The Future of Breast MRI: Improving Outcomes

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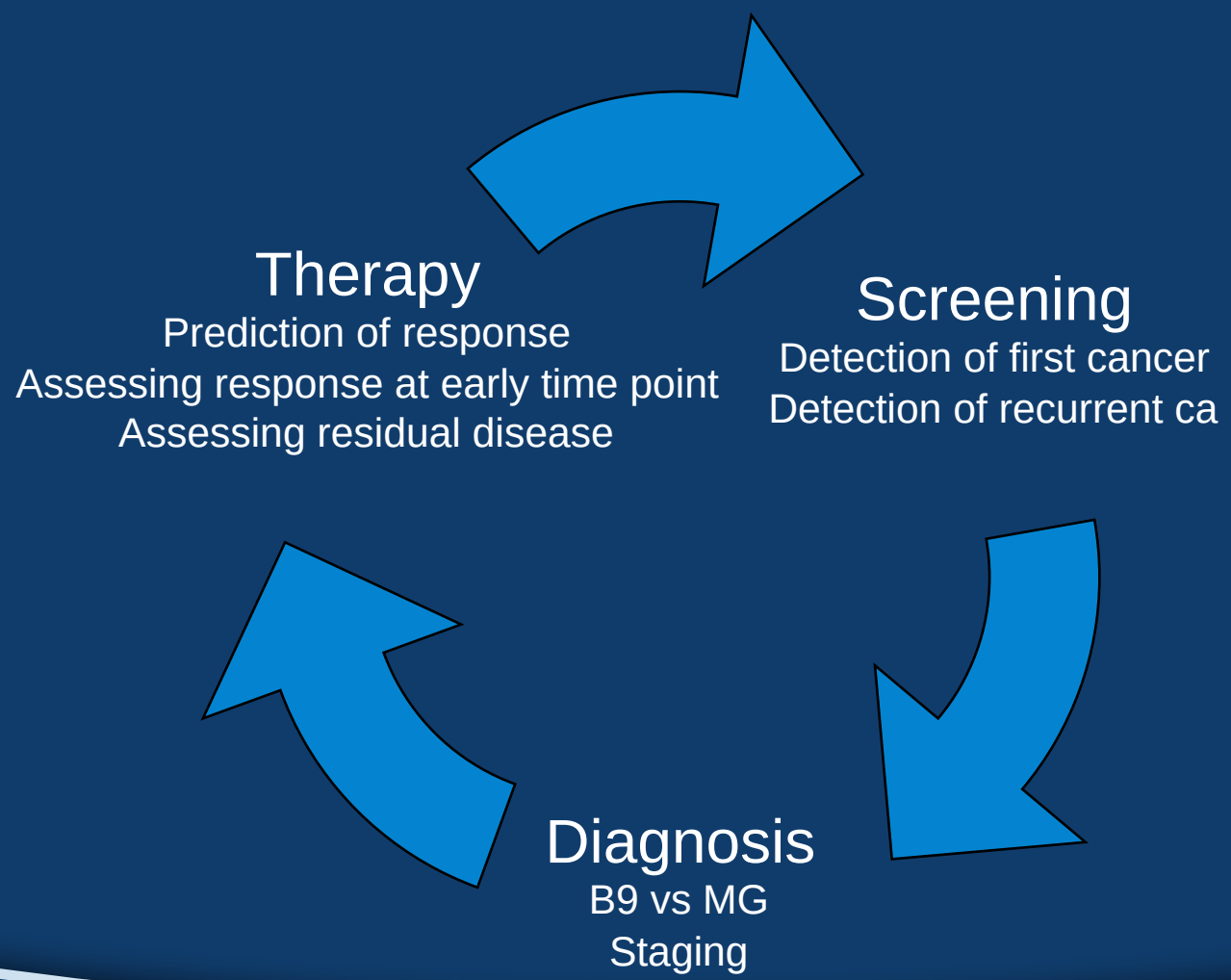
- **20th Century**
  - Importance of early detection through screening recognized
  - Shift in treatment from rad mx to BCS with rad
  - Genetic mutations related to breast cancer risk
  - New approaches to identifying women at high risk
- **21st Century**
  - Limitations of mammography screening
  - Focus on biology of disease and more targeted, less aggressive treatment methods
  - Debate regarding importance of early detection of any cancer vs. efforts to avoid “Bad Outcomes”

Imaging and Breast Cancer: Patient Care Cycle



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Imaging and Breast Cancer: Patient Care Cycle

- Screening
  - Improve utlilization of MRI in high risk women
  - Rapid, less expensive technology for CE imaging
- Diagnosis
  - Apply MRI to avoid unnecessary surgeries and unnecessary biopsies
- Treatment
  - Apply MRI to reduce overtreatment and provide patients with more targeted therapy options that maintain excellent outcomes, but with associated lower morbidity

Sensitivities by Modality

Study	Sensitivity		
	Mammo	**US**	**MRI**
Tilanus, 2000	0% (0/3)*	--	100% (3/3)
Podo, 2002	12.5% (1/8)	12.5% (1/8)	100% (8/8)
Morris, 2003	0% (0/14)*	--	100% (14/14)
Kriege, 2004	40.0% (18/45)	--	71.1% (32/45)
Warner, 2004	36.4% (8/22)	33.3% (7/21)	77.3% (17/22)
Kuhl, 2005	32.6% (14/43)	39.5% (17/43)	90.7% (39/43)
Lehman, 2005	25.0% (1/4)	--	100% (4/4)
Leach, 2005	40.0% (14/35)	--	77.1% (27/35)
Lehman, 2007	33.3% (2/6)	16.7% (1/6)	100 (6/6)
Sardanelli, 2007	58.8% (10/17)	64.7% (11/17)	93.8% (15/16)
Weinstein et al, 2009	55% (11/20)	15% (3/20)	60% (12/20)
Elmore et al, 2010	50% (2/4)	--	100% (4/4)
Kuhl et al, 2010	33.3% (9/27)	37% (10/27)	92.6% (25/27)
Sardanelli et al, 2011	50% (25/50)	52% (26/50)	91.3% (42/46)
Total	**38.6%** (115/298)	**39.6%** (76/192)	**84.6%** (248/293)

* To be included, subjects had to have negative mammogram.

MRI Alone for Screening High Risk Populations?

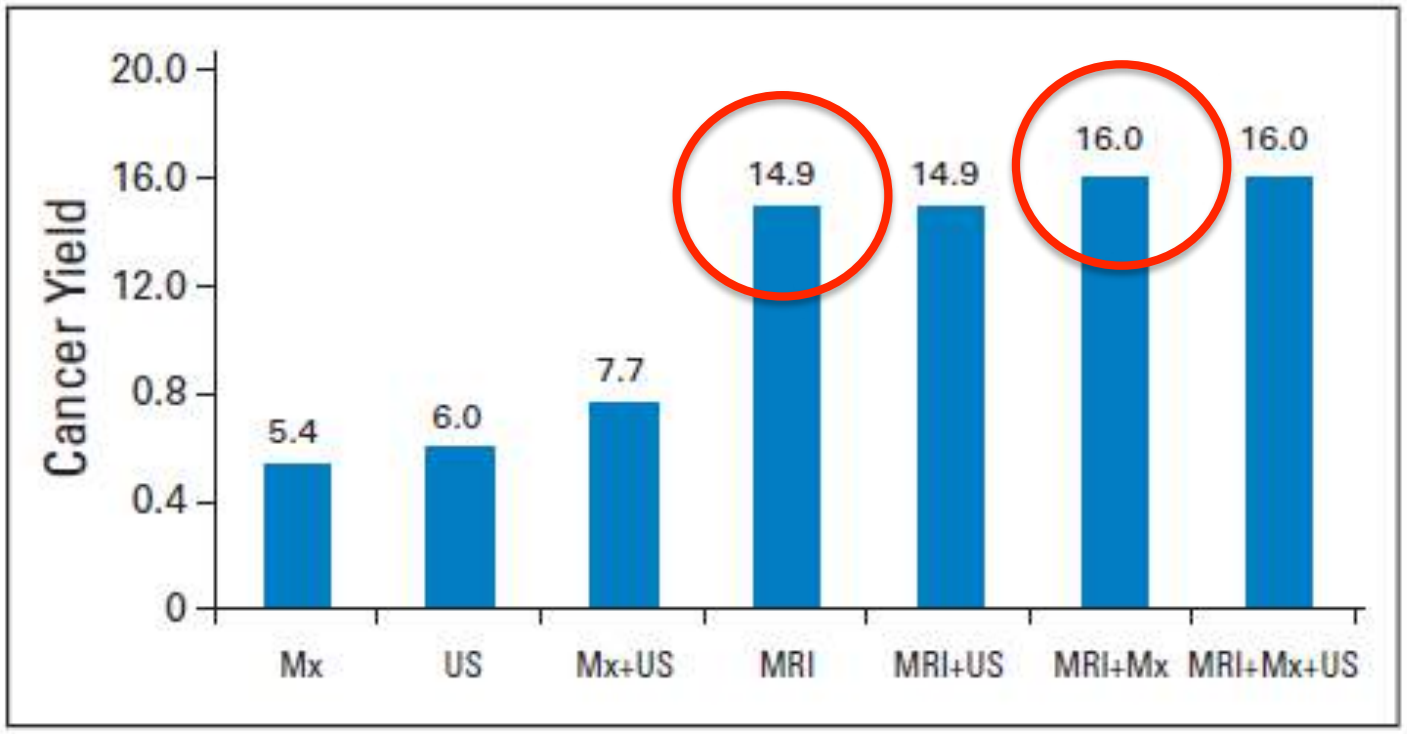


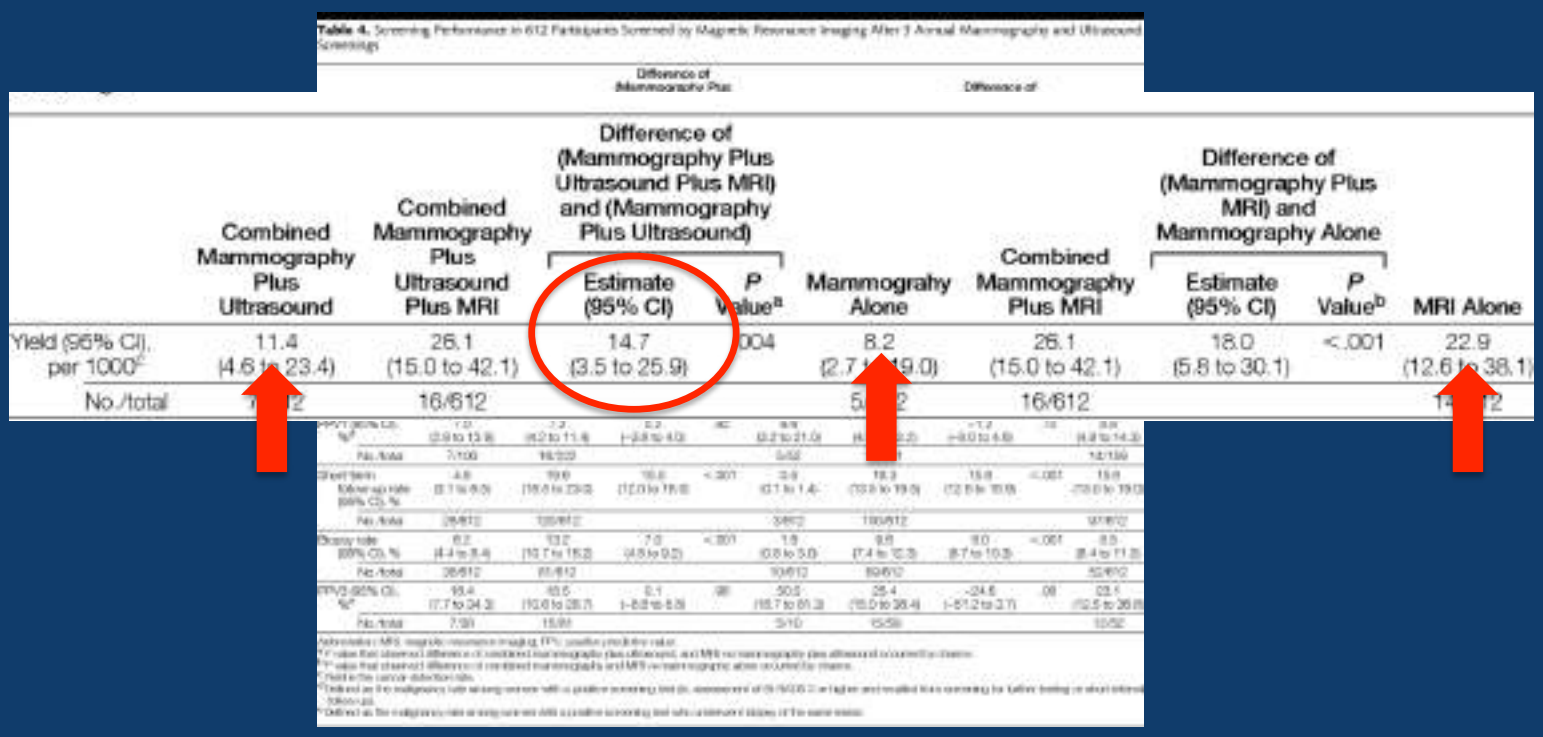
Fig 1. Cancer yield of the different imaging methods, used alone or in combination. Number of true-positive diagnoses per 1,000 complete screening rounds. Mx, mammography; US, ultrasound; MRI, magnetic resonance imaging.

Kuhl et al, 2010 JCO

ACRIN 6666---Single MRI performed after multiple rounds of screening ultrasound….

From: **Detection of Breast Cancer With Addition of Annual Screening Ultrasound or a Single Screening MRI to Mammography in Women With Elevated Breast Cancer Risk**

JAMA. 2012;307(13):1394-1404. doi:10.1001/jama.2012.388. ACRIN 6666: Berg



	Combined Mammography Plus Ultrasound	Combined Mammography Plus Ultrasound Plus MRI	Difference of (Mammography Plus Ultrasound Plus MRI) and (Mammography Plus Ultrasound) Estimate (95% CI)	*P* Value[a]	Mammography Alone	Combined Mammography Plus MRI	Difference of (Mammography Plus MRI) and Mammography Alone Estimate (95% CI)	*P* Value[b]	MRI Alone
Yield (95% CI), per 1000[c]	11.4 (4.6 to 23.4)	26.1 (15.0 to 42.1)	14.7 (3.5 to 25.9)	.004	8.2 (2.7 to 19.0)	26.1 (15.0 to 42.1)	18.0 (5.8 to 30.1)	<.001	22.9 (12.6 to 38.1)
No./total	7/612	16/612			5/612	16/612			14/612

Myth of Poor Specificity

Study	Cancer Yield from MRI Alone	Biopsies Recommended Based on MRI	PPV of Biopsies performed
Tilanus Linthorst, 2000	2.8% (3/109)	4.6% (5/109)	60.0%
Podo, 2002	6.7% (7/105)	8.6% (9/105)	88.9%
Morris, 2003	3.8% (14/367)	16.1% (59/367)	23.7%
Kriege, 2004	1.2% (22/1909)	2.9% (56/1909)	57.1%
Warner, 2004	3.0% (7/236)	15.7% (37/236)	46.0%
Kuhl, 2005	3.6% (19/529)	14.7% (78/529)	50.0%
Lehman, IBMC 2005	0.8% (3/367)	6.3% (23/367)	17.4%
Leach, 2005	2.9% (19/649)	--	25.0%
Lehman, IBMC 2007	2.3% (4/171)	8.2% (14/171)	42.9%
Sardanelli, 2007	2.2% (6/278)	9.0% (25/278)	60.0%
Weinstein, 2009	1.3% (8)	7.9% (48/609)	25.0%
Elmore, 2010	1% (2)	10.5% (21/200)	19.1%
Kuhl, EVA TRIAL 2010	2.1% (14)	7.6% (52/687)	48.1%
Sardanelli, HBCRI1 2011	3.2% (16)	15.0% (75/501)	56.0%

American Cancer Society 2007

"Based on the evidence from studies of MR screening high risk women, and the limitations of mammography and CBE alone, the American Cancer Society recommends annual MR screening in conjunction with mammography in women at significantly increased risk of breast cancer."

ACS, ACR (SBI), NCCN support screening MRI in high risk women

Current ACS Recommendations for MRI Screening

- Recommend annual screening for particular high risk groups*
  - *BRCA* mutation
  - First-degree relative of BRCA carrier, but untested
  - Lifetime risk ~20–25% or greater, as defined by BRCAPRO or other models that are largely dependent on family history

*Saslow S, et al. American Cancer Society Guidelines for Breast Screening with MRI as an Adjunct to Mammography. CA Cancer J Clin 2007;57:75–89

Current ACS Recommendations for MRI Screening

- Insufficient evidence to recommend *either* for or against "moderate risk"
  - Lifetime risk 15-20%
  - High risk biopsy: ADH, ALH, LCIS
  - Heterogeneously or extremely dense breasts on mammogram
  - Personal history of breast cancer
- Not recommended for average risk

Current ACS Recommendations for MRI Screening

Patterns of Breast Magnetic Resonance Imaging Use in Community Practice FREE

Karen J. Wernli, PhD[1]; Wendy B. DeMartini, MD[2]; Laura Ichikawa, MS[1]; Constance D. Lehman, MD, PhD[2]; Tracy Onega, PhD[3]; Karla Kerlikowske, MD, MS[4,5,6]; Louise M. Henderson, PhD[7]; Berta M. Geller, EdD[8,9]; Mike Hofmann, MS[5]; Bonnie C. Yankaskas, PhD[7]; for the Breast Cancer Surveillance Consortium

[+] Author Affiliations

JAMA Intern Med. 2014;174(1):125-132. doi:10.1001/jamainternmed.2013.11963. Text Size: A

- 2005-2009 Breast Cancer Surveillance Consortium
- 1.3 million mammograms, 9,000 breast MRIs

Current ACS Recommendations for MRI Screening

Table 4. Breast Cancer Risk Assessment Tool (BCRAT) Scores for Lifetime Breast Cancer Risk for Women Screened With Breast Magnetic Resonance Imaging (MRI) and Women Screened With Mammography Alone, 2005 Through 2009

	Year, No. (%)					
BCRAT Lifetime Risk Score	2005	2006	2007	2008	2009	Total
Examinations of women who received breast MRI for screening[a]						
<15%	57 (74)	147 (50)	227 (55)	194 (53)	202 (50)	827 (53)
15%-20%	13 (17)	85 (29)	84 (20)	79 (21)	87 (21)	348 (22)
>20%	7 (9)	60 (21)	101 (25)	96 (26)	119 (29)	383 (25)
Examinations of women who received screening mammography only						
<15%	234 209 (92)	229 157 (92)	228 708 (92)	222 685 (92)	216 402 (92)	1 131 161 (92)
15%-20%	15 120 (6)	14 480 (6)	14 590 (6)	14 560 (6)	13 657 (6)	72 407 (6)
>20%	5153 (2)	5110 (2)	5033 (2)	5021 (2)	4920 (2)	25 237 (2)

[a] Test for trend comparing total proportion at higher than 20% (high) risk to 20% risk or lower (P <.001).

- 75% of all screening MRIs performed were in women with less than 20% lifetime risk
- Of women at greater than 20% lifetime risk, less than 2% had received an MRI

Current ACS Recommendations for MRI Screening

JOURNAL OF CLINICAL ONCOLOGY | E D I T O R I A L

Rethinking Breast Cancer Screening: Ultra FAST Breast Magnetic Resonance Imaging

Elizabeth A. Morris, *Memorial Sloan Kettering Cancer Center, New York, NY*

Abbreviated Breast Magnetic Resonance Imaging (MRI): First Postcontrast Subtracted Images and Maximum-Intensity Projection—A Novel Approach to Breast Cancer Screening With MRI

Christiane K. Kuhl⇑, Simone Schrading, Kevin Strobel, Hans H. Schild, Ralf-Dieter Hilgers and Heribert B. Bieling

Conclusion An MRI acquisition time of 3 minutes and an expert radiologist MIP image reading time of 3 seconds are sufficient to establish the absence of breast cancer, with an NPV of 99.8%. With a reading time < 30 seconds for the complete AP, diagnostic accuracy was equivalent to that of the FDP and resulted in an additional cancer yield of 18.2 per 1,000.

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Comparison of Abbreviated Breast MRI and Digital Breast Tomosynthesis in Breast Cancer Screening in Women with Dense Breasts

ECOG-ACRIN
cancer research group
Reshaping the future of patient care

Christopher Comstock M.D.
Christiane Kuhl M.D.
Gillian Newstead M.D.

ECOG-ACRIN AB-MR Working Group

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Future of Breast MRI in Era of Precision Medicine

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Study of Breast Biopsies Finds Surgery Used Too Extensively

By DENISE GRADY
Published: February 18, 2011

- 1.6 million breast biopsies are performed annually in the U.S.
- 30% of biopsies 2003-2008 are surgical (recommendation is less than 10%)
- 300,000 women have unnecessary breast surgery every year in the United States, hundreds of millions of dollars
- $5,000 for a needle biopsy, $10,000 for surgical biopsy
- $1000 for a breast MRI?

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Gland Surg. 2014 May; 3(2): 142–148.
doi: 10.3978/j.issn.2227-684X.2014.04.01
PMCID: PMC4115760

Minimally invasive surgical management of benign breast lesions

Anna Lakoma and Eugene S. Kim

Author information ▶ Article notes ▶ Copyright and License information ▶

Abstract

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Benign breast disease is common among women, and when symptomatic, definitive surgical management is preferred by both clinicians and patients. Given the nonmalignant nature of these lesions, an important factor in treatment is cosmesis. Novel minimally invasive techniques for breast lesions are rapidly emerging and demonstrate good efficacy, safety and cosmesis. This review will describe minimally invasive techniques of breast lesions via surgical and percutaneous approaches and discuss the outcomes, advantages and limitations for each. Based on promising initial results, the future standard of care for benign breast lesions may focus on one or more of these minimally invasive techniques.

Breast MRI provides patients with alternatives to surgical excision

- Excision of benign lesions
- Excision of high risk lesions
- Duct “exploration”/excision
- Multiple re-excisions for clear margins in breast cancer patient
- And provides information about future risk

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FGT and Density

Characteristic	Cancer	No Cancer	OR (CI)	P value
Mammographic Density			1.4 (0.7-3.0)	0.4
Almost entirely fat	0 (0%)	1 (4%)		
Scattered densities	6 (26%)	8 (35%)		
Heterogeneously dense	12 (52%)	10 (44%)		
Extremely dense	5 (22%)	4 (17%)		
MRI Amount FGT			1.2 (0.7-2.2)	0.5
Almost entirely fat	1 (4%)	2 (9%)		
Scattered FGT	6 (26%)	6 (26%)		
Heterogeneous FGT	8 (35%)	10 (43%)		
Extreme FGT	8 (35%)	5 (22%)		

UW Dontchos, Rahbar et al

BPE

Characteristic	Cancer	No Cancer	OR (CI)	P value
BPE			2.3 (1.0-5.4)	0.02
Minimal	5 (22%)	13 (57%)		
Mild	9 (39%)	6 (26%)		
Moderate	5 (22%)	3 (13%)		
Marked	4 (17%)	1 (4%)		
BPE (dichotomous)			9.0 (1.1-71.0)	0.007
Minimal	5 (22%)	13 (57%)		
Mild, moderate, or marked	18 (78%)	10 (43%)		
BPE pattern			0.6 (0.1-2.5)	0.5
Peripheral	8 (35%)	10 (43.5%)		
Central	15 (65%)	13 (56.5%)		

UW Dontchos, Rahbar et al

Clinical Relevance

- BPE, not density, is more likely to aid in refining risk assessments in women already at elevated risk
  - Supplemental screening strategies
    - MRI eligibility, frequency of screening
  - Prevention strategies
    - Chemoprevention selection and monitoring
    - Prophylactic mastectomy decision-making

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Future of Breast MRI in Era of Precision Medicine

ACR	Support use of breast MRI in pre-operative setting Acknowledgement of sparse quality data on long term outcomes
SBI	Support use of breast MRI in pre-operative setting Acknowledgement of sparse quality data on long term outcomes
EUSOBI	Support use of breast MRI in pre-operative setting Acknowledgement of sparse quality data on long term outcomes
NCCN	Support consideration of breast MRI in pre-operative setting Acknowledgement of sparse quality data on long term outcomes
SSMO	Imaging including mammography and MR as pre treatment work up
SIGN	Imaging including MR where indicated to diagnose. Use for surveillance to detect relapse.

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Breast MRI Prior to Breast-Conserving Treatment Does Not Improve Outcome

Mastectomy Rates Have Risen Recently, as has Breast MRI

May 21, 2008 — More women with early breast cancer are opting for mastectomies than they were a few years ago and, at the same, the use of breast magnetic resonance imaging (MRI) has increased. Mayo Clinic researchers reporting the 2 trends speculate that they are related.

Precision Diagnostics/Sloppy Therapeutics

Positive margins/Re-excision rates vary widely

- 10% to 80% without MRI
- Multiple other factors impact re-excision rates
  - Selection of patients by size and location of tumor
  - Surgical technique used
- Mastectomy rates vary widely
  - Multiple factors impact physician-patient decision (age, family history, extent of disease, patient desire, interest in reconstruction, anxiety regarding continued surveillance

Can MRI support a future of more targeted, less aggressive, treatment paradigms in select patients?

- Surgical oncology
  - Decrease mastectomies
    - Offer reassurance of unifocal disease in patient with dense breast tissue
    - Offer lumpectomies to patients with small tumors in more than one quadrant

Can MRI support a future of more targeted, less aggressive, treatment paradigms in select patients?

- Radiation oncology
  - Decrease need for full breast radiation
  - Support success of partial breast radiation treatments

Can MRI support a future of more targeted, less aggressive, treatment paradigms in select patients?

- Medical oncology
  - Enhance information re risk for recurrence
  - Reduce need for chemotherapy
  - Guide targeted treatments

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Breast MRI Prior to Breast-Conserving Treatment Does Not Improve Outcome

Clinical Validity and Utility

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Studies have shown that Recurrence Score results reduce chemotherapy use, spare patients the negative health and quality of life impact of unnecessary chemotherapy, and reduce the costs to society and the healthcare system[3-6]

1. Paik S, Tang G, Shak S, et al. Gene expression and benefit of chemotherapy in women with node-negative, estrogen receptor–positive breast cancer. *J Clin Oncol.* 2006;24:3726-3734.

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ECOG-ACRIN DCIS 4112: MRI and OncoType in BrCa Treatment Decision Making

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cancer research group
Reshaping the future of patient care

Constance Lehman, M.D., Ph.D.
Study Chair
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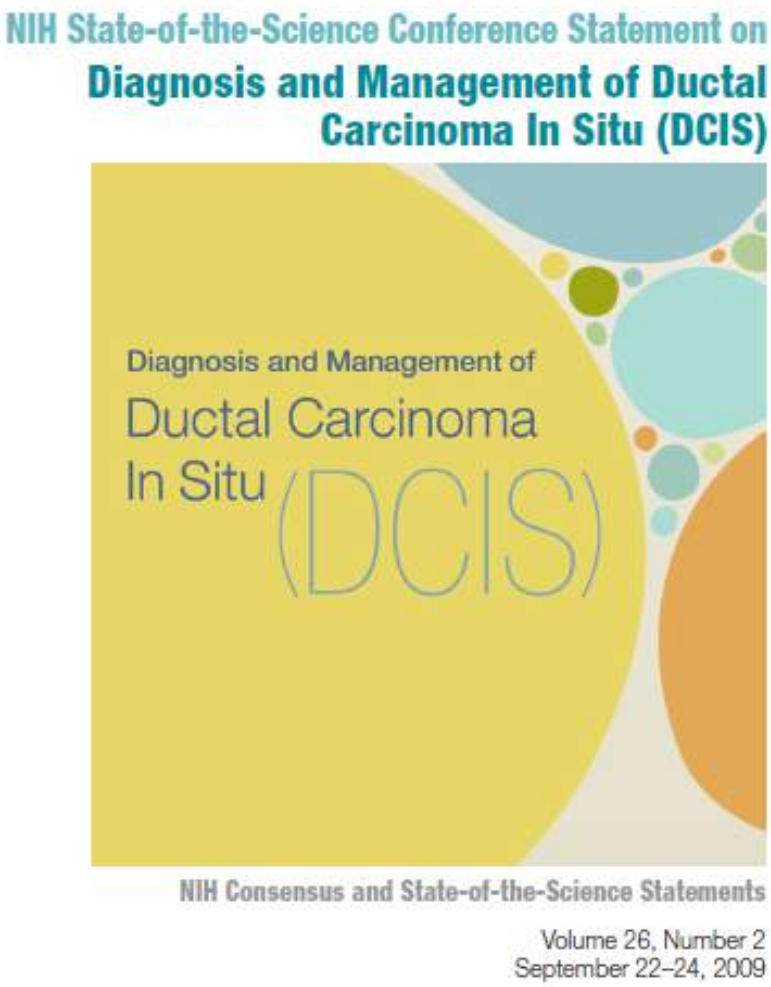
Background



Primary question remains and must focus on identifying subset of women with DCIS who may be managed less aggressively without sacrificing excellent outcomes

NCI Recommendations

- Investigate and validate combinations of new and existing clinical, radiological, pathological, and molecular factors to improve risk stratification of DCIS patients and thus to identify the optimal therapy for each individual.
- Investigate patient preferences and decision making concerning the diagnosis and treatment of DCIS
- Investigate the impact the diagnosis and treatment of DCIS has on the quality of life

Goals of E4112

1. **Breast MRI as It Impacts Treatment Decisions:** To determine how often the results of breast MRI change the recommended surgery for the treatment of DCIS from lumpectomy to mastectomy.

2. **OncoType DCIS Score as It Impacts Treatment Decisions:** In women undergoing lumpectomy, can radiation therapy be avoided in a subset of women based on a low OncoType DCIS Score (a test on tumor tissue)?

Study Schema