Artificial intelligence (AI) in mammographic screening in Norway

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BreastScreen Norway discusses how the results from their screening programme for early breast cancer detection can influence future artificial intelligence to streamline early breast cancer detection

Breast cancer is a significant global health concern, with more than 2 million new cases diagnosed and over half a million women dying from the disease annually.[1] Many countries, including Norway, have implemented mammographic screening to detect breast cancer in an early stage of disease development, as an early intervention has clear benefits on the disease outcome. In Norway, all women aged 50 to 69 years are invited to biennial mammographic screening through the national screening program, BreastScreen Norway.[2]

The screening process involves two-view digital mammography independently interpreted by two breast radiologists. Cases of potential malignancy are flagged and discussed in a consensus meeting to decide whether further assessment (recall) is needed. However, the time-consuming task of screening interpretation only returns a rate of examinations positive for breast cancer of about 0.6%, at the same time as there is an increasing shortage of breast radiologists in Norway and globally.

Artificial intelligence (AI) and deep learning have been introduced in various healthcare domains, including radiology, to enhance efficiency and improve patient care. Promising results for the use of AI-assisted interpretation in mammographic screening have quickly emerged and several vendors offer solutions for AI-assisted breast cancer detection. Most of these AI algorithms will, based on mammography image analysis, provide a risk of malignancy score – a probability of cancer being present in the image or examination. By utilising AI in BreastScreen Norway, we may be able to reduce the interpretation volume for the radiologists without compromising the quality of the screening program. AI can analyse mammograms with high accuracy, reducing the burden of incorrect diagnoses and optimising treatment decisions. AI can also assist in assessing breast density, predicting individual risk levels, and evaluating image quality, providing valuable insights for personalised screening approaches.

From images to algorithm

In 2018, BreastScreen Norway and the Norwegian Computing Centre set forth to develop an AI algorithm for mammography image interpretation. Through two projects, funded by the Research Council of Norway, mammograms from more than 750,000 screening

examinations performed in BreastScreen Norway have been included in the development of an advanced AI algorithm, designed to select mammograms with low suspicion of malignancy.

Mammograms from another 650,000 examinations will be used to further develop the algorithm to become even more robust and reliable. Preliminary results assessing the performance of the current version of the AI algorithm have shown the in-house algorithm to be comparable to commercially available algorithms.[3] To be able to use the in-house algorithm in BreastScreen Norway, its clinical value must be evaluated. This will include long and potentially costly processes to secure that the algorithm complies with EU regulations to achieve CE-marking (Conformité Européenne).

Retrospective evidence

BreastScreen Norway's now comprehensive database of mammograms from more than one million screening examinations, enables retrospective studies using commercially available and CE-marked breast AI products for different purposes.

In mammographic screening, AI-assisted screening can be included in different modes:

1. AI as decision support to aid the radiologists to decide on their course of action during screen-reading
2. AI as an independent interpreter, replacing one of the two radiologists in a double-reading setting, and
3. AI as a triaging tool, using solely AI to separate examinations into groups to be interpreted by either one or two radiologists depending on the risk scores.

Retrospective analyses from BreastScreen Norway show that screening mammograms were assigned to the highest risk score by AI in 86-89% of screen-detected cancer cases.[4,5]

Furthermore, the highest risk score was assigned in 45% of the screenings where an interval cancer was later diagnosed (cancer detected in the period between to screenings, based on patient-experienced symptoms). In a triage scenario defining 50% of the examinations with the highest AI scores as positive and the remaining 50% as negative, 99.3% of the screen-detected and 85.2% of the interval cancer cases were classified as positive, leaving us to assume that only 0.7% of the screen-detected cancers were classified as false negative for cancer by the AI system and 15% of the interval cancers are potentially true 'interval' cancers, i.e. not missed by the previous screen but indeed have become detectable in the period between two mammographic screenings.[6]

Prospective evidence

Before breast AI can be implemented into clinical practice, available algorithms must be thoroughly tested in clinical studies – exploring algorithm performance, safety, and reliability, as well as patient outcomes, and ethical and legal aspects, including discrepancies between AI and radiologists. Several challenges and questions remain, including how to integrate AI in breast cancer screening, what is considered an

acceptable threshold at which AI can be trusted as an independent reader alongside a radiologist, and what is the impact of AI on readers consensus, recall, and breast cancer detection rates, as well as whether implementation of AI indeed alleviates the workload of radiologists? A natural next step on the road to implementing AI in BreastScreen Norway is to test AI-assisted image interpretation in a real-life screening environment.

Therefore, BreastScreen Norway is starting a randomised controlled trial, comparing AI-assisted mammographic screening with the current standard of care (independent double reading). The trial aims to test different modes of AI-assisted image interpretation and breast AI products, using AI risk score to stratify examinations for single or double reading.

Personalised screening programme

The use of AI will also open avenues for including additional risk factors in the stratification process during screening, including environmental and behavioral factors and research-based factors such as genetics in an overall genetic risk for breast cancer based on inherited genetic variants (polygenic risk scores, PRS).

An academic collaboration between members of the Oslo Cancer Cluster (OCC), Norwegian hospitals, the University of Oslo and the company Antegenes in Estonia has shown that stratification of women based on genetic risk can identify women at several-fold higher risk for breast cancer before the current screening age.[7] Such information can be leveraged to invite women at high risk into the screening earlier, whilst offering women at very low baseline genetic risk a later age of screening startup. Such scenarios may benefit the overall detection rate and alleviate the burden on the breast radiographers, but such additional approaches will need thorough exploration in comprehensive studies before entering the road towards clinical implementation.

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J Clin. 2021;71(3):209-49.
2. Hofvind S, Tsuruda K, Mangerud G, Ertzaas AK, et al. The Norwegian Breast Cancer Screening Program, 1996-2016: Celebrating 20 years of organised mammographic screening. In: Cancer in Norway 2016
   – Cancer incidence, mortality, survival and prevalence in Norway. Oslo: Cancer Registry of Norway; 2017.
3. Martiniussen MM, Hovda T, Kristiansen MU, Larsen M, Dahl FA, Eikvil L, et al. Comparing cancer detection and markings of tumors performed by two AI systems: a retrospective study of 130,312 screening examinations carried out in BreastScreen Norway. Radiology: Artificial Intelligence. 2024 – submitted.
4. Larsen M, Aglen CF, Lee CI, Hoff SR, Lund-Hanssen H, Lång K, et al. Artificial Intelligence Evaluation of 122 969 Mammography Examinations from a Population-based Screening Program. Radiology. 2022:212381.

5. Bergan MB, Larsen M, Moshina N, Bartsch H, Koch HW, Aase HS, et al. AI performance by mammographic density in a retrospective cohort study of 99,489 participants in BreastScreen Norway. European radiology. 2024.
6. Larsen M, Olstad CF, Lee CI, Hovda T, Hoff SR, Martiniussen MA, et al. Performance of an Artificial Intelligence System for Breast Cancer Detection on Screening Mammograms from BreastScreen Norway. Radiol Artif Intell. 2024;6(3):e230375.
7. Akdeniz BC, Mattingsdal M, Dominguez-Valentin M, Frei O, Shadrin A, Puustusmaa M, et al. A Breast Cancer Polygenic Risk Score Is Feasible for Risk Stratification in the Norwegian Population. Cancers (Basel). 2023;15(16).

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