Benefits and Risks of Breast Cancer Screening – Opportunities for Precision Medicine

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July 15, 2019

Sunnybrook RESEARCH INSTITUTE

DISCLOSURE

- Martin Yaffe:
  - holds shares in Volpara Health Technologies, a manufacturer of software for breast cancer imaging
  - lab has a research collaboration on breast tomosynthesis and contrast-enhanced digital mammography with GE Healthcare
    - receives no remuneration or other personal considerations related to that collaboration
  - principal of Mammographic Physics Inc which provides QC services for mammography

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Learning Objectives

- To discuss the benefits and risks of breast cancer screening , and to understand how this discussion drives and is impacted by technological developments communications, politics and guidelines

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Screening for Earlier Detection of Breast Cancer

- Communications, politics and Guidelines
- Performance Characteristics
- Evidence for Benefit
- Limitations and Harms
  - Missed cancers
  - "False Positives" - Abnormal recalls, no cancer
  - Negative biopsies
  - Overdetection/overdiagnosis/overtreatment
  - Radiation risk
- Cost effectiveness – will not discuss today
- How to improve screening – new techniques
- Stratified screening

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Recommendations On Breast Cancer Screening

- American Cancer Society
  - Individual woman's decision with guidence from primary healthcare provider
  - Screening should be available from age 40
  - and is strongly recommended from age 45
  - Performed premenopausally, should be annual (fewer deaths)
  - Switch to two years after menopause if no major risk factors
  - Recommendations were based on RCTs, modern observational studies and modeling

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Canadian Task Force on Preventive Health Care

- CTFPHC (Similar to US Preventive Services Task Force)
  - Did not accept evidence from other than old RCTs
  - Recommend against routine mammo. screening before 50
    - Consult with physician re risk factors. Little info provided to physicians on such risk factors
    - No recommendations for high-risk women (should ideally receive MRI)
  - Biennial or triennial (no supporting evidence) screening for women over 50
  - Recommend against routine clinical exams

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The Media

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The New York Times

Vast Study Casts Doubts on Value of Mammograms

By Gina Kolata

Feb. 11, 2014

One of the largest and most meticulous studies of mammography

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THE STAR

Is the need for routine mammograms a big lie? Expose casts doubt on decades of research

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Why is there controversy about breast cancer screening?

- Intense philosophical differences regarding preventive measures vs acute care
  - Screening is expensive – many women must be screened to save a few lives
  - Money is spent now – benefit, if it occurs, comes later
  - Only 3% of women die of breast cancer
    - Screening potentially reduces mortality by 40% (when delivered ideally), so would reduce to 1.8%
    - But viewed another way screening would avert 10,000 breast cancer deaths in US each year as well as avoidance of some mastectomy and chemo
- Without question, screening has limitations. Individuals put different emphasis on their importance to support their position

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Why is there controversy about breast cancer screening?

- Despite solid scientific evidence to the contrary, some authors suggest that screening doesn't work
- These publications are covered widely by the media while careful meta-analyses are largely ignored
- News media prefer stories that disrupt the prevailing wisdom. It makes better headlines:

"NEW STUDY SHOWS THAT MAMMOGRAPHY SCREENING DOESN'T SAVE LIVES!"


"BOY BITES DOG!"

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How Media Works

Reporters are busy, have short deadlines and do not have time to read the relevant underlying scientific literature. Instead they attempt to get balance by interviewing "the usual suspects", *i.e.* one person who supports the findings of a study and one who does not. Give equal weight to both regardless of evidence.

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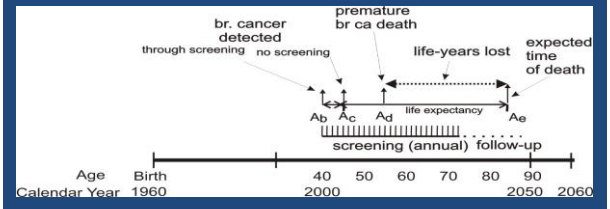
Principles of Screening



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Properties of an Ideal Screening Technique

- Sensitive – finds small "early" cancers
  - Prognostic – finds the bad cancers
- Specific – accurate in identifying when cancer is not present
- Safe
- Innocuous
- Cost effective

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Performance of Modern Screening Mammography

- Cancer detection rate – 2-5 per 1000 screens
- Sensitivity – 80-85%
  - 60% in very dense breasts
- Specificity 93% on recurring screens
  - 85% on initial screens (15% of women called back)
  - 96% in Europe
- Biopsy rate – 1-1.5%
- Efficiency - 86 women needed to screen per death averted
  - 4.1 per life-year gained

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Limitations of Modern Screening Mammography

- Misses 15% - 40% of cancers
  - Greatest problem in dense breasts and women at high risk (lack of sensitivity)
- 7% - 15% of women without cancer are called back after screening for "false positives" (lack of specificity)
- 2 out of 3 biopsies are negative for cancer (unnecessary biopsies?)
- 86 women needed to screen per death averted (inefficient)
- Some of the cancers are indolent and could probably have been ignored (overdetection)

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The Lancet · Saturday 13 April 1985

REDUCTION IN MORTALITY FROM BREAST CANCER AFTER MASS SCREENING WITH MAMMOGRAPHY

Randomised Trial from the Breast Cancer Screening Working Group of the Swedish National Board of Health and Welfare

L. TABÁR, A. GAD, L. H. HOLMBERG, U. LJUNGQUIST — *Kopparberg County Project Group**

C. J. G. FAGERBERG, L. BALDETORP, O. GRÖNTOFT, B. LUNDSTRÖM, J. C. MÅNSON — *Östergötland County Project Group†*

G. EKLUND, F. PETTERSSON, N. E. DAY

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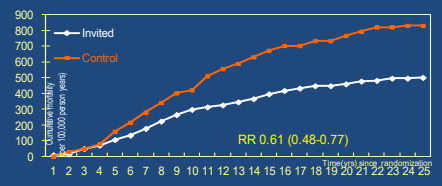
The Lancet · Saturday 13 April 1985



39% mortality reduction

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The Evidence for Screening (Intent to Screen Analysis)

Trial	# of women	Age range	Follow-up interval (years)	RR for breast CA mortality
New York	60 686	40-64	10	0.77
Malmö	42 283	45-69	8.8	0.96
Two-county	133 065	40-74	13	0.70
Edinburgh	54 654	45-64	7 and 14	0.71
Canada (CNBSS)	89 835	40-59	13	1.04
Stockholm	60 261	40-64	11	0.74
Göteborg	11 724	39-59	11	0.55
Age (UK)	160 921	39-41	10.7	0.83

Slide courtesy Dr. Jean Seely, Ottawa

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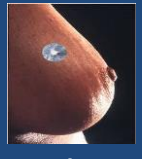
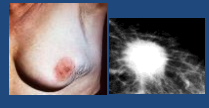
Screening - By detecting cancers earlier we reduce the incidence of the lethal cancers





Clinical detectability

- Are we accomplishing this?

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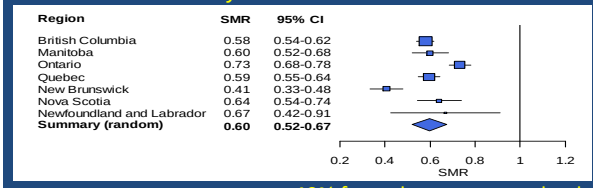
More recent data: women who actually got screened

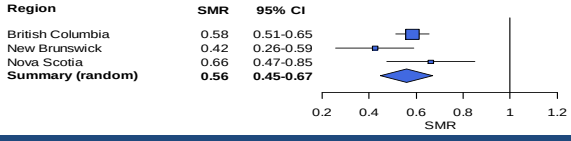
Pan-Canadian Study of Mammography Screening and Mortality from Breast Cancer



40% fewer breast cancer deaths

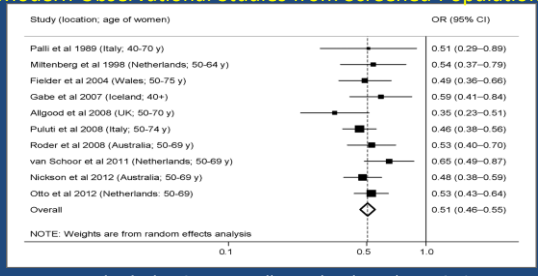
Coldman AJ et al. J Natl Cancer Inst (2014) 106(11)

Women first participating at age 40-49



44% fewer breast cancer deaths

Modern Observational Studies from Screened Populations

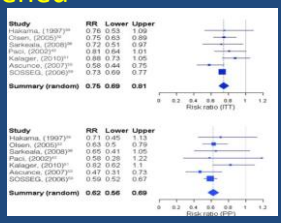


For women in their 40s, mortality reduction about 24%

To Benefit from Screening One Must Be Screened

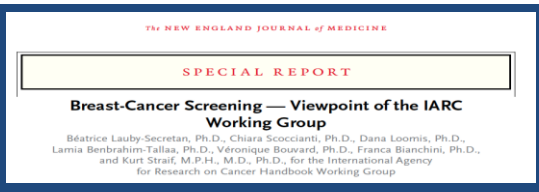
Breast cancer mortality reduction in women invited versus not invited
25% reduction in mortality

Breast cancer mortality reduction in women screened versus not screened
38% reduction in mortality



TT = intention to treat PP = per protocol

Broeders et al. J Med Screen 2012
Slide – courtesy, Dr. Solveig Hofvind - Oslo


The NEW ENGLAND JOURNAL of MEDICINE

SPECIAL REPORT

Breast-Cancer Screening — Viewpoint of the IARC Working Group

Béatrice Lauby-Secretan, Ph.D., Chiara Scoccianti, Ph.D., Dana Loomis, Ph.D., Lamia Benbrahim-Tallaa, Ph.D., Véronique Bouvard, Ph.D., Franca Bianchini, Ph.D., and Kurt Straif, M.P.H., M.D., Ph.D., for the International Agency for Research on Cancer Handbook Working Group

Lauby-Secretan, C Scoccianti, D Loomis, et al, N Engl J Med 372;24 June 11, 2015

Conclusions of IARC working group

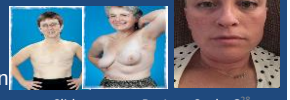
- Women 50 to 69 years of age who were **invited** to attend mammographic screening had, on average, a 23% reduction in the risk of death from breast cancer; women who **attended** mammographic screening had a higher reduction in risk, estimated at about 40%

The NEW ENGLAND JOURNAL of MEDICINE

B Lauby-Secretan, C Scoccianti, D Loomis, et al, N Engl J Med 372;24 June 11, 2015

Reduced Morbidity for Screen-Detected Cancers

- Earlier Diagnosis = More easily tolerated treatment
- Tumours < 2 cm less likely to require more surgery
  - Lumpectomy *vs* mastectomy
  - Sentinel node bx vs axillary dissection : less chance of lymphedema
- Tumours < 2 cm less likely to require chemotherapy
- Smaller tumours: < $$$ spent on treatment and less time off work



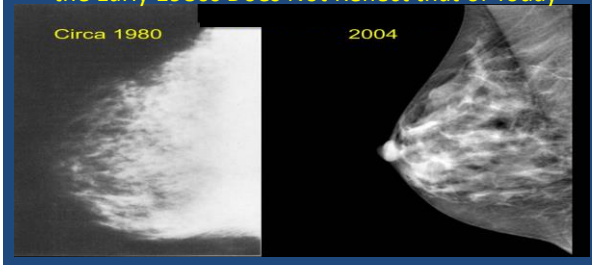
Slide courtesy Dr. Jean Seely, Ottawa

Earlier Detection vs Improved Therapy

- It has been suggested that with newer therapies there is no benefit in detecting breast cancers early.
  - Little evidence for this
- Rather than a tension there is actually a synergy between earlier detection and therapy
  - Easier to treat earlier disease – reduced mortality and morbidity
  - Reduction of treatment costs:
    - Stage 1 breast cancer $30,000
    - Stage 4 - $66,000

Mittmann N et al, Health system costs for stage-specific breast cancer: a population-based approach, Curr, Oncol. Vol 21, No 6 (2014)

The Quality of Mammography Screening Available in the Early 1980s Does Not Reflect that of Today



Also, major advances in therapies – Trastuzumab, Aromatase inhibitors

DMIST TRIAL 2005

Pisano, Gatsonis, Hendrick, Yaffe et al.

- Compared digital mammography to SF Mammography for screening
- For women who were pre- or –peri-menopausal and/or had dense breasts
  - DM was more sensitive in detecting cancers than SFM with no loss in specificity

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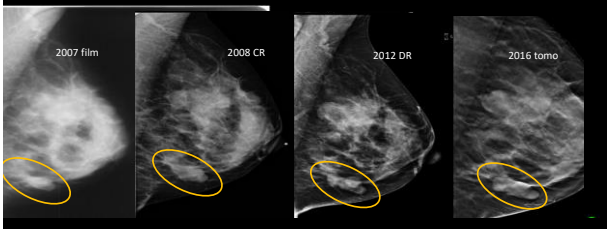
Improvements in mammography



Slide courtesy Dr. Jean Seely, Ottawa

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Modelling

- Because no new randomized trial data available the best way to estimate benefits (and harms) of modern screening is by modelling

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Modelling Health Outcomes in Screening Mammography


Yaffe MJ, Mittmann N, Lee P, Tosteson ANA, Trentham-Dietz A, Alagoz O, Stout NK. Clinical outcomes of modelling mammography screening strategies. Health Reports Dec. 2015

Work used a modified WISCONSIN breast cancer model, developed under CISNET, an NCI consortium

Outcomes

- Burden
  - Deaths due to bc
  - Life-years lost
  - QALYs lost
- Benefits
  - Deaths averted, LY gained, QALYs gained
- Harms
  - Additional deaths and LY lost, QALYs lost

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How Should We Compare Benefits and Harms?

- Need a common currency
- QALYs (quality-adjusted years of life)
- Assign a utility factor (0-1 scale) that is multiplied by each year of life to describe its quality (eg reduced due to a biopsy or having chemo)
- For perfect quality of life 1 QALY = 1 life-year

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Table 1

Breast cancer deaths averted, mortality reduction, life-years (LY) saved, screening examinations and women needed to be screened per death averted, and women needed to be screened per LY, compared with No Screening, by screening strategy,

Screening strategy	Breast cancer deaths averted per 1,000 women alive at age 40	Mortality reduction (%) with 15 years follow-up	LY gained per 1,000 women alive at age 40	Maximum screening examinations per woman	Screening examinations per death averted	Women screened per death averted	Women screened per LY gained
Annual 40 to 69	9.1	50.2	201.1	30	2,984	99	4.5
Annual 40 to 74	10.1	53.4	213.5	35	3,023	86	4.1
Annual 50 to 69	7.4	45.5	148.0	20	2,360	118	5.9
Annual 50 to 74	8.4	49.2	160.9	25	2,484	99	5.2
Biennial 40 to 74	7.3	38.5	149.8	18	2,165	138	6.7
Biennial 50 to 69	5.2	32.3	105.2	10	1,696	170	8.4
Biennial 50 to 74	6.1	35.9	116.3	13	1,783	137	7.2
Triennial 50 to 69	4.0	24.6	80.0	7	1,557	222	11.1
Triennial 50 to 74	4.8	27.9	89.2	9	1,589	177	9.4
Annual 40 to 49, Biennial 50 to 69	7.0	38.7	158.2	20	2,651	133	5.9
Annual 40 to 49, Biennial 50 to 74	7.9	42.0	170.3	22	2,593	118	5.5
Annual 40 to 49	2.0	18.6	58.0	10	5,152	526	17.2

Yaffe MJ, Mittmann N, Lee P, Tosteson AN, Trentham-Dietz A, Alagoz O, Stout NK. Clinical outcomes of modelling mammography screening strategies. Health Rep. 2015 Dec 16;26(12):9-15.

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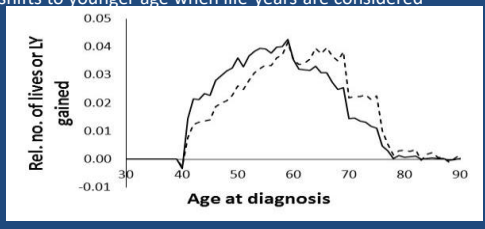
Lives vs Life-Years

Both burden of breast cancer and potential value of screening shifts to younger age when life-years are considered



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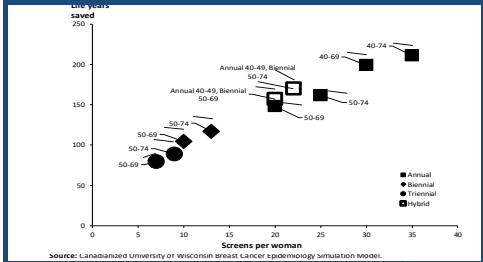
NCI Wisconsin CISNET Model



Yaffe, Mittmann et al Health Reports 2015

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What are the "harms" of screening?

- Missed cancers – false reassurance
- Missed screens
- Radiation
- "False positives"?
- Additional negative biopsies
- Overtreatment due to overdiagnosis and/or overdetection
- Could have spent time and money on something more important?

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Missed Cancers

- Sensitivity can be as high as 90% in fatty breasts when prior mammograms are available for comparison
- Can fall to 60% or lower in very dense breasts
  - Probably other techniques should be considered for screening such women
    - Ultrasound
    - Tomosysnthesis
    - Breast MRI
- Missed opportunities for detection also occur if women do not attend screening at recommended intervals

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False Positive

- A better name would be "Abnormal recall/ no cancer" (false alarm)
- Most women called back after screening do not have cancer
  - North America
    - After first screen recall rate is 12-14%
    - After subsequent screens ~7% -related to skill, experience
  - Europe 4-5%
- Most of the recalls are to rule out the very small chance of a cancer being present. They are not "errors"
- It would be helpful if this process were made more clear to patients

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Overdiagnosis

- Cancers that never would have surfaced in a woman's lifetime if they had not been detected by screening
- Correct term is overdetection – diagnosis takes place in the path lab
- Tests used in pathology cannot fully determine if the cancer will be aggressive or indolent – thus overdiagnosis
- This leads lead to overtreatment (or undertreatment)

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How big a problem is overdetection?

- Some have claimed 50%!
- Bleyer and Welch (2012) estimated that 22% of cancers were overdetected
- But there were large errors in their methodology - no apparent correction for lead time due to screening or temporal changes in incidence
- Pulitti has shown that if proper correction is made for these effects the estimates reduce to the range 1-10%
  - Most of the overdetection is likely in the form of DCIS
  - But DCIS can also be undertreated

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Overdetection

- The question is, should we forgo the opportunitity to save lives and reducing morbidity by detecting some cancers, when other cancers probably don't need to be detected? This has been suggested.
- Perhaps a more rational approach is to use existing biomarkers (and seek new ones) that predict aggressiveness and use these to guide treatment.
  - Some cancers may receive minimal treatment or watchful waiting (as in prostate cancer)

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How do Benefits and Harms of Screening Compare?

- My analysis using QALYs (caution preliminary work) Annual screening 40-74 *vs* biennial 50-74
- For 1000 women, followed from age 40-89
  - Benefit = 50 QALYs
  - Harm of FPs – 7.1 QALYs
  - Harm of Overdetection/overtreatment – 0.5 QALYs
  - Benefit:Harm 50/(7.6) = 6.6:1

Values for benefit from CISNET and OncoSim models-Yaffe MJ, Mittmann et al. Health Rep. 2015 Dec 16;26(12):9-15.
Values for harms from work of Dr. Craig Earle -J Clin Oncol 2000 18:3302-3317

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The truth is that screening is inefficient

- Must screen many women (200*) to detect a cancer and many more (2600*) to save a life.
- But, depends how you look at it:
  - If screening is carried out over an appropriate period at an appropriate interval, about one breast cancer death will be averted per 90 women screened
  - A year of life gained for every 4 women screened

* One time

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Can We Do Better? -The Opportunities

- Improved sensitivity and specificity
  - Digital breast tomosynthesis
  - Ultrasound
  - Contrast imaging based on angiogenesis
    - MRI
    - CEDM
- Stratified screening
  - Breast MRI for High-Risk Women
  - Identifying other groups who should be screened differently (very low risk, intermediate risk)

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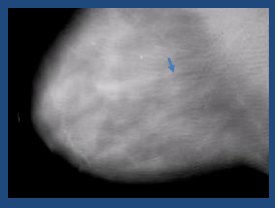
Tomosynthesis – should it replace DM for breast cancer screening?



Cancer was occult on 2D mammog

Preliminary Performance Data for Tomosynthesis

- Better imaging of the moderately dense breast
- Reduced abnormal recall rate when no cancer present – fewer false positives/greater specificity
- Improved detection of small invasive cancers
- Better characterization of cancers

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TMIST (ECOG-ACRIN)

- Randomized trial in 165,000 women will compare the number of **advanced/aggressive cancers** detected using Tomosynthesis *vs* Digital Mammography
- Study Chair Etta Pisano, MD, Canadian PI Martin Yaffe, PhD

With advanced or aggressive cancers defined as-

1) All invasive cancers over 2.0 cm. in size.
2) All invasive tumours that are over 1 cm. in size and which have prognostic markers that suggest aggressive behavior, (ie triple negative or Her2+).
3) All tumours that have positive nodes or metastases at the time of diagnosis

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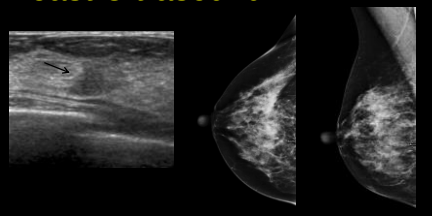
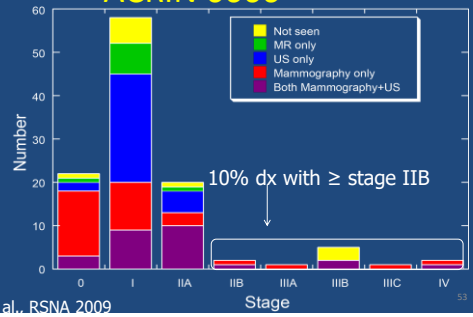
Breast Ultrasound



60F, 5-yr risk 2.5%, 24-mo US: 12 mm grade 1 IDC-DCIS, N0

Courtesy WP Evans, III, MD[52]

ACRIN 6666



Berg WA, et al., RSNA 2009

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Breast Ultrasound

- Detects small invasive cancers not seen on mammography
- Reduced specificity
- Handheld ultrasound is user-dependent and very labour intensive
- Performance of automated ultrasound historically not as good - improving

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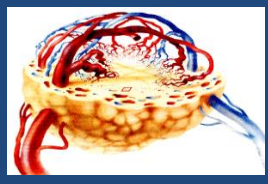
Angiogenesis

- Tumour induces angiogenesis
- Resulting vessels are of poor quality & leaky



Vascularized tumour penetrated by capillaries

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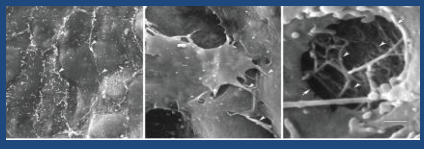
Leaky Angiogenic Vessels



Choyke and McDonald – Nature Medicine

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Breast MRI for High-Risk Women

- Studies in Canada, Germany, The Netherlands, UK demonstrated that this method was highly accurate in detecting breast cancer in these women.

Drs. Donald Plewes and Ellen Warner

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Performance of MRI vs Mammog. For High Risk Women


ACCEPTED MANUSCRIPT

Performance measures of magnetic resonance imaging plus mammography in the High Risk Ontario Breast Screening Program

Anna M Chiarelli, Kristina M Blackmore, Derek Muradali, Susan J Done, Vicky Majpruz, Ashini Weerasinghe, Lucia Mirea, Andrea Eisen, Linda Rabeneck, Ellen Warner

JNCI: Journal of the National Cancer Institute, djz078, https://doi-org.offcampus.lib.washington.edu/10.1093/jnci/djz078

Published: 24 June 2019 **Article history**

- Ontario High Risk Breast Screening Program
- 8,782 women ages 30-69 undergoing annual mammography and MRI (20,053 exams)

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Performance of MRI vs Mammog.

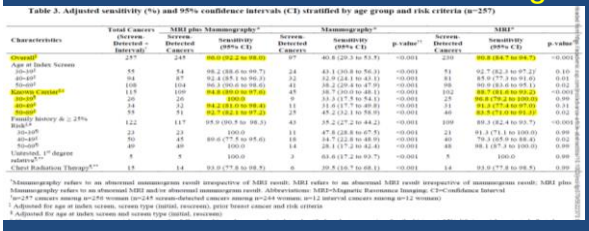
Table 3. Adjusted sensitivity (%) and 95% confidence intervals (CI) stratified by age group and risk criteria (n=257)

Characteristics	Total Cancers (Screen-Detected + Interval)[1]	MRI plus Mammography[2]		Mammography[2]		MRI[2]	
		Screen-Detected Cancers	Sensitivity (95% CI)	Screen-Detected Cancers	Sensitivity (95% CI) p.value[3]	Screen-Detected Cancers	Sensitivity (95% CI) p.value
Overall[4]	257	245	88.0 (82.2 to 88.0)	97	40.8 (29.3 to 53.5) <0.001	220	80.8 (84.7 to 84.7) <0.001
Age at Index Screen							
30-39[5]	55	54	98.2 (88.6 to 99.7)	24	43.1 (30.8 to 56.3) <0.001	51	92.7 (82.3 to 97.2) 0.10
40-49[5]	94	87	92.4 (85.1 to 96.3)	32	32.9 (24.1 to 43.1) <0.001	81	85.9 (77.3 to 91.4) 0.01
50-69[5]	108	104	96.3 (90.6 to 98.6)	41	38.2 (29.4 to 47.9) <0.001	98	90.9 (83.6 to 95.1) 0.02
Known Carrier[6]	115	109	94.8 (89.0 to 97.6)	45	38.7 (30.0 to 48.1) <0.001	102	88.7 (81.6 to 93.2) <0.001
30-39[5]	26	26	100.0	9	33.3 (17.5 to 54.1) <0.001	25	96.8 (79.2 to 100.0) 0.99
40-49[5]	34	32	94.2 (81.0 to 98.4)	11	31.6 (17.7 to 49.8) <0.001	31	91.2 (77.4 to 97.0) 0.31
50-69[5]	55	51	92.7 (82.1 to 97.2)	25	45.2 (32.1 to 58.9) <0.001	46	83.5 (71.0 to 91.1) 0.02
Family history & ≥ 25% Risk[7,8]	122	117	95.9 (90.5 to 98.3)	43	35.2 (27.2 to 44.2) <0.001	109	89.3 (82.4 to 93.7) <0.001
30-39[5]	23	23	100.0	11	47.8 (28.8 to 67.5) <0.001	21	91.3 (71.1 to 100.0) 0.99
40-49[5]	50	45	89.6 (77.5 to 95.6)	18	34.7 (22.8 to 48.9) <0.001	40	79.3 (65.9 to 88.4) 0.02
50-69[5]	49	49	100.0	14	28.1 (17.2 to 42.4) <0.001	48	98.1 (87.3 to 100.0) 0.99
Untested, 1st degree relative[9]	5	5	100.0	2	63.4 (17.2 to 93.7) <0.001	5	100.0 0.99
Chest Radiation Therapy[8,10]	15	14	93.0 (77.8 to 98.5)	6	39.5 (16.7 to 68.1) <0.001	14	93.0 (77.8 to 98.5) 0.99

[1]Mammography refers to an abnormal mammogram result irrespective of MRI result; MRI refers to an abnormal MRI result irrespective of mammogram result; MRI plus Mammography refers to an abnormal MRI and/or abnormal mammogram result. Abbreviations: MRI=Magnetic Resonance Imaging; CI=Confidence Interval

[2]n=257 cancers among n=250 women (n=245 screen-detected cancers among n=244 women; n=12 interval cancers among n=12 women)

[3] Adjusted for age at index screen, screen type (initial, rescreen), prior breast cancer and risk criteria

[4] Adjusted for age at index screen and screen type (initial, rescreen)

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Stage Distribution of Cancers

	MRI Cohort N=41	Controls N=77
Mean Age	**48**	**48**
DCIS	**24%**	**12%**
Invasive, mean	**0.9 cm**	**1.8 cm**
≤ 1 cm	**74%**	**35%**
> 2 cm	**3%**	**29%**
Node +	**13%**	**40%**

Warner, E. et al. JCO 2011;29:1664-9

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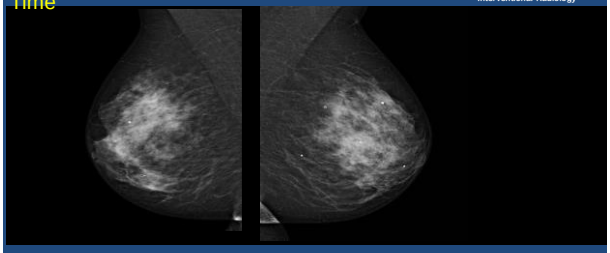
Abbreviated Breast MRI - Reduced Imaging Time

UNIKLINIK RWTH AACHEN
Department of Diagnostic and Interventional Radiology

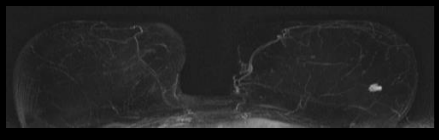


56-year old woman, dense breast

Images courtesy of Dr. Christiane Kuhl, Aachen, Germany

Reading MIP images

UNIKLINIK RWTH AACHEN
Department of Diagnostic and Interventional Radiology

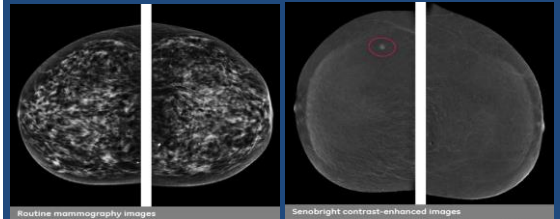


abnormal
L breast

9 mm invasive cancer NST
MRI detects cancers that are occult on mammography

Images courtesy of Dr. Christiane Kuhl, Aachen, Germany

Contrast-Enhanced Digital Mammography (IV Iodine Contrast)



Routine mammography images

Standard mammography images (MLO view) showed very dense and heterogeneous breasts with left density asymmetry. A speculated mass was also visible in the right inner quadrant in CC view.

Senobright contrast-enhanced images

Highlighted area does not correspond to the speculated mass detected on the routine image. SenoBright images show a suspicious area in the right upper quadrant, which the biopsy proved to be invasive ductal carcinoma.

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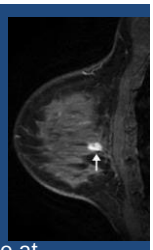
CEDM vs MRI



- Both have superior sensitivity to mammo
- No claustrophobia
- More accessible
- More specific?
- Patient preference
- May be useful for imaging women with dense breasts and for screening those at intermediate risk

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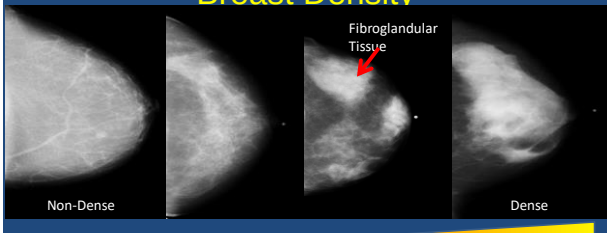
Breast Density



Risk of Developing Cancer

Mammography Sensitivity

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Stratified Screening: Precision medicine for detection

- What if we provided alternative screening for all women with dense or poor detectability breasts?

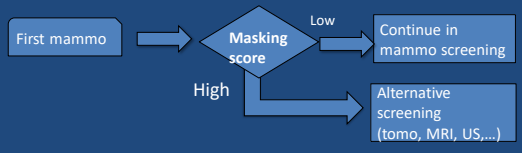

Evidence of the effect of adjunct ultrasound screening in women with mammography-negative dense breasts: Interval breast cancers at 1 year follow-up


ORIGINAL ARTICLE

The Connecticut Experiment: The Third Installment: 4 Years of Screening Women with Dense Breasts with Bilateral Ultrasound

Jean M. Weigert, MD, FACR

Stratified Screening Strategy based on Masking



Impact: fewer missed cancers
fewer call-backs?

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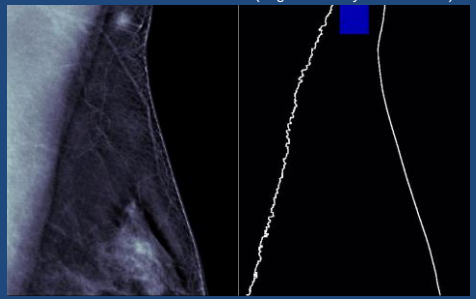
Simulated lesions

Detectability Map
(brighter = easy to see lesion)



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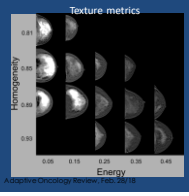
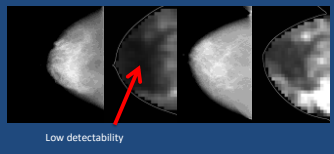
Radiomic Masking Index

- A measure of the masking probability or risk caused by density and its arrangement in a given mammogram
- Based on image texture and "detectability"

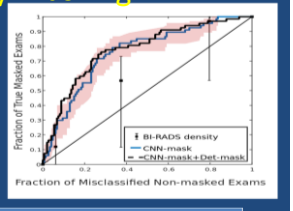




Stratified Screening by Masking

Mainprize JG,
Alonzo-Proulx O, Yaffe MJ

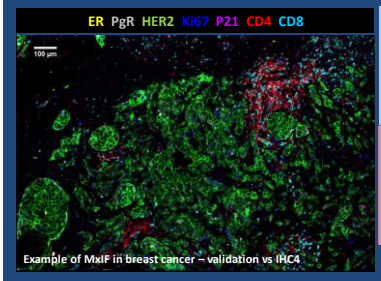
AI!



Model	AUC
BI-RADS	0.67 [0.57-0.76]
DET-mask	0.79 [0.69-0.87]
CNN-mask	0.79 [0.70-0.89]
DET + CNN	0.82 [0.72-0.90]

We need better tools in the pathology lab to distinguish killer cancers from indolent ones

Multiplex Immunofluorescence (MxIF)- Bartlett Group/ GE GRC



Example of MxIF in breast cancer – validation vs IHC4

IHC4

ER PgR
HER2 KI67
+ Segmentation markers
Cytokeratin (epithelial)
Ribosomal S6 (cytoplasm)
Na+K+ATPase (membrane)

Immune

CD3 PD-1
CD8 PD-L1
+ Segmentation markers
Cytokeratin (epithelial)
Ribosomal S6 (cytoplasm)
Na+K+ATPase (membrane)

Collaborate. Translate. Change lives.

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