (4.6/1000)</td>
<td>0 (0%)</td>
<td>18%</td>
</tr>
<tr>
<td>HH-US</td>
<td>Berg</td>
<td>2,809</td>
<td>43 (4.5/1000)</td>
<td>1 (2%)</td>
<td>8%</td>
</tr>
<tr>
<td>HH-US</td>
<td>Ohuchi</td>
<td>36,859</td>
<td>61 (1.7/1000)</td>
<td>9 (15%)</td>
<td>9.7%</td>
</tr>
<tr>
<td>AB-US</td>
<td>Brem</td>
<td>15,318</td>
<td>30 (1.9/1000)</td>
<td>2 (7%)</td>
<td>9.8%</td>
</tr>
</tbody>
</table>

Mean radiologist time 21 mins

Supplemental yield with US: CA #11 (28%) 4.5/1000

**Benefits, Harms, and Cost-Effectiveness of Supplemental Ultrasonography Screening for Women With Dense Breasts**

**Rationale**
- Mammography not perfect
  - May miss aggressive cancers
  - Limited in dense breast tissue

**Ultrasound not perfect**
- Lower Cancer Yield
- Lower PPV
- Time and cost

**MRI is a better test**
- Functional examination
- Much higher cancer yield and PPV

**Breast MRI for screening**

<table>
<thead>
<tr>
<th>Rationale</th>
<th>May miss aggressive cancers</th>
<th>Limited in dense breast tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultrasound not perfect</td>
<td>Lower Cancer Yield</td>
<td>Lower PPV</td>
</tr>
<tr>
<td>MRI is a better test</td>
<td>Functional examination</td>
<td>Much higher cancer yield and PPV</td>
</tr>
</tbody>
</table>

**CONCLUSION**: Supplemental ultrasonography screening for women with dense breasts would substantially increase costs while providing limited additional benefits in women with dense breasts only ($100,000/QALY considered “cost-effective”)

**References**: Sprague B et al., Annals Int Med, 12/8/14:1-14
Breast MRI for screening

- MRI is a powerful and versatile imaging method
- Historically this method has been used for diagnostic imaging after other methods have been employed
- MRI is a functional imaging method using complex pulse-sequence protocols providing
  - High resolution, high contrast, 3 dimensional images for morphologic analysis
  - Quantitative kinetic computer analysis of kinetic data
  - Advanced computer morphologic analysis
  - Predictive and prognostic biomarker data

We need fast dynamic contrast-enhanced MR Imaging

- Cancers need nutrients and oxygen to grow
- Growth of new blood vessels: Angiogenesis
- Leaky new capillaries and Rapid enhancement following contrast injection
- Rapid drainage of toxic cellular waste products and Rapid washout

Breast MRI for high-risk screening

- Clinical trials of high-risk women
  - Variable study designs and populations
  - All trials used a full diagnostic MRI protocol
- Most of the women in highest risk categories
  - Gene mutation carriers
  - >20–25% lifetime risk due to family history
- Analysis of 10 studies from Germany, the Netherlands, Canada and USA
  - 4605 high-risk women screened
  - 138 (3% - prevalence) cancers detected with MR and NOT seen on mammogram
- MRI shown in all studies to have the highest sensitivity
  - MRI: 85% (60-100%)
  - Mammography: 40% (13-59%*)
  - US: 40% (13-65%) (No added benefit)

High-risk screening: Sensitivity

<table>
<thead>
<tr>
<th>Study</th>
<th>Mammography</th>
<th>Ultrasound</th>
<th>MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tilanus-Linthurst.</td>
<td>0% (0/3)</td>
<td>100% (3/3)</td>
<td></td>
</tr>
<tr>
<td>Podo et al.</td>
<td>12.5% (1/8)</td>
<td>12.5% (1/8)</td>
<td>100% (8/8)</td>
</tr>
<tr>
<td>Morris et al.</td>
<td>0% (0/4)</td>
<td>100% (4/4)</td>
<td></td>
</tr>
<tr>
<td>Krieger et al.</td>
<td>40% (18/45)</td>
<td>71.1% (32/45)</td>
<td></td>
</tr>
<tr>
<td>Werner et al.</td>
<td>36.4% (8/22)</td>
<td>33.3% (7/21)</td>
<td>77.3% (17/22)</td>
</tr>
<tr>
<td>Kuhl et al.</td>
<td>22.6% (4/45)</td>
<td>39.5% (17/43)</td>
<td>90.7% (29/32)</td>
</tr>
<tr>
<td>Leach et al.</td>
<td>40.0% (14/35)</td>
<td>77.1% (27/35)</td>
<td></td>
</tr>
<tr>
<td>Lehman et al.</td>
<td>25.0% (1/4)</td>
<td>100% (4/4)</td>
<td></td>
</tr>
<tr>
<td>Lehman et al.</td>
<td>33.3% (2/6)</td>
<td>16.7% (1/6)</td>
<td>100% (6/6)</td>
</tr>
<tr>
<td>Sardanelli et al.</td>
<td>58.8% (10/17)</td>
<td>64.7% (11/17)</td>
<td>93.8% (15/16)</td>
</tr>
<tr>
<td>Weinstein et al.</td>
<td>35.0% (11/20)</td>
<td>15.0% (3/20)</td>
<td>60.0% (12/20)</td>
</tr>
<tr>
<td>Elmore et al.</td>
<td>50.0% (2/4)</td>
<td>100% (3/3)</td>
<td></td>
</tr>
<tr>
<td>Kuhl et al.</td>
<td>33.3% (9/27)</td>
<td>37.0% (10/27)</td>
<td>92.6% (25/27)</td>
</tr>
<tr>
<td>Sardanelli et al.</td>
<td>50.0% (25/50)</td>
<td>52.0% (26/50)</td>
<td>91.3% (42/46)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>38.6% (115/298)</td>
<td>39.6% (76/192)</td>
<td>84.6 (248/293)</td>
</tr>
</tbody>
</table>

Eva Trial

Kuhl C et al. JCO 2010;28:1450–1457

Prospective Multicenter Study, Respective contribution of clinical examination, MG, US, MRI

- Implementation of Abbreviated Breast MRI Protocols
- March 10, 2016
Added value of mammography and ultrasound practically negligible

Eva Trial
Kuhl C et al. JCO 2010;28:1450-1457

687 participants
Study period 2002-5
1,679 women years
27 cancers detected
81% minimal cancers
Positive nodes 11%
Sensitivity MRI 93%
Sensitivity US 37%
Sensitivity MG 39%

What about all those false positive diagnoses?

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>PPV MRI</td>
<td>48%</td>
<td>43%</td>
<td>63%</td>
<td>50%</td>
</tr>
<tr>
<td>PPV MG</td>
<td>39%</td>
<td>50%</td>
<td>77%</td>
<td>23%</td>
</tr>
<tr>
<td>PPV US</td>
<td>33%</td>
<td>25%</td>
<td>65%</td>
<td>11%</td>
</tr>
</tbody>
</table>

Guidelines American Cancer Society

MRI screening recommended (evidence based)
- BRCA mutation or TPEN of TP53 gene
- First degree relative BRCA carrier, but untested
- Approximately 20–25% or greater estimated lifetime risk by model
- RT to chest 10–30 y dose >4 Gray (based on expert consensus)
- Beginning at age 30 as long as patient is in good health


Supplemental breast screening methods for women at high and moderately increased risk

- Digital Breast Tomosynthesis, DBT
  - Extra cancer yield 1.25/1000 (range 1.2-2.7)
  - Decreased recall rate and increased PPV 24.2–29.45
- Contrast-enhanced digital mammography, CEDM
- Hand-held ultrasound, HHUS
- Automated screening ultrasound, AUS
  - All US trials concordant: Extra cancer yield 4.1/1000
- Magnetic resonance imaging, MRI
  - Extra cancer yield 18.2/1000 (Kuhl et al. JCO 6.2014)

MR–Only Invasive Cancers are Small

Small cancer-focus

4 mm focus, Rapid uptake Plateau curve MR biopsy = Hi grade solid CIS

Age 41, Personal History of Breast Cancer
When to biopsy a focus or a small mass?

- If it is:
  - Spiculated
  - Irregular
  - Rim-enhancing
  - Isolated focus with washout

Small Mass or Focus

- Circumscribed Shape
- Rim Enhancement
  - No
  - Yes
- Inflammatory cyst?
  - Yes
  - No
- Yes
  - High T2
  - No
- Yes
  - Benign
  - Biopsy
- No
  - Benign
  - 6 Month FU vs Biopsy

MR–Only Non–Invasive cancers can be small or large!!
Screen-detected DCIS

Age 59. Linear clumped NME.
Pathology: invasive ductal carcinoma with DCIS at lumpectomy

Age 68. Segmental clumped NME
Pathology: DCIS, high grade, apocrine type by lumpectomy

MR Biopsy = 9 cms DCIS solid, cribriform

MR Biopsy = ALH
Atypical cells are homogeneous with slightly enlarged nuclei, and clearly defined cell borders.

Screen-detected DCIS

5mm DCIS hi grade solid with necrosis ER/PR +

Screen-detected DCIS

MR BX = ALH
Atypical cells are homogeneous with slightly enlarged nuclei, and clearly defined cell borders.

Non-mass enhancement

Distribution
Linear or Segmental

Biopsy:

Distribution
Focal, Regional, Multiple Regions Diffuse

Internal Enhancement
Clumped, Heterogeneous, Clustered Ring

Associated fibrocystic change?

6 Month FU

Benign

High-risk MRI screening is underutilized!

The proportion of women screened using breast MRI at high lifetime risk for breast cancer (>20%) increased from 9% in 2005 to 29% in 2009. Breast Cancer Surveillance Consortium data.

How has screening MRI been incorporated into clinical practice in the USA?

Rates per 1000 Women Overall and by Clinical Indication 2005-2009

- The overall rate of breast MRI from 2005 through 2009 nearly tripled from 4.2 to 11.5 examinations per 1000 women, with the most rapid increase from 2005 to 2007.
- 25,630 women; lifetime risk >20%.
- 383 (1.3%) received a screening MRI.

Abbreviated breast MRI for screening

- Observational reader study (abbreviated vs full protocol)
  - 443 women/606 MRIs (mild to moderate ↑ risk)
  - Negative/benign digital mammograms
  - Negative ultrasound for dense breasts
- Results
  - 11 cancers (4 DCIS; 7 invasive); yield 18.2 per 1,000
  - All T1N0, intermediate/high grade
  - MIP + in 10/11 (90.9%)
  - Median cancer size 8.4 mm; no interval cancers
  - All 11 cancers detected with abbreviated protocol

Abbreviated breast MRI for screening

- Images reviewed
  - One pre- and one post-contrast MRI
  - 3D subtraction MIP review for significant enhancement
  - Then subtraction and (optionally) acquired images
  - FAST images: First post contrast subtracted images
- Image Acquisition time
  - 3 min versus 17 minutes for full diagnostic protocol
- Reading time
  - MIP: 2.8 seconds
  - To rule out any significant enhancement
  - Entire abbreviated protocol:
Abbreviated breast MRI for screening

Current reasons why MRI is not used on a broader scale for screening include:
- High direct and indirect cost
- Limited availability
- Current breast MRI protocols used for screening are identical to the full MRI protocols used for diagnostic purposes

Make breast MRI a real screening tool:
- Reduce MR acquisition time: strip pulse sequence protocol down to essentials
- Reduce radiologist reading time
- Special training for radiologists

Could breast MRI be used as a population-based screening tool?

Examination time for screening breast MRI: 3 mins, scout 10 sec, Dynamic series: one pre-and one post-contrast image. C Kuhl MD

Implementation of MRI screening:
- Recruitment
- Streamlined workflow
  - Scheduling-menstrual cycle
  - Preparation
  - Claustrophobia, allergic predisposition
  - Contraindications: Foreign Bodies
  - Renal function
  - Prior studies on PACS
- Standardized Reporting
- Screening Audit
Accelerated breast MRI
-as distinct from abbreviated MRI!

- Under-sampling methods
  - k-Space segmentation protocols
- View sharing
  - Update low spatial frequency, central k-space data, frequently
  - Update high spatial frequency, peripheral k-space data, less frequently
- Images reconstructed using data from multiple frames
- Quantitative pharmacokinetic parameters of perfusion

Technical advances in breast MRI
First Phase Ultrafast Dynamic Imaging

- 5-7 second whole breast imaging in the first post-contrast series
- This protocol is combined with SENSE acceleration to further increase temporal and/or spatial resolution
- With progressive aliasing it is possible to perform complete sampling of enhancing regions, in most cases without errors or loss of information

<table>
<thead>
<tr>
<th>Philips Achieva 3T-TX</th>
<th>Ultrafast MRI</th>
<th>Standard MRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voxel size (mm³)</td>
<td>1.5 x 1.5 x 3.0</td>
<td>0.8 x 0.8 x 1.6</td>
</tr>
<tr>
<td>Sense acceleration factor</td>
<td>4</td>
<td>2.5</td>
</tr>
<tr>
<td>Scan time (sec)</td>
<td>7</td>
<td>75</td>
</tr>
<tr>
<td>Number of slices</td>
<td>115</td>
<td>215</td>
</tr>
<tr>
<td>Field of view (mm)</td>
<td>360</td>
<td>360</td>
</tr>
</tbody>
</table>

University of Chicago: F Frieds, PhD, GS Karczmar, PhD, M Medved, PhD, Inabe, MD, PhD, M Mori, MD, PhD, K Tsuchiya, MD, PhD, K Kulkarni, MD, D Smith, MD, D Schacht, MD.

Ultrafast AB-MRI University of Chicago acquisition protocol

Fat-suppressed ultrafast 3T acquisition. Temporal resolution 6.9 s to 9.9 s, for the first minute post contrast injection, followed by four high spatial resolution acquisitions with temporal resolution of 60 s – 79.5 s.
A filter is used to identify significantly enhancing voxels, and to reduce spurious enhancement due to noise or artifacts.

Technical advances in breast MRI
First Phase Ultrafast Dynamic Imaging

- Imaging Protocol
  - Five pre ultrafast and one pre standard scan, with 8 post UF scans, followed seamlessly by 4 post standard scans
  - Post UF scan started 10 seconds post contrast injection
  - 0.01mmol/kg of GBCA was injected followed by 20 cc saline flush
Implementation of Abbreviated Breast MRI Protocols

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3 second imaging

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March 10, 2016
Abbreviated Breast MRI for Screening

- Clinical trials are underway
  - USA (ECOG/ACRIN)
  - UK
  - Netherlands
  - Italy, Czech Republic

**Abbreviated Screening Protocol for Breast MRI**

Abbreviated protocol for breast MRI: on multiple sequences needed for cancer detection

Abbreviated protocol for breast MRI: on multiple sequences needed for cancer detection

Abbreviated breast MRI for screening

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Future directions

Advanced computer analytics

- Is it possible to decide on a targeted therapy based on imaging-genomics association results?
- Could imaging features inform important genomics features?
- Could integration of imaging and genomics features lead to higher predictive power?
- Could imaging serve as a virtual biopsy?
  - Non-invasive, encompasses entire tumor & repeatable
  - TCGA Breast Phenotype Research Group


*The cancer genome atlas
New approach to screening needed

After decades of mammography screening, breast cancer continues to be the leading cause of cancer death in women. Under-diagnosis is a more important problem than “over-diagnosis.” More diagnosis is not necessarily “over-diagnosis.” We need early detection of aggressive cancers. Abundant MR screening evidence points to superior cancer detection compared with all other methods. The challenge will be to incorporate a simple, short MRI examination into clinical practice.