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# SCIENTIFIC MEETING

## ABSTRACT SYLLABUS

Scientific Abstracts  
Authors – from A to Z



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# SCIENTIFIC ABSTRACTS

## Authors – from A to Z

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## I did it my way....

### I. Andersson

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#### **BODY**

I will give you some glimpses of my life with mammography ending up in the nomination for the EUSOBI GOLD MEDAL and illustrating how chance plays an important role in life and – somewhat surprising- also in science!

Life puts you at a series of cross-roads. If you choose the right way the result may be a lifelong fascinating journey and hopefully a valuable contribution to Medicine.

#### **TAKE HOME POINTS**

Various lucky coincidences made me end up with the world's first individually randomised study of mammography only screening for breast cancer, continuing with recruiting outstanding colleagues investigating various aspects of mammography screening, such as so-called overdiagnosis, breast tomosynthesis and artificial intelligence, with some humble contributions from myself.

## Monitoring Primary Systemic Treatment

### A. Athanasiou

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#### BODY

Primary systemic therapy (PST) has become a frequently used option for systemic therapy in breast cancer not only for locally advanced and/or inflammatory breast cancer but also in cases of operable breast cancer harboring specific molecular characteristics.

**In more specific terms, PST can be used in the following clinical situations:**

When breast conserving surgery is not possible (locally advanced, T4d disease, inflammatory breast cancer) or is likely to be suboptimal in terms of cosmesis.

In patients whose tumors express specific molecular characteristics that would be surrogate markers of good response to PST such as high-grade tumors, triple negative subtypes and HER2 positive subtypes.

High axillary burden and luminal B disease could also be subject to PST after case-to-case discussion in multidisciplinary rounds (depending on tumor size and KI67 expression rate).

**PST especially in operable breast cancer can be of benefit in the following points:**

It can improve surgical options.

It can reduce mortality from breast cancer whilst reducing toxicity.

It can provide early information on disease biology by the surrogate marker of response to treatment.

**Imaging holds an important role as an adjunct to PST:**

Before the onset of treatment, it helps to identify the extent of the disease.

During treatment it can be used to differentiate good responders for whom the treatment can be reasonably continued from the non-responders for whom other treatment options should be encountered to reduce toxicity.

At the end of treatment, it is of utmost importance to evaluate the extent of residual disease and to guide surgery accordingly. Clinical examination, mammography and ultrasound are, of course, systematically performed; however, most experts agree that magnetic resonance imaging MRI is by far the most accurate imaging tool we can dispose in this setting. Especially multiparametric breast MRI can act as an imaging biomarker by providing information on tumor angiogenesis (through dynamic contrast enhanced sequences) as well as on tumor internal cellularity (through diffusion sequences) and metabolism (through the most elaborated spectroscopy sequences). Several studies have shown that MRI findings are

strongly correlated with pathology, hence the importance of this technique in this setting.

Fluorodeoxyglucose positron emission tomography FDG-PET CT has also an increasing role in this setting. Changes in tumor uptake as measured by SUV values have been investigated in several studies and found to be reliable early indicators of pathologic complete response pCR.

Interestingly enough, the most “traditional” imaging tools, mammography and ultrasound, have recently gained additional role in this clinical context through the use of contrast agents. Contrast enhanced mammography CEM and quantitative multiparametric contrast enhanced ultrasound can also reliably depict tumor angiogenesis and internal structure modifications under treatment. Ongoing studies are on the field of optimizing these techniques.

Last but not least, the use of Artificial Intelligence AI tools, through Radiomics and Radiogenomics, represent an exciting area where images can be much more than simple pixels: they can translate molecular subtle changes in a very early stage and they can further complete the imaging tools we dispose in evaluating response to PST.

#### LEARNING OBJECTIVES

1. To be familiar with indications and regimens of PST.
2. To understand the concept of imaging biomarkers.
3. To gain knowledge on accuracy and diagnostic performance of imaging modalities used in this clinical setting.
4. To understand the imaging signs differentiating responders from non-responders.
5. To appreciate the role of upcoming tools and techniques, especially in the field of AI.

#### TAKE HOME POINTS

Primary Systemic Treatment is indicated in specific clinical scenarios ranging from locally advanced/inflammatory breast cancer to specific molecular subtypes such as triple negative and HER2 positive tumors.

Imaging holds a pivotal role in evaluating response to PST; it can provide insight into tumoral changes under treatment and reliably distinguish between good responders and non-responders.

At the end of treatment, evaluation of residual disease is of utmost importance to ensure the best surgical approach.

Breast MRI is the most accurate imaging modality in this setting, followed by FDG-PET/CT.

CEM and multiparametric ultrasound have been also used in this setting with promising results as shown in recent studies. AI is of particular interest and can provide insight into tumoral heterogeneity and molecular changes under treatment in a very early stage.

### References

- St Gallen Consensus 2021. *Breast Care* 2021;16:135-143. DOI:10.1159/000516114
- Reig B, et al. Breast MRI for Evaluation of Response to Neoadjuvant Therapy. *Radiographics*. 2021 May-Jun;41(3):665-679. doi: 10.1148/rg.2021200134.
- Akimoto et al. Role of 18 F-PET/CT in Predicting Prognosis of Patients With Breast Cancer After Neoadjuvant Chemotherapy. *Clin Breast Cancer* 2018 Feb;18(1):45-52. doi: 10.1016/j.clbc.2017.09.006
- Sannachi L, et al. Quantitative Ultrasound Monitoring of Breast Tumour Response to Neoadjuvant Chemotherapy: Comparison of Results Among Clinical Scanners. *Ultrasound Med Biol*. 2020 May;46(5):1142-1157. doi: 10.1016/j.ultrasmedbio.2020.01.022
- Sogani J et al. Contrast-enhanced mammography: past, present, and future. *Clin Imaging*. 2021 Jan;69:269-279. doi: 10.1016/j.clinimag.2020.09.003
- Tahmassebi A, et al. Impact of Machine Learning With Multiparametric Magnetic Resonance Imaging of the Breast for Early Prediction of Response to Neoadjuvant Chemotherapy and Survival Outcomes in Breast Cancer Patients. *Invest Radiol*. 2019 Feb;54(2):110-117. doi: 10.1097/RLI.0000000000000518.

## Equity of access to screening from a patient perspective

### E. Bergsten Nordström

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#### BODY

I am a patient advocate representing Europa Donna, the European Breast Cancer Coalition addressing screening from a patient perspective. Europa Donna has a total of 47 national member fora, apart from the EU-countries, also including countries according to WHO definition as part of the European Region.

Access to screening through screening programs is not evident in all countries, even within EU and far from all countries within the European Region have tools for breast cancer screening at all.

Access to Mammography-screening - unequal - not only between countries within EU, but also within an individual country.

Many countries still do not have Screening programs - even within EU.

Information to women to actually participate in Mammography screening is another question. And as populations in Europe today is not as for 25 years ago there is also a need for information to immigrant populations.

Breast cancer used to be the older women's disease, but not anymore - maybe due to life style factors, which is difficult to ascertain through scientific research for obvious reasons. Shall screening programs change age wise due to this knowledge also considering the possible false positive results?

Information of "false positives" should be described with pros and cons by the profession where facts are described and include patient organizations, with the aim to widen the understanding health-wise as well as for financial/healthcare systemic issues.

Dense breast is another issue that may affect screening programs. Young women have dense breasts, but even older women can have dense breasts. Patient's right to know if they have dense breasts is another question, more of a legal character maybe, but this will also affect screening programs. Other, more costly and sometimes less accessible methods may be necessary - for example MRI.

Research has been developing rather rapidly and new methods of screening, such as MRI, Staging, DBT not to mention CESM and DWI -brief information necessary to avoid misunderstanding among patients.

Access to new methods - unequal - AND it should be noted that ECIBC Guidelines are not in line with latest research - also both understandable and reasonable - as those have the low-level grading, but this could possibly be pointed out as one of the facts that EU have no ruling of internal healthcare systems in the member countries.

Generally: information to patient organizations and collaboration in some issues could be a way to lift issues to policymakers and interact in a positive way with healthcare administrations.

#### TAKE HOME POINTS

Patient perspective:

- regarding access to screening
- screening programs and accessibility within EU
- information to women to participate in screening
- information regarding "false positives"
- dense breast issue
- research development fast, information behind and access to new methods behind
- collaboration with Patient organisations?

## FDG PET/CT for distant staging

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### BODY

Currently, there is evidence that 2-[18F]FDG PET/CT is useful in breast cancer management, namely in the initial staging of distant disease, assessing treatment response, radiation therapy planning, relapse detection, biopsy-site guidance and re-staging.

2-[18F]FDG avidity of breast cancer is related to tumour grade, receptor status, proliferation index and histologic type. Therefore, high 2-[18F]FDG uptake correlates with tumour aggressiveness and is associated with worse prognosis.

The impact of 2-[18F]FDG PET/CT in breast cancer distant staging has been documented by several studies that demonstrated its utility compared to combined conventional imaging (combination of bone scintigraphy, abdominal ultrasound or abdominal CT, chest X-ray or CT-chest) or whole-body MRI. The majority of authors recommend 2-[18F]FDG PET/CT for distant staging in breast cancer patients with TNM stage  $\geq$  IIB, because it leads to staging changes in more than 20% of patients and, consequently, allows for the most appropriate and most cost-effective treatment. This is of particular importance in inflammatory breast cancer.

Overall, 2-[18F]FDG PET/CT has shown good diagnostic accuracy to evaluate distant metastases, when compared to combined conventional imaging, in particular due to its high sensitivity (the reported values of sensitivity range between 97-99% vs 56-75% and specificity range between 95-99% vs 88-99%). Focusing specifically on bone metastases, 2-[18F]FDG PET/CT may be more useful than CT and/or bone scan. It enables earlier detection of bone metastases and helps identify non-measurable lesions by morphologic examinations. All in all, 2-[18F]FDG PET/CT can be considered a valuable whole-body imaging tool for the early identification of metastatic disease.

### TAKE HOME POINTS

- 2-[18F]FDG PET/CT is useful for detecting distant metastases in breast cancer patients with TNM stage  $\geq$  IIB.
- 2-[18F]FDG PET/CT enables early identification of metastatic disease and may be more useful than CT and/or bone scan for bone metastases evaluation.

### A. D'Angelo

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#### BODY

Male breast lesions are divided in benign neoplastic and non-neoplastic and malignant lesions. Gynecomastia (GM), a non-neoplastic enlargement of the male breast, secondary to ductal hyperplasia and stromal proliferation, is one of the most common benign non-neoplastic male breast lesions (1, 2). GM can be physiologic (during puberty), related to drug abuse, cirrhosis, hypogonadism, or neoplasms (Germ cell tumors, Leyding cell tumor, Sertoli cell tumor ecc...). Three mammographic patterns were described: diffuse, nodular and dendritic (3). In case of diffuse gynecomastia US could be proposed as the primary imaging tool for diagnosing GM. Mammography could be reserved only in the case of suspected sonographic malignant findings to confirm diagnosis before interventional procedures. In case of nodular or dendritic patterns, biopsy remains mandatory for a definitive diagnosis and for excluding breast cancer (4). Pseudogynecomastia is the second most common benign non-neoplastic condition, it is characterized by increased subareolar fat without enlargement of the breast glandular component. Mammography can help in the differentiation between GM and pseudogynecomastia (5). As for the benign tumor of the male breast, lipoma is the most frequent. At mammography, a lipoma can be difficult to distinguish from surrounding fat and may display a thin, radiopaque capsule (6).

Male breast cancer (MBC) accounts for up to 1% of all breast cancers and 0.17% of all cancers in males (7). MBC is usually unilateral, occurring bilaterally in less than 1% of cases. Infiltrating ductal carcinoma not otherwise specified is the most common histologic subtype of MBC, followed by ductal carcinoma in situ (8). Usually it occurs as a painless palpable mass or with nipple discharges. Risk factors for the development of MBC include advanced age, chronic increased exposure to estrogen, genetic predisposition (BRCA1/2 mutation), cryptorchidism, testicular injury, hepatic dysfunction, and Klinefelter syndrome (9). Data to support breast screening in men are limited.

Men testing positive for BRCA1/2 should have an annual clinical breast examination and undergo training in breast self-examination with regular monthly practice starting at 35 years of age. No recommendations exist for screening mammography for men at high-risk of MBC, despite mammography depicts clinically occult malignancy in this patient population (10). Annual mammogram screening in men with GM may be considered, beginning at age 50 or 10 years before the earliest known breast cancer in the family (11).

Transgender patients, nonbinary individuals who can be transfeminine persons (male-to-female) or transmasculine persons (female-to-male), have an increased risk for breast cancer due to exposure to exogenous feminizing hormones and androgen suppression in the first case, and because their genotype is female in the second case without mastectomy (12, 13). Breast cancer screening recommendations are based on patient's age, the sex assigned at birth, risk factors, and use of exogenous hormones. Anyway, there are no relevant data on the use of digital breast tomosynthesis (DBT) and digital mammography for breast cancer screening of transgender individuals. US and MRI are usually not appropriated (14). When evidence is lacking or equivocal, expert opinion may supplement the available evidence to recommend imaging or treatment. There is a need of larger trials and guidelines.

#### TAKE HOME POINTS

Further and larger studies needed to validate results and provide more definitive recommendations in male breast. Mammography is useful in case of indeterminate mass in patient >25years old. Selective mammography screening in men at elevated risk for breast cancer is beneficial.

#### References

1. Braunstein GD. Clinical practice. Gynecomastia. *N Engl J Med*. 2007 Sep 20;357(12):1229-37. doi: 10.1056/NEJMc070677. PMID: 17881754.
2. Nguyen C, Kettler MD, Swirsky ME, Miller VI, Scott C, Krause R, Hadro JA. Male breast disease: pictorial review with radiologic-pathologic correlation. *Radiographics*. 2013 May;33(3):763-79. doi: 10.1148/rg.333125137. PMID: 23674773
3. Appelbaum AH, Evans GFF, Levy KR, Amirkhan RH, Schumpert TD. Mammographic appearances of male breast disease. *Radiographics*. 1999;19:559-68.
4. Telegrafo M, Introna T, Coi L, Cornacchia I, Rella L, Stabile Ianora AA, Angelelli G, Moschetta M. Breast US as primary imaging modality for diagnosing gynecomastia. *G Chir*. 2016 May-Jun;37(3):118-122. doi: 10.11138/gchir/2016.37.3.118. PMID: 27734795; PMCID: PMC5119698.
5. Lattin GE Jr, Jesinger RA, Mattu R, Glassman LM. From the radiologic pathology archives: diseases of the male breast: radiologic-pathologic correlation. *Radiographics*. 2013 Mar Apr;33(2):461-89. doi: 10.1148/rg.332125208. PMID: 23479708.
6. Chen L, Chantra PK, Larsen LH, et al. Imaging characteristics of malignant lesions of the male breast. *RadioGraphics* 2006;26(4):993-1006.
7. Günhan-Bilgen I, Bozkaya H, Ustün EE, Memiş A. Male breast disease: clinical, mammographic, and ultrasonographic features. *Eur J Radiol*



- 2002;43(3): 246–255. The lifetime risk for men is 1 in 833.
8. Mathew J, Perkins GH, Stephens T, Middleton LP, Yang WT. Primary breast cancer in men: clinical, imaging, and pathologic findings in 57 patients. *AJR Am J Roentgenol* 2008;191(6):1631–1639.
  9. Mathew J, Perkins GH, Stephens T, Middleton LP, Yang WT. Primary breast cancer in men: clinical, imaging, and pathologic findings in 57 patients. *AJR Am J Roentgenol* 2008;191(6):1631–1639.
  10. Marino MA, Gucalp A, Leithner D, Keating D, Avendano D, Bernard-Davila B, Morris EA, Pinker K, Jochelson MS. Mammographic screening in male patients at high risk for breast cancer: is it worth it? *Breast Cancer Res Treat*. 2019 Oct;177(3):705-711. doi: 11.1007/s10549-019-05338-1. Epub 2019 Jul 6. PMID: 31280425; PMCID: PMC6745275.
  12. NCCN clinical practice guidelines in oncology (NCCN guidelines): Genetic/familial high-risk assessment—breast and ovarian, version 2.2021
  13. Maglione KD, Margolies L, Jaffer S, et al. Breast cancer in male-to-female transsexuals: use of breast imaging for detection. *AJR Am J Roentgenol* 2014;203:W735-40.  
Stone JP, Hartley RL, Temple-Oberle C. Breast cancer in transgender patients: a systematic review. Part 2: Female to male. *Eur J Surg Oncol* 2018;44:1463-8.
  14. Expert Panel on Breast Imaging, Brown A, Lourenco AP, Niell BL, Cronin B, Dibble EH, DiNome ML, Goel MS, Hansen J, Heller SL, Jochelson MS, Karrington B, Klein KA, Mehta TS, Newell MS, Schechter L, Stuckey AR, Swain ME, Tseng J, Tuscano DS, Moy L. ACR Appropriateness Criteria® Transgender Breast Cancer Screening. *J Am Coll Radiol*. 2021 Nov;18(11S):S502-S515. doi: 10.1016/j.jacr.2021.09.005. PMID: 34794604.

## Breast imaging in children and adolescents

### E. Giannotti

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#### BODY

While breast cancer is rare in adolescents and young adults, breast symptoms are common. The spectrum of breast disease is different from that in adults and most lesions are benign, but often they cause anxiety and significant family distress. In fact the high prevalence of adult breast cancer is the source of worry in many parents of children with breast complaints. Yet breast cancer hardly ever afflicts children or adolescents. With that in mind a tailored diagnostic and management approach is necessary for paediatric and adolescents breast complaints. Clinical evaluation is an essential component of a complete assessment of children and adolescents breast complaints. With pertinent history and physical exam, breast complaints in this age group can be correctly categorised and only required reassurance. When necessary ultrasound is the primary imaging modality, given its diagnostic specificity and lack of ionizing radiation.

In contrast to the adult population mammography is contraindicated because of the extremely low risk of breast cancer, the increased risk of radiation-induced malignant changes and poor images quality due to dense fibroglandular breast.

Furthermore because the developing breast is uniquely vulnerable to iatrogenic injury, which can lead to permanent disfigurement, biopsy should be reserved only for lesion of high suspicion in children.

The radiologist need to know and understand normal breast development and the spectrum of pediatric and adolescents lesions. Normal anatomic structure can mimic breast masses, non neoplastic benign entities include cystic lesions, hematoma due to trauma, mastitis/ abscess and skin lesion. The most common benign solid mass is fibroadenoma. Removal should be considered if the lesion rapidly enlarged to exclude the possibility of a phylloides tumour (regarding benign ultrasound appearance +/- initial benign pathology at biopsy). Children and adolescents can present with bloody nipple discharge due to drugs, exercise, trauma and a conservative approach is recommended. Other rare benign masses include hamartoma, intraductal papilloma and juvenile papillomatosis. Malignant lesions are rare, more commonly metastatic disease and occasionally primary breast malignancy. Phylloides tumour is the most common breast malignancy, while invasive ductal carcinoma is extremely rare of which the secretory subtype is the most common.

Results of a retrospective review of 5 year breast ultrasound of patients <19 years old [ 586 (562 female, 24 male) patients, with a median age of 16.5 years] performed at Nottingham Breast Institute will be presented. There were two cases of phylloides tumour (1 benign and 1 border line ) (incidence 0.3% ).

#### TAKE HOME POINTS

- Breast cancer hardly ever afflicts children or adolescents
- History & clinical examination are an essential component of a complete assessment
- The radiologist need to know and understand normal breast development and the spectrum of pediatric and adolescents lesions
- When necessary ultrasound is the primary imaging modality, given its diagnostic specificity and lack of ionizing radiation
- Surgical excision need to be performed in rapidly enlarging symptomatic breast masses (regarding benign ultrasound appearance +/- initial benign pathology at biopsy)

## OXFORD DEBATE: This house believes that AI is ready to be used in screening mammography (Yes)

### F. Gilbert

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#### BODY

The release of 100,000 mammograms for the DREAM challenge stimulated over 68 groups to submit AI tools for the detection of cancer. Several companies were spun out of this academic work. These and others have undertaken numerous retrospective studies where performance of a stand alone AI tool has been compared to the first reader in a screening programme. Some of these tools have matched or almost matched the sensitivity and specificity of the human reader in independent testing in the UK and Sweden and so are ready to be tested prospectively in a double reading environment. Rule out where the algorithm is able to predict no cancer with 99% sensitivity have been published with AI able to dismiss 19-60% of cases. Rule in, where an AI tool can identify those cases with a high likelihood of cancer, is also useful and current literature suggests at 96% specificity (4% recall rate) that an additional 27% of interval cancers could be flagged with up to 35% of next round cancers flagged. AI is ready to be implemented into screening practice to be used alongside human readers. However as with introduction of any new device regular audit is required to ensure that the unintended consequences of reducing reader performance due to over reliance on prompts or AI results is avoided.

#### TAKE HOME POINTS

1. AI tools can be used as an independent single reader, to rule out cases requiring double reading and to rule in highly suspicious lesions
2. AI tools should be tested on independent datasets
3. Reader performance should be monitored following the introduction of AI to detect whether or not there is improvement or deterioration in human performance
4. AI tools are being developed to predict risk of developing breast cancer over the next 5 years.

## How to define a women's breast cancer risk

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### BODY

For risk-based breast cancer screening to be efficient, the individual risk of breast cancer has to be determined. Current risk models include established risk factors for breast cancer and, sometimes, crude measures of mammographic density. Image based and artificial intelligence (AI) derived models for risk prediction of breast cancer has received attention over the last years. The advantage of pure image-based models is that risk assessment could be fully automatized and no additional information, except for age, is needed. Some of these models also include established risk factors and genetic determinants of breast cancer.

For identification of women in need of supplemental screening, it is probably better to use a short-term risk compared to a model that gives a 5-, 10-year or lifetime risk. A suggestion would be to use a risk model with the same time span as the screening interval of the screening program. This approach identifies women at high risk of developing an interval cancer and thus in need of supplemental screening.

One of the major challenges in risk modelling is to define what should be considered high risk. Currently, arbitrary cut offs, not adopted for short term risk estimates, are used. An alternative would be to decide on the proportion of interval cancer that would potentially develop in women at a certain risk. That is, if the target is to identify 50% of all interval cancers, what proportion of women at high risk has to be invited for supplemental screening? The risk of this proportion of women could define the high-risk population.

### TAKE HOME POINTS

During my presentation I will discuss how image based, AI derived tools could be used in the breast cancer screening setting. I will discuss the advantage of short-term risk models and what risk factors that should be included. Further, I will discuss the risk cut offs used today and suggest alternatives. Lastly, I will touch on what we are planning to do the coming years when it comes to targeted primary and secondary prevention of breast cancer.

## Radiomic nomogram for prediction of axillary lymph node metastasis in breast cancer

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### BODY

#### Introduction

Breast cancer has been the most common malignant tumor all over the world

The presence of axillary lymph node metastasis (ALNM) and the number and location of metastatic lymph node determine the pathologic stage, the need for systemic therapy, the extent of surgery, reconstruction options, and the need for radiation therapy after mastectomy

For decades, the surgical axillary staging and treatment of early breast cancer have been developed from complete axillary lymph node dissection (ALND) to sentinel lymph node biopsy (SLNB) to avoid complications

Clinical paradigms for axilla treatment have been further changed by the American College of Surgeons Oncology Group (ACOSOG) Z0011 trial, it showed that patients with 1-2 metastatic sentinel lymph nodes who accept breast conserving surgery and systemic therapy can avoid ALND

Over the decades, with the transformation of axillary surgical treatment mode to more precise and less invasive, it is not enough to identify ALNM only through imaging

Radiomics and deep learning or artificial intelligence based integration of imaging and clinical-pathologic information promise to improve the accuracy of predicting metastatic lymph nodes in the future

#### Purpose

develop a radiomic nomogram for predicting ALNM based on MR images and clinical information

#### Materials and methods

*Patients:* 411 were enrolled, 148 with lymph node metastasis and 263 without randomly divided into a training set (n=279) and a validation set (n=132)

*Clinical characteristics:* Lymph node status, the number of metastatic lymph nodes, HER2, ER, PR, KI-67, histological tumor type, lymph node palpability

*MR image acquisition:* 1.5 T MRI system (HDx, GE Healthcare), T1-weighted images of dynamic contrast enhanced (T1-DCE) MR images

*MRI-reported lymph node status:* Circular shape, missing fatty hilum, eccentric cortical thickening

*Multifocality:* More than one lesion on MRI

*ROI segmentation:* Manually segment the tumor area on the first phase of T1-DCE images using ITK-SNAP software

*Feature extraction:* 808 radiomic features were extracted using open-source software (Pyradiomics)

*Feature selection:* First Mann-Whitney U tests were performed, and features with  $p < 0.1$  were selected as potentially informative features; next, two selection models (LASSO regression model and leave-one-out cross-validation method) were used to select optimal features

*Prediction model construction:* Radiomic signature: Linear support vector machine (SVM) to predict lymph node metastasis based on the selected MRI features

*Clinical model:* Univariate analysis to select clinical factors related to lymph node metastasis; multivariate logistic regression to establish a clinical model

*Combined model:* Incorporating the radiomic features in the best radiomic signature and the clinical factors in the clinical model

#### Results

*Clinical characteristics:*

Histological type, lymph node palpability, multifocality and MRI-reported lymph node status have Statistical differences between lymph node metastasis group and non lymph node metastasis group

All the clinical characteristics between the training set and the validation set have no statistical difference

# Radiomic nomogram for prediction of axillary lymph node metastasis in breast cancer

**Table 1** Clinical characteristics

Characteristics	LN-metastasis group (n = 148)	Non-LN-metastasis group (n = 263)	p value	Training cohort (n = 279)	Validation cohort (n = 132)	p value
Age (mean ± SD)	52.37 ± 9.7	51.87 ± 9.4	0.612	52.10 ± 9.7	51.95 ± 10.4	0.890
Tumor size on MRI (mm)	20.08 ± 8.5	19.07 ± 9.0	0.264	19.56 ± 8.5	19.17 ± 9.4	0.670
Histologic type <sup>#</sup>			< 0.001			0.186
Precursor lesions	2	31		19	14	
Invasive carcinoma	146	231		259	118	
Other <sup>#</sup>	0	1		1	0	
Estrogen receptor status			0.059			0.228
Negative	40	95		97	38	
Positive	108	168		182	94	
Progesterone receptor status			0.977			0.122
Negative	70	124		139	55	
Positive	78	139		140	77	
HER2 status			0.877			0.262
Negative	118	208		217	109	
Positive	30	55		62	23	
KI-67 status			0.065			0.292
Negative	23	61		53	31	
Positive	125	202		226	101	
LN palpability			< 0.001			0.941
Yes	29	9		26	12	
No	119	254		253	120	
Multifocality			< 0.001			0.353
Yes	32	24		35	21	
No	116	239		244	111	
MRI-reported LN status			< 0.001			0.666
Negative	54	236		195	95	
Positive	94	27		84	37	
LN metastasis						
Yes				97	51	0.445
No				182	81	

### Radiomic signature building:

We build a radiomic signature based on 12 lymph node status-related features, including 3 first-order features, 1 shape feature, 4 gray level co-occurrence matrix (GLCM) features, 3 gray level size zone matrix (GLSZM) features, and 1 gray level run length matrix (GLRLM) feature

The prediction performance of the radiomic signature was moderate, with an AUC of 0.76 in the training cohort and 0.78 in the validation cohort

### Construction of the radiomic nomogram:

We developed a nomogram based on radiomic signature, MRI-reported lymph node status, and lymph node palpability. As they were all discovered as independent risks for lymph node metastasis in the multivariable logistic regression model

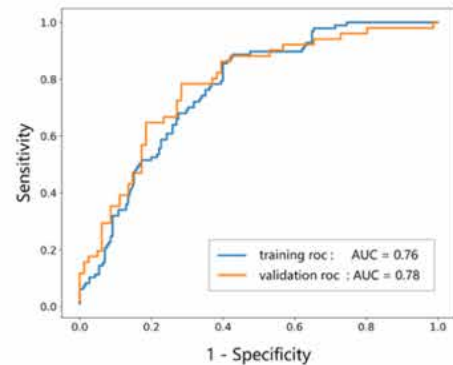
The predictive performance of the nomogram was better than that of the radiomic signature, with an AUC of 0.84 and 0.87 in the training set and validation set, respectively

# Radiomic nomogram for prediction of axillary lymph node metastasis in breast cancer

**Table 2** LN status-related features

First-order feature	Shape feature	GLCM	GLSZM	GLRLM
Median	Surface area to volume ratio	Informal measure of correlation (IMC)1	Size zone non-uniformity normalized (SZNN) (HLL)	Short run emphasis (SRE)
Robust mean absolute deviation		Entropy	Size zone non-uniformity normalized (SZNN) (LHH)	
Range		Sum entropy	Large area low gray level emphasis (LALGLE)	
		Sum average		

GLCM gray level co-occurrence matrix, GLSZM gray level size zone matrix, GLRLM gray level run length matrix



**Fig. 2** ROC curve of radiomic signature for prediction LN metastasis in the training and validation cohorts

### Clinical use:

Nomogram

Decision curve analysis

*Distinguish the number of metastatic lymph nodes (less than or equal to 2 and more than 2):*

We also construct another radiomic signature to distinguish the number of metastatic lymph nodes

It based on 11 lymph node number-related features, containing 2 first-order features, 1 shape feature, 4 gray level co-occurrence matrix (GLCM) features, 2 gray level size zone matrix (GLSZM) features, and 2 gray level run length matrix (GLRLM) features

The radiomic signature showed moderate distinguishing performance, with a mean AUC of 0.79

### Limitations

The radiomic signature and nomogram based on features extracted from primary tumors instead of the lymph nodes themselves, the reason is that it is difficult to match the lymph nodes that have been biopsied or dissected was the lymph nodes imaged on MRI

We only cross-validated the radiomic signature for distinguishing the number of metastatic lymph nodes, which was limited by the sample size. Independent validation in larger samples will be needed to develop high-level evidence needed for clinical use

### Conclusions

We developed a nomogram based on radiomic signature, MRI-reported lymph node status, and lymph node palpability, it can predict lymph node metastasis non-invasively

We also construct a radiomic signature to predict the number of metastatic lymph nodes (less than 2 lymph nodes/more than 2 lymph nodes), it showed moderate predictive performance Both nomogram and radiomic signature can be used as tools to assist clinicians in assessing lymph node metastasis in breast cancer patients

### TAKE HOME POINTS

ALNM is an important factor affecting breast cancer patients' treatment and prognosis

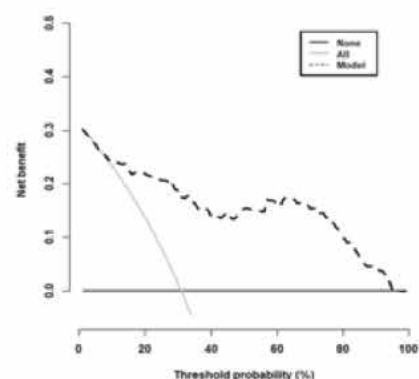
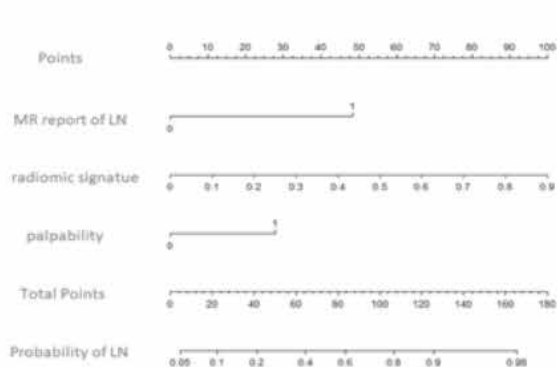
Traditional imaging examinations have limited value for evaluating axillary lymph node status

Radiomics and deep learning or artificial intelligence promise to improve the accuracy of predicting metastatic lymph nodes in the future

# Radiomic nomogram for prediction of axillary lymph node metastasis in breast cancer

**Table 3** Multivariable logistic regression analysis of risk factors for LN metastasis

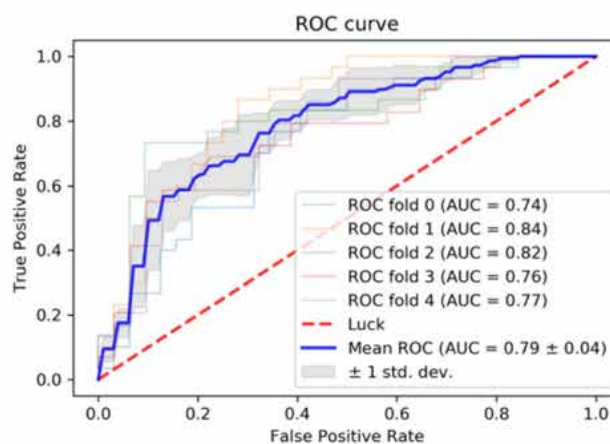
Characteristic	Nomogram			
	$\beta$	Odds ratios (95%CI)	<i>p</i> value	
Radiomics score	4.725897	7.8144 (3.999500–15.2680)	<0.0001	
MR reported LN status	2.055972	3.6011 (2.204100–5.8837)	<0.0001	
LN palpability	1.186217	3.2747 (1.062600–10.0920)	0.0389	
	AUC	Sensitivity	Specificity	Accuracy
Training cohort	0.8388 (0.7887–0.8888)	0.6042	0.9382	0.8212
Validation cohort	0.8735 (0.7927–0.9542)	0.8529	0.8026	0.8182



**Table 4** Metastatic LN number-related features

First-order feature	Shape feature	GLCM	GLSZM	GLRLM
Maximum	Major axis	Inverse difference normalized (IDN)	Large area high gray level emphasis (LAHGLE)	Long run low gray level emphasis (LRLGLE)
Skewness		Difference variance	Small area emphasis (SAE)	Gray level non-uniformity normalized (GLNN)
		Correlation		
		Autocorrelation		

GLCM gray level co-occurrence matrix, GLSZM gray level size zone matrix, GLRLM gray level run length matrix



**Fig. 5** ROC curve of radiomic signature for distinction the number of metastatic LNs (less than or equal to 2 and more than 2)



## Highlights of Japanese Breast Research

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<sup>2</sup>Institute for Advancement of Clinical and Translational Science (iACT), Kyoto University Hospital, Kyoto, Japan

### BODY

In Japan, only 40-50% of eligible women take mammography for breast cancer screening. The incidence of breast cancer is higher in Japanese women in the 40- to 49-year-old age group compared to the elder group. Furthermore, a significant number of young Asian women tend to have small and dense breasts toward which mammography is notoriously difficult to interpret, resulting in low sensitivity. This situation clearly points out specific issues regarding the Japanese population which stand out from populations of Western countries, prompting radiologists and healthcare authorities to consider more suitable imaging modalities beyond mammography (or breast tomosynthesis), or a combination of modalities, to deliver better breast cancer screening and management in Japan.

Such modalities include contrast-enhanced mammography, elastography, electrical impedance tomography, optical imaging, scinti-mammography, breast-specific gamma imaging, positron emission mammography, and MRI. Among them, breast MRI has been found to be the most sensitive imaging modality for detecting and characterizing breast lesions. Breast MRI techniques, such as diffusion MRI (DWI) or ultrafast contrast-enhanced MRI (UF-DCE), can provide quantitative parameters (tissue microstructure and perfusion from DWI; kinetic parameters on neo angiogenesis from UF-DCE MRI), which are unique and have the potential to improve the clinical performance of MRI for lesion detection and classification, as well as treatment management and monitoring. Both UF-DCE and DWI MRI have been the object of cutting-edge research in Japanese academia 1–3 and industry (Canon, Hitachi). Exclusively dedicated breast PET systems also have been investigated (Shimadzu).

### TAKE HOME POINTS

Regarding breast imaging the Asian population present specificities which have lead radiologists and healthcare authorities to actively seek other imaging modalities than mammography. Among them breast MRI is standing out and has been the object of cutting-edge research in Japanese academia and industry.

### References

1. Iima, M. et al. Diffusion MRI of the breast: Current status and future directions. *J. Magn. Reson. Imaging* 52, 70–90 (2020).
2. Someya, Y. et al. Investigation of breast cancer microstructure and microvasculature from time-dependent DWI and CEST in correlation with histological biomarkers. *Sci. Rep.* 12, 6523 (2022).
3. Kataoka, M. et al. Ultrafast dynamic contrast-enhanced MRI of the breast: How is it used? *Magn. Reson. Med. Sci.* 21, 83–94 (2022).

## Conventional staging

### G. Ivanac

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#### BODY

Mammography is the proven effective imaging modality for the screening of breast cancer; however, its sensitivity is considerably lower in women with dense breasts than in women with primarily fatty breasts. Also, the detection of synchronous malignancy is more challenging because the additionally detected breast cancer lesions are known to be smaller and less suspicious than the index cancer. Contrast enhanced mammography (CEM) can be an alternative to MRI. Once the initial size of the tumor is assessed, CEM can be used to accurately determine if the disease is unifocal, multifocal, multicentric, or bilateral. Studies of CEM in preoperative staging show that CEM can be a viable alternative to MRI. Bilateral whole-breast ultrasonography has been traditionally used to overcome limitations of mammography and has been reported to be moderately effective in evaluating the extent of the breast cancer in preoperative staging. Mainstay of ultrasound is the gray-scale (B-mode), but color Doppler provides information about vascularization of lesions. Relatively new is sonoelastography that enables evaluation of elasticity/stiffness of focal lesions, and is included in BI-RADS lexicon sonographic criteria. Stiffness can be quantified using shear-wave sonoelastography, and stiffer the lesion is higher is the likelihood of malignancy. Tissue sampling by biopsying breast lesions is most commonly performed under the ultrasound guidance because it is the fastest and cheapest. Contrast-enhanced ultrasound can be used to evaluate vascularisation of focal breast lesions and is primarily used to follow up the response to neoadjuvant chemotherapy of the breast cancer. Evaluation of axillary lymph nodes with ultrasound is superior to mammography and even MRI, and biopsy or fine-needle aspiration of sonographically suspicious or enlarged lymph-nodes can be performed quickly and accurately under the ultrasound guidance. In case of suspicious metastatic breast cancer computerized tomography is used in staging, as well as PET-CT.

#### TAKE HOME POINTS

1. Mammography is not optimal to evaluate the extent of breast cancer, especially in dense breasts.
2. Ultrasound is good modality to evaluate extent breast cancer in dense breasts, and especially to guide biopsies and evaluate axillary nodes.
3. Conventional imaging modalities are inferior to MRI for breast cancer staging.

## A Comparison of CESM and Breast MRI

### J. James

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#### **BODY**

CESM images the abnormal vasculature associated with breast cancer, combining tumour morphology with an element of functional information in a similar fashion to breast MRI. This approach improves the sensitivity of conventional 2D mammography and is particularly useful in younger women with dense mammographic background patterns. CESM compares favourably with breast MRI for the local staging of breast cancer and may have a role in assessing response to neoadjuvant chemotherapy and screening higher risk women. The indications for CESM and MRI are very similar and so there is a danger that CESM is seen as second best to MRI with its well established and larger evidence base. Often considered the 'gold standard' MRI is not without problems. CESM is straight forward to perform, well tolerated by patients and can be fitted easily into everyday clinical practice.

#### **TAKE HOME POINTS**

- 1) CESM is proving a useful tool in diagnosing and staging breast cancer, screening and assessing the response to neoadjuvant chemotherapy with performance equivalent to breast MRI
- 2) CESM is well tolerated by women and has potential workflow advantages over MRI

## Novel developments in US and opto-acoustics

### P. Kapetas

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#### BODY

Breast ultrasound (US) is an established adjunct to mammography in the diagnostic setting, while it is also the most usually implemented imaging modality for supplemental screening of women with an average-to-intermediate risk for breast cancer. B-mode US is the basis of the sonographic evaluation of breast lesions- however, the role of further additional techniques has been highlighted in recent years. Moreover, the development of automated breast US devices provides an alternative to time-consuming, resource-intensive handheld US for screening purposes. At the same time, the advances and increased use of artificial intelligence (AI) algorithms in medical imaging could not have left breast US unaffected. A substantial part of recent research on breast US involves utilization of AI techniques, not only for the differentiation of benign from malignant lesions but also in further applications, with some of them having already found their way into clinical practice.

On the other hand, optoacoustic (OA) imaging utilizes near-infrared optical excitation to generate US waves in tissue, combining an increased spectral contrast (due to the use of light) and the high resolution (due to their inherently low scattering) of the propagating US waves. Both tomographic and handheld systems have been developed in the last years, while, through the use of more than one wavelengths, functional and molecular information (like oxy- and deoxygenated hemoglobin) can be acquired. Based on these parameters, malignant tumors can be differentiated from benign ones- however, their potential reaches further, to the depiction of tumor heterogeneity, molecular tumor subtyping and prediction of tumor response to neoadjuvant chemotherapy. Specific OA contrast agents are currently being developed and evaluated, while other researchers focus on the acquisition of further biochemical tissue data (like lipid and collagen signals). Finally, implementation of AI to identify not obviously apparent OA features is expected to improve radiologist assessment, as shown by initial studies.

#### TAKE HOME POINTS

1. Additional sonographic techniques can offer valuable complementary information to B-mode imaging of breast lesions.
2. Automated breast ultrasound dissociates image acquisition from its interpretation, making it a valid alternative for supplemental screening.
3. Optoacoustic imaging achieves differentiation of benign from malignant breast lesions, but also has a substantial potential beyond that.
4. Implementation of AI in breast ultrasound and optoacoustic imaging may improve their diagnostic performance.

## Immunotherapy in breast cancer?

**K. Leandersson**

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### **BODY**

Lymphocytes of the adaptive immune system can eradicate tumor cells. However, the tumors counteract the immune system by skewing it towards a silent “tolerant” state. In this state the immune response is suppressed by the tumor but also provoked to induce a wound healing processes that stimulates tumor progression. These mechanisms are mostly mediated by innate immune cells. The local presence of suppressive innate immune cell populations in the primary tumor of breast cancer patients strongly correlates with a decreased survival. The parallel systemic immune response in breast cancer patients is less well characterized. Lately, immune checkpoint inhibitor therapy has revolutionized oncology as a promising treatment for advanced cancer disease. However, breast cancer is one of the cancer diagnoses where this type of therapy is still less successful. Knowledge is still lacking as to why, but it seems clear that type of breast cancer matter for response.

### **TAKE HOME POINTS**

In this presentation, a brief overview of immune responses in breast cancer, and a summary to present and possible future immunotherapy options, will be given.

# Contrast-enhanced Mammography History and State of the Art

J. Lewin

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## BODY

### Introduction

Screening mammography has been shown to reduce breast cancer mortality in randomized clinical trials. It is an effective screening test due to its short exam time, patient convenience and low cost. The sensitivity of mammography for the detection of cancer in screening populations is not perfect, however, ranging as low as 60% in women with extremely dense tissue. Contrast-enhanced breast MRI, on the other hand, has very high sensitivity, approaching 100%. The high sensitivity of MRI is due almost entirely to the use of the contrast agent; non-contrast MRI is not sensitive for cancer detection. The disadvantage of MRI is its relatively high cost.

With the development of digital mammography as a replacement for film mammography in about 2000, work began to develop a technique that would allow digital mammography to be used with intravenous contrast to depict cancers that would otherwise be invisible on standard unenhanced mammography. Those efforts resulted in the development and clinical testing of contrast-enhanced mammography (CEM) using the dual energy subtraction technique. (1) Today CEM is available commercially for clinical use around worldwide.

### Performance of the examination

To perform a CEM examination, an iodinated contrast agent is administered intravenously at about 3ml/s using a power injector. Contrast agents with iodine concentration between 300 mg/ml and 370 mg/ml are typically used. The volume of contrast is similar to that used for a CT scan, approximately 1.5 ml/kg body weight, typically around 90-150 ml. After a delay of at least 90 seconds from the end of the injection, the patient is positioned for standard mammography views of each breast. Rather than a standard mammogram, however, for each projection, the CEM device acquires a pair of images at different x-ray energies. The x-ray energy is varied by adjusting the kVp and changing filters. The low-energy pair is acquired at typical mammogram energy and uses a typical kVp (28-31) and filter (Mo, Rh, Ag) combination. The high energy mammogram is typically obtained at 45-49kVp with a copper filter. Since there is less than 1 second between the low-energy and high energy images, the imaging time is the same as that needed for a standard mammogram. Additional projections may be obtained since optimally enhanced images can typically be obtained up to 7-10 minutes following injection.

Following image acquisition, contrast-enhanced subtraction

images are produced using a weighted logarithmic subtraction of the low energy image from the high energy image. Because the difference in iodine absorption between the images is larger than the difference in tissue absorption, this dual energy subtraction technique has the effect of increasing the visibility of the iodine while almost completely eliminating the visibility of background tissue. The resulting images are sent to a review workstation or PACS for interpretation by the radiologist. The low energy images, which, because the iodine cannot be seen, are identical to standard unenhanced mammograms, are also used in the interpretation.

### Clinical Studies

Most published studies on the performance of CEM were performed in patients with suspicious lesions or known cancers. As would be predicted, studies have shown that CEM is more sensitive for the detection of cancer than is standard unenhanced mammography (2, 3). More interesting are studies comparing CEM to contrast-enhanced MRI. These studies have uniformly shown CEM to have sensitivity similar to MRI. (4, 5) The specificity of CEM in these studies is generally either equivalent or superior to MRI. One study compared CEM, MRI and contrast-enhanced tomosynthesis, an experimental technique in which dual energy tomosynthesis is performed following a contrast injection. The study found no difference among the three techniques in terms of accuracy/ROC analysis but showed all three to be superior to standard mammography and digital breast tomosynthesis. The addition of contrast-enhanced tomosynthesis to CEM did not result in improved accuracy. (6)

With the publication of additional studies it became possible to perform meta-analyses. Two meta-analyses have been published. The first of these, looking at only 8 reported studies, determined that the sensitivity and specificity of CEM were 98% and 58%. (7) The other, larger analysis concluded that CEM has a sensitivity of 89% and a specificity of 84%. (8)

A few studies have looked at CEM for screening, comparing cancer yield to that of standard mammography. The largest of these included 611 intermediate-risk patients. As expected, CEM found many more cancers than mammography with a yield of additional cancers of 13.1/1000. This is similar to MRI screening results. (9)

Additional studies have looked at specific diagnostic applications, such as evaluation of mammographic

abnormalities, evaluation of the symptomatic patient, evaluation of extent of disease in newly diagnosed cancers, and response to neo-adjuvant chemotherapy. (10)

### Clinical Uses for CEM

Based on the results of the studies referenced above, CEM is being used or further studied as a replacement for MRI for most applications. A 2015 study showed that patients prefer CEM to MRI since patients are averse to the noise and claustrophobia associated with breast MRI. (11) Note that, because it uses standard mammographic positioning, CEM is not useful for evaluation of the axilla or chest wall.

One barrier to widespread use of CEM at this time is the inability to perform CEM-guided biopsy. Lesions detected on CEM are generally evaluated using ultrasound. If ultrasound confirms the finding then ultrasound-guided biopsy is performed. A lesion that is not visible on ultrasound but can be reliably identified on mammography may undergo stereotactic biopsy. Otherwise, if the finding is suspicious enough, MRI is performed and the lesion biopsied under MRI guidance. Biopsy systems for CEM have been developed and should be clinically available soon.

### Summary

CEM is a promising technique for showing cancers that are not visible on standard mammography. It is approved for clinical use and is performed on commercial systems. Results of clinical studies show it to have sensitivity and specificity comparable to contrast-enhanced breast MRI. Current and proposed uses include additional evaluation of symptomatic patients or patients with abnormal screening examinations, assessment of newly diagnosed breast cancers, problem solving abnormal mammograms, monitoring of neoadjuvant chemotherapy and high-risk screening.

### TAKE HOME POINTS

1. Contrast-enhanced mammography (CEM) is a technique that utilizes the diagnostic capability of contrast enhancement at a lower cost than contrast-enhanced MRI
2. Multiple studies show that CEM has performance parameters similar to MRI, although there is a trend toward higher sensitivity for MRI, at a cost of more false positives.
3. CEM is now in routine clinical use at sites around the world, but adoption has been slow, due to multiple factors, including financial disincentives

### References

1. Lewin JM, Isaacs PK, Vance V, Larke FJ. Dual-energy contrast-enhanced digital subtraction mammography: feasibility. *Radiology* 2003; 229(1):261-268.
2. Dromain C, Thibault F, Muller S, et al. Dual-energy contrast-enhanced digital mammography: initial clinical results. *Eur Radiol*. 2011; 21(3):565-574.
3. Cheung Y-C, Lin Y-C, Wan Y-L, et al. Diagnostic performance of dual-energy contrast-enhanced subtracted mammography in dense breasts compared to mammography alone: interobserver blind-reading analysis. *Eur Radiol*. 2014; 24(10):2394-2403.
4. Jochelson MS, Dershaw DD, Sung JS, et al. Bilateral contrast-enhanced dual-energy digital mammography: feasibility and comparison with conventional digital mammography and MR imaging in women with known breast carcinoma. *Radiology* 2013; 266(3):743-751.
5. Fallenberg EM, Dromain C, Diekmann F, et al. Contrast-enhanced spectral mammography versus MRI: Initial results in the detection of breast cancer and assessment of tumour size. *Eur Radiol*. 2014; 24:256-64.
6. Chou C-P, Lewin JM, Chiang C-L, et al. Clinical evaluation of contrast-enhanced digital mammography and contrast enhanced tomosynthesis—Comparison to contrast-enhanced breast MRI. *Eur J Radiol*. 2015; 84(12):2501-2508.
7. Tagliafico AS, Bignotti B, Rossi F, et al. Diagnostic performance of contrast-enhanced spectral mammography: Systematic review and meta-analysis. *The Breast*. 2016; 28:13-19.
8. Zhu X, Huang J-M, Zhang K, et al. Diagnostic Value of Contrast-Enhanced Spectral Mammography for Screening Breast Cancer: Systematic Review and Meta-analysis. *Clin Breast Cancer*. 2018; 18(5):e985-e995.
9. Sorin V, Yagil Y, Yosepovich A, et al. Contrast-Enhanced Spectral Mammography in Women with Intermediate Breast Cancer Risk and Dense Breasts. *AJR Am J Roentgenol*. 2018; 211(5):W267-W274.
10. Patel BK, Hilal T, Covington M, et al. Contrast-Enhanced Spectral

*Mammography is Comparable to MRI in the Assessment of Residual Breast Cancer Following Neoadjuvant Systemic Therapy. Ann Surg Oncol. 2018; 25(5):1350-1356.*

11. Hobbs MM, Taylor DB, Buzynski S, Peake RE. Contrast-enhanced spectral mammography (CESM) and contrast enhanced MRI (CEMRI): Patient preferences and tolerance. *J Med Imaging Radiat Oncol.* 2015 Jun; 59(3):300-5.



## What can AI currently do in mammography, US, and MRI?

### L. Moy

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#### **BODY**

There has been an exponential increase in the literature on AI and breast imaging. A similar trajectory is seen with an increase in AI products approved by the U.S. Food and Drug Administration and the EU Conformité Européenne marking devices and software before they can be applied for diagnostic purposes. This talk will summarize the literature on AI and digital mammography, digital tomosynthesis, breast ultrasound, and breast MRI. These papers illustrate the potential of AI to assist with improved cancer detection rate, reduce the abnormal interpretation rate, and reduce the number of follow-up exams and benign biopsies. Another critical issue is whether AI may help reduce the interpretation time of various breast imaging exams.

#### **TAKE HOME POINTS**

AI for mammography is being rapidly implemented in the clinical setting. Standalone AI and triaging of normal exams may be feasible soon.

AI may help decrease false-positive findings for hand-held breast U.S. and automated whole breast ultrasound exams.

AI may assist radiologists in decreasing their interpretation time for breast MRI and reducing its acquisition time.

## Automating decision-making in medical contexts: ethical promises and perils

**S. Nagel**

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### **BODY**

How should we benefit from machine learning applications that support medical personnel in decision-making processes?

New technologies and the use of machine learning algorithms in medicine promise to improve the healthcare system as a whole, and in particular increase the availability and quality of care for patients. Special potential lies in the development and use of support systems of decision-making processes.

I will first address the promised benefits of automated decision-support systems in medicine. I will then highlight three selected, interrelated challenges that focus on ethical questions regarding automated decision-support systems:

- 1) Challenge to autonomy: How do systems influence physicians' autonomy?
- 2) Challenge of epistemic accessibility: How do we handle systems that are (partly) opaque and how does transparency matter?
- 3) Challenge of responsibility attribution: How to approach systems which are no suitable bearer of responsibility? Who can be held responsible?

Due to the scale of the impact these technologies are likely to have on the medical system, it is vital to pre-emptively engage with the ethical and social questions they pose.

## Management of high risk lesions

F. Pediconi, V. Rizzo

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### BODY

B3 lesions, borderline lesions or lesion of uncertain malignant potential is a category mainly consists of breast lesions which may provide benign histology on needle core biopsy, but either are known to show heterogeneity or to have an increased risk (albeit low) of associated malignancy. Among these lesions are: atypical ductal hyperplasia, atypical lobular hyperplasia, lobular carcinoma in situ, papillary lesions, radial sclerosing lesions, fibroepithelial lesions, mucocoele-like lesions and columnar cell lesions. The term high-risk breast lesion is given to a breast lesion that carries an increased risk for the future development of breast cancer or carries suspicion of a more sinister pathology around or in association with the lesion. The term has some overlap with borderline breast disease. Many radiologists recommend excision of these lesions when they are revealed on pathological analysis after a core biopsy. However, to avoid the risk of overtreatment, a methodological approach that also includes the possibility of clinical follow-up and vacuum assisted excision (VAE) should be preferred. Although high-risk lesions have an uncertain malignant behavior in common, each of them represents a different nosological entity, with different morphological, pathological and imaging characteristics and deserve a different diagnostic-therapeutic process. The lecture presented will be an excursus on the main features of the high-risk breast lesions, the radiological and histological diagnosis, the treatments and the most appropriate clinical management according to our latest knowledge.

### TAKE HOME POINTS

- B3 lesions, borderline lesions or lesion of uncertain malignant potential is a category mainly consists of breast lesions which may provide benign histology on needle core biopsy
- Many radiologists recommend excision of these lesions, however a methodological approach includes the possibility of clinical follow-up and vacuum assisted excision (VAE)
- Treatments and clinical management of B3 lesions

## Surveillance (Follow-up) of breast cancer patients

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Utrecht / Nijmegen, Netherlands

### BODY

Surveillance of breast cancer patients is advocated in all guidelines. Mostly in a one-size fits all format, consisting of annual mammography for the duration of 5 years after primary surgery. This all accounts for residual disease or new tumor manifestations in the breast, not for distant disease manifestations. Three Randomized Control Trial showed no survival benefit from intensive screening for asymptomatic metastatic disease. A lack of specificity may lead to more tests and patient anxiety.

We will have to switch from a one-size fits all surveillance with mammography to a model that is also taking into account age of the patient, comorbidity, post-surgical TNM classification, grade of the initial breast tumor and molecular subtype. Although only performance of yearly follow-up mammography is supported by evidence, we have to tailor the modality (DBT, MRI, CEM) for follow-up according to the above mentioned criteria.

### TAKE HOME POINTS

Target surveillance only for loco-regional recurrence / second tumor

No surveillance targeted for asymptomatic distant disease (metastasis)

Tailor modality, duration and frequency for individual patient and tumor characteristics

## OXFORD Debate: This house believes that DWI is ready for integration in clinical practice (Yes)

### K. Pinker-Domenig

Memorial Sloan Kettering Cancer Center, Department of Radiology, New York, United States

#### BODY

Dynamic contrast-enhanced magnetic resonance imaging (DCE-MRI) is the most sensitive test for breast cancer detection with a pooled high sensitivity of 93% but lower but good pooled specificity of 71%. Positive predictive values of MRI-guided biopsies range between 20% and 40%, indicating that still many women undergo invasive procedures for benign breast disease detected at DCE-MRI.

In this context, diffusion-weighted imaging (DWI) has emerged as a valuable imaging technique to complement DCE-MRI, specifically to improve the DWI information has been shown to complement DCE MRI to help distinguish between benign and malignant lesions findings to decrease unnecessary biopsies, predict, and monitor response to and monitor response to neoadjuvant therapy, and stratify ductal carcinoma in situ from invasive disease. There is ongoing research for use of DWI as a component of non-contrast MRI protocols for screening. A recent survey among all European Society of Breast Imaging (EUSOBI) radiologist members to gather representative data regarding the clinical use of breast DWI showed that while report integration of qualitative and quantitative DWI data is not uniform. clinical performance of breast DWI is in good agreement with the current recommendations of the EUSOBI International Breast DWI working group. DWI should be integrated in clinical practice with next necessary step being to provide a standardized reporting system for DWI with ADC mapping that it can be easily and formally integrated into the radiology report similar to BI-RADS.

#### TAKE HOME POINTS

DWI should be integrated in clinical practice with next necessary step being to provide a standardized reporting system for DWI with ADC mapping that it can be easily and formally integrated into the radiology report similar to BI-RADS.

#### References

- [1] Baltzer P, Mann RM, Lima M, Sigmund EE, Clauser P, Gilbert FJ, Martincich L, Partridge SC, Patterson A, Pinker K, Thibault F, Camps-Herrero J, Le Bihan D; EUSOBI international Breast Diffusion-Weighted Imaging working group, (2020), Diffusion-weighted imaging of the breast-a consensus and mission statement from the EUSOBI International Breast Diffusion-Weighted Imaging working group., *European Radiology*, <https://pubmed.ncbi.nlm.nih.gov/31786616/>
- [2] Lo Gullo R, Sevilimedu V, Baltzer P, Le Bihan D, Camps-Herrero J, Clauser P, Gilbert FJ, Lima M, Mann RM, Partridge SC, Patterson A, Sigmund EE, Thakur S, Thibault FE, Martincich L, Pinker K; EUSOBI International Breast Diffusion-Weighted Imaging working group, (2022), A survey by the European Society of Breast Imaging on the implementation of breast diffusion-weighted imaging in clinical practice., *European Radiology*, <https://pubmed.ncbi.nlm.nih.gov/35507050/>

## Imaging of the reconstructed breast

**S. Pérez Rodrigo**

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### **BODY**

The standard treatment of breast cancer is conservative surgery plus radiotherapy (RT), which has shown similar survival rate than mastectomy. However, mastectomy rates have increased recently. Due to all those reasons, reconstructive surgeries have also increased and evolved being necessary for the radiologist to know the types, characteristics, radiologic appearance and complications.

We will review the imaging characteristics of the main types of reconstruction:

#### **1) Heterologous:**

- Implant based reconstruction
- Injection of different substances

#### **2) Autologous**

- Flap reconstruction
- Lipofilling

Last but not least it is important to keep in mind that even despite a mastectomy there is possibility of recurrence and it is mandatory to know differentiating it from postsurgical or post reconstructive changes.

### **TAKE HOME POINTS**

- To be familiarized with the different types of breast reconstructions
- To know the main characteristic of each reconstructive technique
- To identify the normal appearance of the operated and the reconstructed breast
- To identify the possible complications of the implants, flaps and lipofilling
- To know that even despite a mastectomy, the recurrence is possible, so it is essential to differentiate one from the other

# Multi-parametric Breast Ultrasound Imaging as a potential Biomarker for Breast Cancer

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## BODY

### Introduction and background of the study:

Patients with a palpable mass in the breast or suspicious findings in mammography typically undergo breast ultrasound (BUS) examination as a supplemental imaging modality. Findings are then used for tumor classification according to the American College of Radiology (ACR) BI-RADS lexicon. Suspicious findings undergo later an ultrasound-guided biopsy, which might cause discomfort for the patient, might introduce emotional stress, and may involve – albeit quite low - risk of complications (such as bleeding and infections). Nowadays conventional BUS B-mode images do not have the specificity to reliably differentiate between malignant and benign lesions and hence a biopsy intervention or close follow-up is necessitated in indeterminate lesions. Multi-parametric imaging biomarkers such as the novel method of speed-of-sound (SoS) imaging may provide additional indicators to help with lesions' classification prior to biopsy and avoid any further work-up.

Previous studies[1] have already shown a correlation between an increase of speed-of-sound and ultrasound signal attenuation in cancerous tissues. Several methods have been proposed to measure these properties by means of transverse and reflective ultrasound, which all use custom, complex, bulky, and expensive hardware limiting their widespread use in the clinics and in the typical BUS workflow.

The proposed novel method used in this study does not need any custom hardware. It uses a standard ultrasound system and works using a specialized signal processing algorithm which allows to extract the desired bio-mechanical properties out of the standard ultrasound echo signal.

### Primary objective:

The objective of the study is to collect data from breast lesions in the clinical routine setting and then to correlate the findings of the localized and quantified multi-parametric imaging markers with the reference standard methods. For breast tissue classified as BI-RADS IV and above the reference standard is the ultrasound guided breast biopsy (BUS-bx). Patients with BI-RADS III may undergo biopsy in selected cases (otherwise, watchful waiting). For BI-RADS I and II, the diagnosis is made by the clinician based on BUS only.

### Materials and Methods:

The study collects data with a standard ultrasound device during normal BUS examination, which are then retrospectively processed to extract the desired multi-parametric BUS (mp-

BUS) information of imaged tissue. In a first step speed-of-sound is considered as biomarker and is briefly described here: The standard B-mode imaging sequence is interleaved with a set of specific transmit sequences, dedicated to illuminate the tissue from different angles. By comparing the echoes from several combinations of two angles, relative delays in the echo signal between the two reception frames can be found. This process is called displacement tracking.

These relative delays originate from the different local speed-of-sound properties of the tissue along the two transmission paths. In a limited-angle tomographic reconstruction a set of local speed-of-sound values along all different paths can be found and thus a map of the speed-of-sound distribution inside the illuminated tissue results.

The SoS-method allows to find the tissue average speed-of-sound of the lesion neighborhood as well as the lesion specific speed-of-sound. The contrast between those values is then compared with the ground truth diagnostics established during the standard BUS examination.

### Results:

100 patients who have undergone a BUS examination (between 21 and 83 years of age). For fifty of them the diagnosis is based on a biopsy supported analysis of lesion tissue, for the other fifty the diagnosis is based on an expert consensus. The lesions have been classified into four groups of lesions (Fibroadenoma, Cyst, breast cancer and others).

### Conclusion:

Preliminary results show that tissue speed-of-sound changes where the lesion area is located and that the amount of change depends upon the lesion type. The statistical evaluation of more than 600 different data sets is still on-going. More details will be available during the talk.

### TAKE HOME POINTS

- Multi-parametric breast ultrasound imaging is a promising method to complement the standard ultrasound modalities such as echo- or Doppler mode.

Our study results have demonstrated that:

- The proposed SoS-imaging method allows to localize tissue areas with modified speed of sound compared to the values in the lesion's neighborhood.
- The SoS increase varies between lesion types which opens the possibility to classify the lesions according to their malignancy.

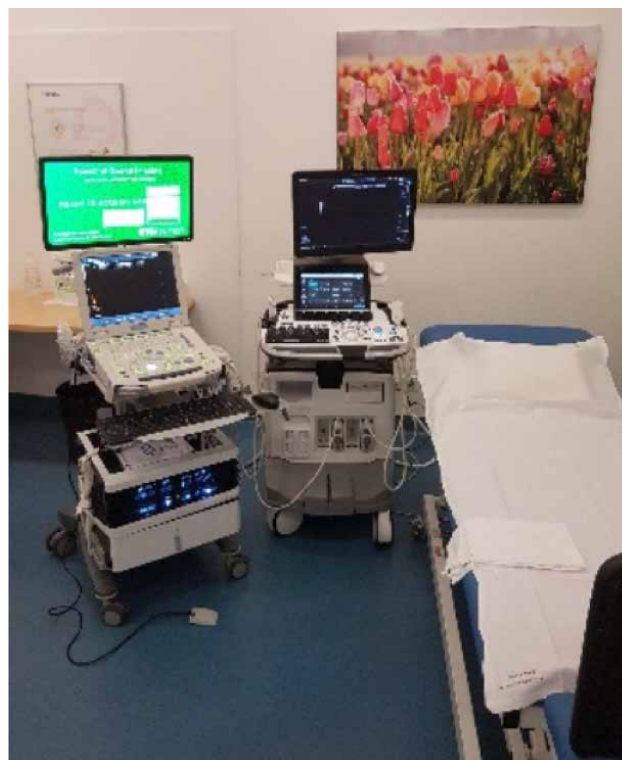


## Multi-parametric Breast Ultrasound Imaging as a potential Biomarker for Breast Cancer

- The method allows to find an average speed-of-sound of tissue without lesions or in their neighborhood. This allows to quantify the SoS change as an SoS-contrast which can therefore be used as tissue biomarker.

### References

- [1] Sergio J Sanabria, Orcun Goksel, Katharina Martini, Serafino Forte, Thomas Frauenfelder, Rahel A Kubik-Huch, Marga B Rominger, (2018), Breast-density assessment with hand-held ultrasound: A novel biomarker to assess breast cancer risk and to tailor screening?, *European Radiology*





## Clinical Implementation of DWI for Breast Imaging

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### **BODY**

Diffusion weighted MR imaging (DWI) is a quick non-contrast MRI technique that has been shown to provide value in a wide range of organ systems. DWI probes water diffusivity within tissue, which is impacted by cellularity, tissue microstructure, and other factors. For breast imaging applications, DWI has been studied extensively over the past two decades. This has generated robust data indicating that breast cancers exhibit greater levels of restricted diffusion when compared to benign lesions. This is particularly true of invasive cancers when compared to pre-invasive ductal carcinoma in situ (DCIS) lesions. This observation has led to DWI being proposed as a supplemental MRI technique to conventional or abbreviated MRI that improves specificity and decreases unnecessary biopsies, as a stand-alone non-contrast screening tool, and as a biomarker that can be used to predict which cancers will achieve complete pathological response after neoadjuvant chemotherapy.

Leveraging the value of breast DWI to improve clinical care has proven more challenging than the generation of data supporting its potential value. This is due to multiple factors, including image quality issues inherent to its echo planar imaging acquisition, lack of standardization of imaging protocols (e.g., inconsistent sensitization (b) values across studies) resulting in a wide range of apparent diffusion coefficient (ADC) values being proposed to be used to reduce unnecessary biopsies, wide ranges in patient populations studied, and a lack of prospective validation of data generated from retrospective studies.

Fortunately, influential organizations are heeding the call to prioritize research on breast DWI in ways that will expedite clinical translation. The European Society of Breast Imaging (EUSOBI) created an International Breast DWI Working Group that produced an influential consensus statement in 2019 outlining minimum breast DWI requirements. This is analogous to steps taken by the American College of Radiology (ACR) to ensure quality across many sites for the use of breast DCE MRI in the United States when DCE-MRI was being implemented into clinical practice. The ECOG-ACRIN research group sponsored a prospective multicenter study (A6702) using a consistent imaging approach to publish benchmark ADC values that can be used for clinical interpretation while also highlighting persistent technical challenges. The RSNA Quantitative Imaging Biomarkers Alliance (QIBA) has also recently put forth their diffusion MRI profile, which establishes guidelines to ensure reproducibility and precision of ADC as a quantitative imaging biomarker. Finally, the next edition (6th)

ACR BI-RADS atlas is anticipated to include DWI for the first time in its clinical manual.

There is still much work to be done for DWI to be fully implemented in clinical practice. Validation of ADC measures in real world prospective clinical environment are needed. Quality prospective clinical trials are needed to determine whether DWI can be used as a standalone imaging technique to screen women for breast cancer and to determine which populations it will best serve. Finally, industry needs to continue to partner to make DWI acquisition less technically challenging and decrease distortions on images that make some radiologists resistant to implementing this technique. With improved focus on clinical implementation, the scientific community is poised to intelligently incorporate DWI into breast MRI approaches to improve breast cancer detection and characterization.

### **TAKE HOME POINTS**

Data supporting the implementation of diffusion weighted imaging (DWI) for breast applications has grown substantially over the past two decades.

Primary uses of DWI center on its use to improve conventional contrast-based MRI specificity, as a standalone tool for screening, and as a biomarker of disease particularly in the neoadjuvant chemotherapy setting.

Despite robust data, actual implementation has been hampered by technical limitations, poor standardization in acquisition, lack of prospective data from robust clinical trials, and a lack of consensus on how to use DWI.

Future work should emphasize addressing these challenges so that routine clinical use of DWI of the breast can become a reality.

## CESM - Indications

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### **BODY**

Contrast-enhanced mammography (CEM) is increasingly being used in breast diagnostic work up as it offers greater sensitivity, specificity and negative predictive value compared with digital mammography.

The indications for this tool, already considered to be part of the breast pathology assessment battery, can be divided into diagnostic, and screening settings.

CEM can be incorporated into the workflow of breast clinics during the work up of inconclusive findings from initial mammography or ultrasound.

CEM can be used during one-stop-clinic pathways for the assessment of suspicious breast symptoms.

In cancer staging, CEM could be useful when MRI is not available or there are contraindications. It should also be considered for elderly patients, who will find the procedure less time consuming and more comfortable.

Contrast mammography is increasingly being used as an alternative to MRI in the evaluation of response to neoadjuvant treatment, and potentially identifying "not responders" following the first or second cycle of chemotherapy.

When following up patients with a history of breast cancer, looking for residual or recurrent disease, CEM could replace digital mammography thanks to offering a more accurate morpho-functional evaluation.

CEM can also be used instead of magnetic resonance in intermedial-risk screening, or high-risk screening when there are contra-indications for MRI.

We are sharing our experience with CEM at Vall d'Hebron University Hospital, a large breast cancer assessment center in Barcelona, Spain.

### **TAKE HOME POINTS**

CEM is a valuable diagnostic tool in breast assessment in many settings, often offering significant advantages over digital mammography and MRI.

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### BODY

The European Commission Initiative on Breast Cancer (ECIBC) was launched in 2014 with the aim of “improving quality of care and reducing inequalities in Europe” in all the fields of breast cancer care, from screening and diagnosis to therapy, follow-up, palliative and survivorship. Six principles were applied: selection of expert panels through public open calls; systematic review of evidence; women advocates as full voting members of the panels; transparency of conflicts of interest; use of GRADE methodology<sup>1</sup> to determine evidence frameworks; recommendations on outcomes relevant to women and rating of the certainty of evidence; stakeholder feedback. Two working groups were established: (1) The Guidelines Development Group (GDG) for the European guidelines on breast cancer screening and diagnosis; and (2) The Quality Assurance Scheme Development Group (QASDG) for the European quality assurance scheme for breast cancer services.

Regarding breast cancer screening for average-risk women, methods for guidelines development were described in [1] and the following recommendations were issued for the context of organized screening mammography programs [2]:

1. women aged 40-44: no screening vs. screening (conditional recommendation [CR], moderate certainty of evidence [CoE]);
2. women aged 45-49: screening vs. no screening (CR, moderate CoE), every 2 or 3 years versus every year (CR, very low CoE);
3. women aged 50-69: screening vs. no screening (strong recommendation [SR], moderate CoE); screening every 2 years vs. every year (SR, very low CoE); screening every 2 years vs. every 3 years (CR, very low CoE);
4. women aged 70-74: screening vs. no screening (CR, moderate CoE); screening every 3 years vs. every 2 years (CR, very low CoE); screening every 3 years vs. every year (SR, very low CoE).

The use of either digital mammography (DM) or digital breast tomosynthesis (DBT) is allowed (CR, very low CoE); the use of both DBT and digital mammography is not suggested (CR, very low CoE). These recommendations were updated considering available evidence until April 15, 2021.

In women with high mammographic breast density detected in previous screening exams, DBT is suggested vs. DM, while screening with MRI or with automated/manual ultrasound is not suggested (CR, very low CoE, for all). These recommendations

were updated considering available evidence until August 3, 2021).

Regarding screening invitation, a letter followed by an SMS notification or an automated phone call is suggested. If these strategies are not available, either an e-mail or an automated phone call alone are suggested. For informing women about the benefits and harms of participating in an organized breast cancer screening program, using numbers (SR, moderate CoE) or infographics (CR, low CoE) in addition to plain language is suggested. A targeted communication strategy over a general communication strategy to improve participation in breast cancer screening programs of non-native speaking women between the ages of 50 and 69 is suggested (CR, low CoE).

About reading mammograms, the following are suggested: double reading, with consensus or arbitration for discordant readings (CR, moderate CoE); mammography readers should read between 3,500 and 11,000 mammograms annually (CR, very low CoE)

Important to note: (i) giving a recommendation the judgment “strong” means that the panel is confident that the desirable effects of adherence to the recommendation outweigh the undesirable effect; (ii) giving a recommendation the judgment “conditional” means that the panel concluded that the desirable effects of adherence to a recommendation probably outweigh the undesirable effect, but new evidence may result in changing the balance of risk to benefit or the benefits may not warrant the cost or resource requirements in all settings. Regarding the possibility that new evidence may lead to change recommendations, consider that a fundamental characteristic of ECIBC is the continuous updating of the guidelines that are freely available on the ECIBC website (<https://healthcare-quality.jrc.ec.europa.eu/ecibc>).

### TAKE HOME POINTS

- ECIBC guidelines regarding breast cancer screening for average-risk women in the context of organized screening programs:
  - no screening for women aged 40-44;
  - screening every 2 or 3 years for women aged 45-49;
  - screening every 2 years for women aged 50-69;
  - screening every 3 years for women aged 70-74;
  - the use of either DM or DBT is allowed;
  - for women with high breast density, DBT is suggested instead of DM.

ECIBC guidelines are continuously updated and freely available on the ECIBC website (<https://healthcare-quality.jrc.ec.europa.eu/ecibc>).

### References

1. Guyatt GH, Oxman AD, Vist GE, GRADE Working Group, et al. *BMJ* 2008. doi: 10.1080/07853890.2022.2098376
2. Schünemann HJ, Lerda D, Dimitrova N, et al. *Ann Intern Med* 2019. doi: 10.7326/M18-3445.
3. Schünemann HJ, Lerda D, Quinn C, et al. *Ann Intern Med* 2020 doi: 10.7326/M19-2125.

## Relationship between Japanese radiology and breast imaging

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#### **BODY**

The prevalence of breast cancer in Japan is approximately one-half compared to the Western countries; however, it is the highest among all Japanese women's cancers and continues to increase. Breast imaging has developed along with radiology in Japan, playing an important role in breast cancer screening, diagnosis, and treatment decision-making. Several academic societies are affiliated with diagnostic breast imaging in Japan, including the Japanese Society of Breast Cancer Imaging and the Japan Radiological Society. Many radiologists belong to these societies and are engaged in activities including research, education, and quality control of clinical examinations, and diagnosis for improvement in breast imaging. Japan has the largest number of CT and MRI scanners per population in the world, but the total number of diagnostic radiologists per population is small. Therefore, many radiologists routinely diagnose images related to breast cancer, regardless of their organ subspecialty. Since most MRI scanners are installed in large hospitals, breast MRI examinations are performed mainly for the purpose of preoperative staging in known breast cancer and the monitoring of the effect of chemotherapy, while it is also being initiated for high-risk screening. A multi-parametric breast MRI protocol including DCE-MRI, T2WI and DWI has been introduced in routine practice; lately, some facilities also use an ultrafast MRI. On the other hand, one of the characteristics of breast imaging in Japan is that we are always trying to acquire high-resolution and high-quality images that can be compared with pathological specimens. In addition, there may be some diagnostic breast imaging unique to Japanese radiology.

#### **TAKE HOME POINTS**

Here, I would like to present and introduce the current state of diagnostic breast imaging in Japan, that have evolved with Japanese radiology.

## Novel developments in x-ray imaging

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#### BODY

The last 20 years have been an exciting time in x-ray-based breast imaging. The introduction of digital detectors opened the flood gates of technology development: digital mammography, stereoscopic mammography, digital breast tomosynthesis, contrast-enhanced digital mammography, dedicated breast CT, among some other initiatives. Most of these advances have been directed at moving away from the planar mammogram to an image that provides at least some depth resolution to improve detection performance.

However, the next 20 years promise to be even more exciting. Detectors are getting faster and better, and, especially important, computing power and deep-learning-based algorithms are advancing in leaps and bounds. Although these advances may usher in the acquisition of images at lower doses and perhaps higher spatial resolutions, other more impactful breakthroughs could result from these new technologies. The combination of cutting-edge hardware and software algorithms will bring in the era of x-ray-based functional breast imaging, making this imaging modality a key asset in all aspects of the breast cancer care chain.

We will review the state-of-the-art technologies in x-ray breast imaging, the advances that are just over the horizon, and the most exciting long-term breakthroughs that hold the promise to revolutionize breast cancer care. (yes, indeed, with the plain old x ray!)

#### TAKE HOME POINTS

- The introduction of digital detector technology allowed for the subsequent development of many new techniques in x-ray breast imaging.
- We are in the midst of a transition from planar imaging to various forms of tomographic imaging.
- In addition to the consolidation of 3D imaging with x-rays, the next great step forward will result in going beyond simple anatomic imaging of the breast.
- X-ray breast imaging will have a crucial role throughout breast cancer care.

## Supplemental ultrasound

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#### BODY

Adjunct ultrasound has proven useful in groups of women where mammography-based screening is not sufficient due to the breast tissue density. Ultrasound has been used for many years as a method which is cheap, easy and accessible in all parts of the world. Breast ultrasound adjunct to mammography in screening is associated with increased cancer detection rate in comparison to mammography alone but it also brings additional biopsies, follow-ups and associated costs.

In the era of the new EUSOBI recommendation for MRI as an adjunct method to mammography in women with dense breast, the role of ultrasound might be questioned.

However due to its availability, low cost, and high comfort for the patients breast ultrasound will probably still play an important role in many women. These groups include women with contraindications or unwilling to undergo MRI and/or in regions with low availability of MRI and MRI guided procedures. There is still much space for further investigation about how to improve accuracy of breast ultrasound and clinical outcomes. New methods like AI might be helpful to improve ultrasound performance and there might be some tools already applicable such as imaging workflow and patient management.

#### TAKE HOME POINTS

- Supplemental ultrasound detects more cancers in women with dense breasts than mammography alone
- It is accompanied with increased costs and false positives
- Adjunct ultrasound remains vital for women who are not eligible for MRI
- There are still ways to improve ultrasound performance and outcomes

## What does AI actually mean?

### F. Strand

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#### **BODY**

AI commonly refers to mathematical models called deep neural networks. Many retrospective studies have shown great promise for AI in screening mammography and DBT.

In this session you will learn alternative implementations of AI in the screening workflow and what are the likely consequences for the radiology department.



## What the breast radiologist should know about intrinsic molecular subtypes in breast cancer

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### **BODY**

Since the discovery of the five intrinsic molecular breast tumor subtypes in 2000, their clinical impact and usefulness has been proven in numerous studies, and they are today the foundations of the major molecular classification scheme in breast cancer. Despite this delineation, breast tumors are intra-tumor heterogeneous, adding complexity to a classification system. Much knowledge has been gathered on the biology of the intrinsic subtypes over the last 20 years, including of an additional subtype, the claudin-low subtype, and their relevance also in pre-invasive breast lesions.

### **TAKE HOME POINTS**

The presentation will cover the basic biology of the breast cancer subtypes, how they have been translated into the Prosigna assay, and how they might carry additional information about rate of progression and risk for recurrence.

## Current situation and outlook for next generation breast cancer screening in Japan

### T. Uematsu

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#### BODY

Breast cancer is the third common incident cancer with estimated 2.0 million incident cases all over the world. For women, breast cancer is the most common incident cancer and the most common cause of cancer deaths in many countries. The incidence rates are high in Western countries/developed regions and low in most of Eastern countries/developing regions. In many developed countries, the incidence rate has already decreased. Japan is one of developed countries, but the incidence rate has been still increasing. The lifetime probability of developing breast cancer is one out of 9 women in Japan now. In addition, the mortality in Japan has been still increasing. Why? I will explain them in my lecture. About 6 years ago, Japanese mass media made a fuss that mammography may miss some cancers in women with dense breasts and women should know their breast density. As a result, dense breast issues become a hot topic in Japan. Then, Ministry of Health, Labour and Welfare, JAPAN and some major medical societies related to screening mammography organized a special task force for handling the breast density issues. I will tell you the statement and measure in my lecture. Finally, I will talk about an outlook for next generation breast cancer screening in Japan based on the concept of risk-stratified breast cancer screening programs and objective viewpoints and data of the J-START (The Japan Strategic Anti-cancer Randomized Trial) results.

#### TAKE HOME POINTS

1. Current situation of breast cancer and screening programs in Japan
2. Action on breast density issues regarding screening mammography in Japan
3. Outlook for next generation breast cancer screening programs in Japan

#### References

1. Uematsu T. The need for supplemental breast cancer screening modalities: a perspective of population-based breast cancer screening programs in Japan. *Breast Cancer* 24, 26–31 (2017).
2. Uematsu T. et al. Do you know how to get the J-START quality assurance guideline? *Breast Cancer* 25, 375–376 (2018).
3. Uematsu T. Sensitivity and specificity of screening mammography without clinical breast examination among Japanese women aged 40–49 years: analysis of data from the J-START results. *Breast Cancer* doi: 10.1007/s12282-022-01353-1. Online ahead of print. (2022).

## Triaging women from MRI to mammography to adapt screening to changes in breast density using artificial intelligence

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### BODY

#### Purpose

Magnetic resonance imaging (MRI) is effective to screen women with extremely dense breasts, but it is more resource intensive than mammography. Breast density decreases with age, but density on MRI is not identical to mammographic density, raising the question when to return women to conventional mammography screening in future MRI-only screening setting. This study assesses the feasibility of artificial intelligence (AI) to triage women from MRI-screening back to mammographic screening when appropriate.

#### Materials and Methods

Women with extremely dense breasts in the multi-institutional DENSE trial received mammography and MRI in biennial screening rounds. We trained a regression convolutional neural network (CNN) to predict the mammographic density percentage (VolparaDensity version 1.5) from MRI only.

We used data from the first two screening rounds to train the CNN. Input were precontrast 3D T1-weighted MRI, output was mammographic density percentage. Data were split in train (60%), validation (20%), and hold-out test (20%) set on participant level.

Correlation between AI-predicted mammographic density based on MRI and actual mammographic density was assessed using Spearman's .

Triaging from MRI to mammographic screening was assessed in the hold-out test set of the second screening round. Triaging was defined 'correct' when VolparaDensity and AI agreed on a density <15.5% for both breasts. We registered how often the AI correctly triaged these women at 95% specificity.

#### Results

4300 MRIs from 2867 women were included. Median mammographic density (interquartile range) was 19% (17%-22%) in the first round and 18% (15%-21%) in the second round. In the test set (N=860), correlation between AI-predicted mammographic density and VolparaDensity was =0.76 (P<0.001). In the test set of the second round (N=380), mammographic density of both breasts decreased to <15.5% in 69/380 (18%) women. The AI correctly identified this decrease in 40/69 (58%) women.

#### Conclusion

AI shows potential to correctly triage more than half the number of women with decreased breast density from MRI-only screening back to mammographic screening at high specificity.

#### TAKE HOME POINTS

AI-based triaging of women with extremely dense breasts from MRI-only screening back to mammography screening is feasible, enabling radiologists to reduce workload and re-allocate resources.

## Axillary staging

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### BODY

Axillary lymph node staging at breast cancer diagnosis mainly consists of axillary ultrasound (US). In clinically node negative (cN0) patients treated with breast-conserving surgery, the landmark study ACOSOG Z0011 trial demonstrated no prognostic benefit if patients underwent completion axillary lymph node dissection versus no further treatment after presence of lymph node metastases at sentinel lymph node biopsy (SLNB) [1]. Consequently, one can argue whether SLNB can be completely omitted in these patients (ongoing SOUND, INSEMA and BOOG 2013-08 trials) [2]. Axillary lymph node staging has become more and more difficult over the last few years, due to the occurrence of axillary lymphadenopathy after COVID-19 vaccination [3]. Accurate axillary lymph node strategies to differentiate between malignant lymph nodes and lymphadenopathy after COVID-19 vaccination are therefore warranted.

In the case of clinically node positive (cN+) patients, several imaging techniques are currently available to determine the number of suspicious axillary lymph nodes (axillary US, MRI, 18F-FDG PET CT/MRI) [4]. cN+ patients are currently treated with neoadjuvant systemic therapy (NST) if possible. As a consequence, cN+ patients might achieve axillary complete pathological response (pCR) after NST. The number of suspicious axillary lymph nodes prior to start of NST has many therapeutic consequences. Recently, many studies have been performed to either improve the imaging techniques, like 18F-FDG PET/CT to determine the number of suspicious axillary lymph nodes [5], or studies investigating a less invasive surgical procedure when compared to ALND to accurately assess whether a patient achieved axillary pCR or not [6].

### TAKE HOME POINTS

In clinically node negative patients, axillary lymph node staging is becoming more and more relevant because of novel surgical developments to omit any axillary surgical procedure.

In clinically node positive patients, the total number of suspicious lymph nodes based on imaging prior to start of neoadjuvant systemic therapy is of importance to determine treatment plan.

### References

- [1] Giuliano AE, Ballman KV, McCall L, Beitsch PD, Brennan MB, Kelemen PR, Ollila DW, Hansen NM, Whitworth PW, Blumencranz PW, Leith AM, Saha S, Hunt KK, Morrow M, (2017), Effect of axillary dissection vs no axillary dissection on 10-year overall survival among women with invasive breast cancer and sentinel node metastasis: the ACOSOG Z0011 (Alliance) randomized clinical trial, *JAMA*, 318(1): 918-926, 2017-09-12
- [2] Reimer T, Engel J, Schmidt M, Offersen BV, Smidt ML, Gentilini OD, (2018), Is axillary sentinel lymph node biopsy required in patients who undergo primary breast surgery?, *Breast care (Basel)*, 13(5): 324-330, 2018-10-01
- [3] van Nijnatten TJA, Jochelson MS, Lobbes MBI, (2022), Axillary lymph node characteristics in breast cancer patients versus post-COVID-19 vaccination: overview of current evidence per imaging modality, *Eur J Radiol*, 152:110334, 2022-07-01
- [4] Samiei S, de Mooij CM, Lobbes MBI, Keymeulen KBMI, van Nijnatten TJA, Smidt ML, (2021), Diagnostic performance of noninvasive imaging for assessment of axillary response after neoadjuvant systemic therapy in clinically node-positive breast cancer: a systematic review and meta-analysis, *Ann Surg*, 273(4):694-700, 2021-04-01
- [5] van Loevezijn AA, van der Noordaa MEM, Stokkel MPM, van Werkhoven ED, Groen EJ, Loo CE, Elkhuizen PHM, Sonke GS, Russell NS, van Duijnhoven FH, Vrancken Peeters MJTFD, (2022), Three-year follow-up of de-escalated axillary treatment after neoadjuvant systemic therapy in clinically node-positive breast cancer: the MARI-protocol, *Breast Cancer Res Treat*, 193(1):37-48, 2022-05-01
- [6] Simons JM, van Nijnatten TJA, van der Pol CC, Luiten EJT, Koppert LB, Smidt ML, (2019), Diagnostic accuracy of different surgical procedures for axillary staging after neoadjuvant systemic therapy in node-positive breast cancer: a systematic review and meta-analysis, *Ann Surg*, 269(3):432-442, 2019-03-01

## Improved axillary treatment strategies according to ultrasound, MRI and 18F-FDG PET findings

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### BODY

Axillary lymph node staging at breast cancer diagnosis based on imaging findings is of utmost importance to differentiate between clinically node negative (cN0) and clinically node positive (cN+) patients. In cN0 patients, there is ongoing debate regarding the difference between axillary treatment strategy depending on surgical treatment of the breast. In the case of breast conserving-surgery surgery, complete omission of axillary treatment is suggested by several ongoing trials. On the other hand, in cN0 patients treated with mastectomy the result of sentinel lymph node biopsy (SLNB) after neoadjuvant systemic therapy (if applicable) determines postmastectomy radiation therapy implications [1].

Once standard breast MRI is performed, axillary ultrasound is only required in the case of suspicious lymph node findings on standard breast MRI [2]. Evaluation of these axillary lymph nodes on MRI does not require dedicated axillary MRI protocols when compared to standard breast MRI, once standard breast MRI includes a complete field of view of the axillary region [3]. In addition, dedicated axillary MRI-based radiomics with node-by-node analysis did not contribute to the prediction of axillary lymph node metastasis in a cohort of 75 patients with 511 axillary lymph nodes [4].

Baseline 18F-FDG PET/CT can be indicated to rule out distant metastases in patients with locally advanced breast cancer. In patients without distant metastases after 18F-FDG PET/CT, neoadjuvant systematic therapy following surgery is indicated. The prediction of axillary response in cN+ patients after neoadjuvant systemic therapy can be performed with baseline 18F-FDG PET/CT, especially in HER2-positive and triple negative patients [5].

A previous study suggested an improved diagnostic performance of axillary lymph node staging once a dedicated axillary 18F-FDG PET/MRI protocol was added to the diagnostic work-up in a small group of cN+ patients [6]. Next, a currently ongoing multicenter study will determine whether dedicated axillary 18F-FDG PET/MRI also improves further differentiation between patients with and without lymph node metastases at SLNB in an anticipated cohort of 125 cN0 patients (NCT03374826).

### TAKE HOME POINTS

Axillary lymph node staging is an emerging topic with many ongoing trials exploring different axillary treatment strategies. Axillary ultrasound should be considered the first imaging modality for axillary lymph node staging, yet several other imaging modalities are currently investigated to improve its diagnostic accuracy and consequently the clinical consequences.

### References

- [1] Samiei S, van Kaathoven BN, Boersma L, Granzier RWY, Siesling S, Engelen SME, de Munck L, van Kuijk SMJ, van der Hulst RRJW, Lobbes MBI, Smidt ML, van Nijnatten TJA, (2019), Risk of positive sentinel lymph node after neoadjuvant systemic therapy in clinically node-negative breast cancer: implications for post mastectomy radiation therapy and immediate breast reconstruction, *Ann Surg Oncol*, 26(12):3902-3909, 2019-11-01
- [2] Van Nijnatten TJA, Ploumen EH, Schipper RJ, Goorts B, Andriessen EH, Vanwetswinkel S, Schavemaker M, Nelemans P, de Vries B, Beets-Tan RGH, Smidt ML, Lobbes MBI, (2016), Routine use of standard breast MRI compared to axillary ultrasound for differentiating between no, limited and advanced axillary nodal disease in newly diagnosed breast cancer patients, *Eur J Radiol*, 85(12):2288-2294, 2016-12-01
- [3] Samiei S, Smidt ML, Vanwetswinkel S, Engelen SME, Schipper RJ, Lobbes MBI, van Nijnatten TJA, (2020), Diagnostic performance of standard breast MRI compared to dedicated axillary MRI for assessment of node-negative and node-positive breast cancer, *Eur Radiol*, 30(8):4212-4222, 2020-08-01
- [4] Samiei S, Granzier RWY, Ibrahim A, Primakov S, Lobbes MBI, Beets-Tan RGH, van Nijnatten TJA, Engelen SME, Woodruff HC, Smidt ML, (2021), Dedicated axillary MRI-based radiomics analysis for the prediction of axillary lymph node metastasis in breast cancer, *Cancers (Basel)*, 2021-02-01
- [5] De Mooij CM, Mitea C, Mottaghy FM, Smidt ML, van Nijnatten TJA, (2021), Value of 18F-FDG PET/CT for predicting axillary pathologic complete response following neoadjuvant systemic therapy in breast cancer patients: emphasis on breast cancer subtype, *EJNMMI Res*, 11(1):116, 2021-11-22
- [6] Van Nijnatten TJA, Goorts B, Vöö S, de Boer M, Kooreman LFS, Heuts EM, Wildberger JE, Mottaghy FM, Lobbes MBI, Smidt ML, (2018), *Eur J Nucl Med Mol Imaging*, 45(2):179-186, 2018-02-01

## What influences cost-effectiveness of screening strategies?

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### BODY

#### Purpose

To evaluate the cost-effectiveness of several breast cancer screening strategies, varying in screening ages, intervals and screening modality, targeted based on risk and breast density.

#### Methods

Using the Microsimulation Screening Analysis-Breast (MISCAN-Breast) model, the cost-effectiveness of various screening scenarios was estimated. The number of quality adjusted life years (QALYs) gained and additional net costs (in €) were predicted (3.5% discounted) and incremental cost-effectiveness ratios (ICERs) were calculated to compare screening scenarios. Firstly, for the overall (average-risk) Dutch female population, 920 breast cancer screening strategies with varying starting ages (40-60), stopping ages (64-84) and intervals (1-4 years) were simulated [1]. Subsequently, optimal strategies for women at relatively high (relative risk [RR] 1.8) and low risk (RR 0.75) were assessed [2], and the cost-effectiveness of screening with MRI for women with extremely dense breasts was evaluated [3].

#### Results

Using a willingness-to-pay threshold of €20 000/QALY gained, for average-risk women biennial screening between ages 40 to 76 years was found to be optimal. However, this strategy resulted in more overdiagnoses and false positives, and required a higher screening capacity than the current strategy in the Netherlands (biennial screening from 50 to 74 years). Triennial screening in the age range 44 to 71 (ICER 9,364) or 44 to 74 (ICER 11,144) resulted in slightly more QALYs gained and lower costs than the current Dutch strategy. Furthermore, these strategies were estimated to require a lower screening capacity [1]. For women at relatively low-risk, optimal screening consisted of a longer interval and lower stopping age than current screening, and for women at relatively high-risk lower starting age was found to be optimal [2]. For women with extremely dense breasts, MRI screening with a 4-year interval was found to be cost-effective (ICER 15,620) [3]. Preliminary results indicate that at the population level, benefits can increase substantially, while reducing costs when using a more personalized approach rather than the current age-based approach.

#### Conclusion

Taken together, these findings indicate that breast cancer screening is cost-effective, and can be optimized by targeting screening scenarios (i.e., varying screening ages, intervals and modalities) using density and risk.

### TAKE HOME POINTS

- Breast cancer screening can be optimized by using more personalized strategies, taking into account risk and breast density
- Optimal screening consists of less intense screening for low-risk women and more intense screening for high risk women
- For women with extremely dense breasts screening with MRI can be cost-effective

#### References

- [1] Kregting, L. M., Sankatsing, V. D., Heijnsdijk, E. A., de Koning, H. J., & van Ravesteyn, N. T., (2022), Finding the optimal mammography screening strategy: A cost-effectiveness analysis of 920 modelled strategies., *International Journal of Cancer*
- [2] Sankatsing, V. D., van Ravesteyn, N. T., Heijnsdijk, E. A., Broeders, M. J., & de Koning, H. J., (2020), Risk stratification in breast cancer screening: cost-effectiveness and harm-benefit ratios for low-risk and high-risk women., *International Journal of Cancer*
- [3] Geuzinge, H. A., Bakker, M. F., Heijnsdijk, E. A., van Ravesteyn, N. T., Veldhuis, W. B., Pijnappel, R. M., ... & DENISE trial study group, (2021), Cost-effectiveness of magnetic resonance imaging screening for women with extremely dense breast tissue., *JNCI: Journal of the National Cancer Institute*

## This house believes that women can make an informed choice on screening methods

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##### Facts about breast cancer screening methods:

Mammography is a perfect tool in saving women's lives through early detection of small cancers, reaching a sensitivity up to the level of 90% in women with fatty breasts. Mammography is not equally beneficial to all women.

30% of cancers will be missed in women with heterogeneous dense tissue and as 40% in women with extremely dense breasts due to masking effect, in which non-calcified carcinomas may be undetected, leading to an increase in the interval cancer rates.

Interval cancers are associated with larger tumor size and greater likelihood of positive nodes at time of diagnosis.

Increased breast density is an independent risk factor for breast cancer and the denser the breast, the greater the risk. Tomosynthesis (DBT) reduces the recall rate by unmasking the impact of superimposed breast tissue.

The performance of DBT is limited by density.

DBT shows a slight increase on breast cancer detection of 1.2/1000 women screened when added to mammography.

Hand-held breast ultrasound (HHUS) and automated breast ultrasound systems (ABUS) are not limited by breast density. Both HHUS and ABUS provide an incremental breast cancer detection of 2.0-2.7 per 1000 women screened; 86-91% of these cancers have been invasive node negative with a slight increase in the recall rate.

Hand-held ultrasound has shown a decrease on interval cancer rates.

Breast magnetic resonance imaging (MRI) and contrast-enhanced mammography (CEM) are functional imaging modalities that are not affected by breast density.

MRI is the most sensitive technique for breast cancer detection. The specificity of MRI ranges between 84% to 98%.

Since 2007 the American Cancer Society recommends adding annual screening MRI to mammography for women at high risk.

Both the National Comprehensive Cancer Network and the American College of Radiology recommend screening MRI annually in women with a personal history of breast cancer who were diagnosed by age 50 or who have dense breasts.

Implementation of MRI has shown an additional 16 cancers after normal mammography plus US, while it reduces the interval cancers, but it requires intravenous administration of gadolinium.

Abbreviated MRI protocols have been applied to decrease time and cost. The European Society of Breast Imaging (EUSOBI) recommendations suggest breast MRI every 2 to 4 years

between the ages of 50-70 years in women with extremely dense parenchyma.

According to the EUSOBI guidelines In case that MRI is not available, breast ultrasound should be considered.

CEM has also shown overall promising results with an incremental CDR equal to 10.7 per 1000 women screened beyond 2D mammography.

Compared to MRI the cost of CEM is lowered, a shorter acquisition time is needed and an increased accessibility has been reported.

CEM requires administration of iodinated intravenous contrast and can be applied for screening of women eligible for MRI, that for various reasons cannot have access to MRI unit.

#### TAKE HOME POINTS

In conclusion by providing accurate information to women about the advantages and limitations of various imaging modalities would allow them to make an informed decision on the adoption of breast cancer screening method.

#### References

- Kerlikowske K, Zhu W, Tosteson AN, et al. Identifying women with dense breasts at high risk for interval cancer: a cohort study. *Ann Intern Med* 2015; 162:673-681.
- Friedewald SM, Rafferty EA, Rose SL, et al. Breast cancer screening using tomosynthesis in combination with digital mammography. *JAMA* 2014; 311:2499-2507.
- Berg WA, Vourtsis A (2019) Screening breast ultrasound using hand-held or automated technique in women with dense breasts. *J Breast Imaging* 1:283-296.
- Bakker MF, de Lange SV, Pijnappel RM, et al. Supplemental MRI Screening for Women with Extremely Dense Breast Tissue. *N Engl J Med* 2019; 381:2091-2102.
- Berg WA, Rafferty EA, Friedewald SM, Hruska CB, Rahbar H. (2020) Screening Algorithms in Dense Breasts: *AJR Expert Panel Narrative Review*. *AJR Am J Roentgenol* 216:275-294.
- Berg WA, Blume JD, Adams AM, et al. Reasons women at elevated risk of breast cancer refuse breast MR imaging screening: *ACRIN 6666*. *Radiology* 2010; 254:79-87.
- Kuhl CK, Schrading S, Stobel K, Schild HH, Hilgers RD, Bieling HB. Abbreviated Breast Magnetic Resonance Imaging (MRI): First Postcontrast Subtracted Images and Maximum-Intensity Projection-A Novel Approach to Breast Cancer Screening With MRI. *J Clin Oncol* 2014; 32:2304-2310.
- Mann RM, Athanasiou A, Baltzer PAT et al. (2022) Breast cancer screening in women with extremely dense breasts recommendations of the European Society of Breast Imaging (EUSOBI). *Eur Radiol* <https://doi.org/10.1007/s00330-022-08617-6>.

## Pros and cons of DBT implementation

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Digital breast tomosynthesis, DBT, is an established 3D technique in clinical breast imaging, while it is still used sparsely in European screening settings. Data from multiple large European prospective population-based screening trials convincingly show that the use of DBT alone or in combination with two-view DM/synthetic DM substantially improves cancer detection compared to two-view DM screening. In other settings, mainly in the US, retrospective studies have been conducted with large reductions in recall rates as the main result. Interval cancer rates following DBT screening has been shown to be significantly lower in one trial but with conflicting results in other. The method is now conditionally recommended for screening average risk women according to ECIBC guidelines and also for women with dense breasts. It is however clear that extremely dense breasts still pose a challenge also in DBT, and for this specific group of women MRI or contrast enhanced mammography might be a better option. The challenge with potentially longer reading time with DBT is a practical issue as is the data storage question. These two issues would most probably be solved along with implementation. The role of artificial intelligence is especially of interest to study in order to facilitate DBT implementation in a heavy screening workflow. In this presentation, the evidence of DBT screening presented and discussed in terms of pros and cons for implementation.

#### TAKE HOME POINTS

- DBT improves breast cancer detection in screening
- Screening with DBT might lead to lower interval cancer rates
- Some women would still benefit from a contrast enhanced imaging method
- AI will play a role in the implementation of DBT in screening



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