Experience of mammography AI in a UK screening centre

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Figure 1
The GEMINI project training day.

Introduction

AI applications in the field of breast imaging have gained a great deal of interest. Despite the use of computer-aided detection in breast screening having been studied in the past, it was not until the last decade that developments in machine learning and processing power made it possible to apply AI to digital imaging and computer systems for breast screening.

Employing these new technologies opens the application of AI in breast screening as an image interpretation tool, where patient outcomes are divided between routine recall versus recall for assessment. This is underpinned by breast screening's comprehensive quality assurance processes and the requirements to track all results and detected cancers.

Aberdeen involvement in AI

In 2018, Innovate UK awarded grants to establish the Industrial Centre for Artificial Intelligence Research in Digital Diagnostics (iCAIRD) in both Aberdeen and Glasgow. In Aberdeen, the first exemplar project was a retrospective analysis using the Mia algorithm from Kheiron Medical Technologies (London) on four years' worth of anonymised screening mammograms from the north-east of Scotland breast screening service. This work, conducted by Dr de Vries and colleagues at the University of Aberdeen using the Aberdeen Data Safe Haven (DaSH), a trusted research environment of the University of Aberdeen, had some significant findings including: the applicability of AI in a UK population; learned lessons about AI calibration; identified workload benefits; and additional interval cancer detection by AI.[1]

The NHS AI in Health and Social Care Award was granted to Kheiron Medical Technologies in 2020 to do further research into the application and assessment of its AI tool in UK screening centres. Given its prior association with NHS Grampian, a proposal was made to evaluate Mia within the Aberdeen breast screening. The project, named GEMINI (Grampians Evaluation of Mia in an Innovative breast screening Initiative) was an NHS Grampian collaborative initiative led by the NHS Grampian Innovation Hub, Kheiron Medical Technologies and the University of Aberdeen.

Figure 2
The patient engagement poster.

Pre-engagement steps

Before AI could be used in the breast screening centre there were a series of approvals obtained from various governance bodies and stakeholders including the Scottish Breast Screening Program Board, the National Breast Screening IT Users Group, the NHS Grampian Director of Public Health, Caldicott Guardian and local screening team. Project management was provided by the NHS Grampian Innovation team. Further data access agreements were agreed with information governance.

Adaptation of the screening service

To ensure connectivity between the Scottish breast screening IT system and AI software, modifications had to be made prior to implementation. Initially, the software was tested and evaluated in shadow mode. A collaborative approach with local PACS and eHealth was required to ensure the safe connectivity and function of the program.

A connection was established between the local breast screening PACS system and a virtual machine that anonymised the images and transferred them to the cloud to be analysed by the AI software. Results were then sent back to the screening centre and linked to the patient images on PACS and the breast screening IT system. Analysis is now underway, led by Dr de Vries and Professor Anderson, from the Aberdeen Centre for Health Data Science at the University of Aberdeen.

Staff and patient engagement and education

Prior to the launch of the evaluation, there was an engagement programme with all staff members including Kheiron, administrative staff, mammographers and breast care nurses. The medical director of Kheiron also conducted web-based training for the clinical staff who would be using AI, which was followed by a short assessment.

Administration and mammography staff members attended AI demonstrations during CPD sessions. This was followed by a staff training day where all staff involved in the evaluation, including the innovation team, university researchers, breast screening and Kheiron personnel had the chance to review the findings of the retrospective research and discuss the protocol and schedule for the upcoming few months of the live implementation (**figure 1**).

Staff members were also involved in designing the patient engagement forms, which were printed and placed in the reception area of both static mobile screening sites (**figure 2**). Additionally, an information website was created for GEMINI[2] and a patient education leaflet was issued along with each invitation to breast screening. This was supported by Kheiron, which had established patient and public involvement groups allowing patients to play a significant role in the creation and wording of all patient-facing materials.

Mammographer experience

The manner of patient recruitment for the service evaluation was opt out rather than opt in. The mammography team discovered that at initial screening, there was very little extra time needed to explain the GEMINI research to patients and responding to their inquiries. While initial steps were being undertaken to assess the accuracy and reliability of Mia, staff were aware that this would cause a small increase in the number of patients called back for further assessment in order to support the opportunity of finding additional cancers that would otherwise not be picked up, potentially not until the woman's next screening round. Additional considerations were made to facilitate the increased capacity required for GEMINI-specific recalls. New procedures and protocols were implemented and followed, which helped to minimise disruption and were adapted as time went on to streamline workflow. Staff commented that: "Over time the workflow became much more efficient when we could anticipate how many patients were coming back." This demonstrated that in the long term, these established pathways could aid future implementation into daily practice.

Positive feedback was received from staff, with one commenting: "We were delighted that we could maintain the same level of care irrespective of the increase in ladies," and another championed "a step in the right direction." Additionally, mammographers who carried out screening found that women were mostly intrigued about the process and were happy to receive a perceived 'extra check,' which

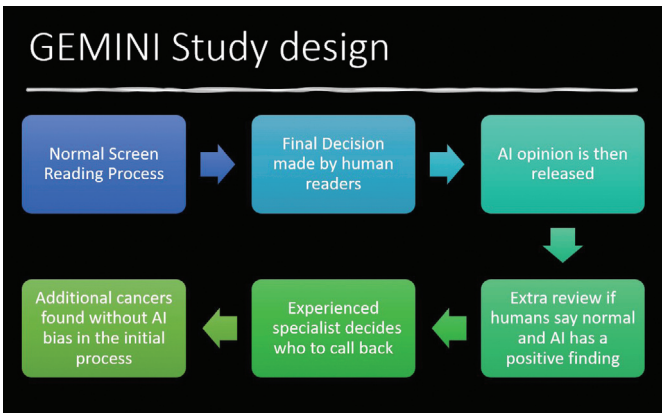

Figure 3
The GEMINI study process.

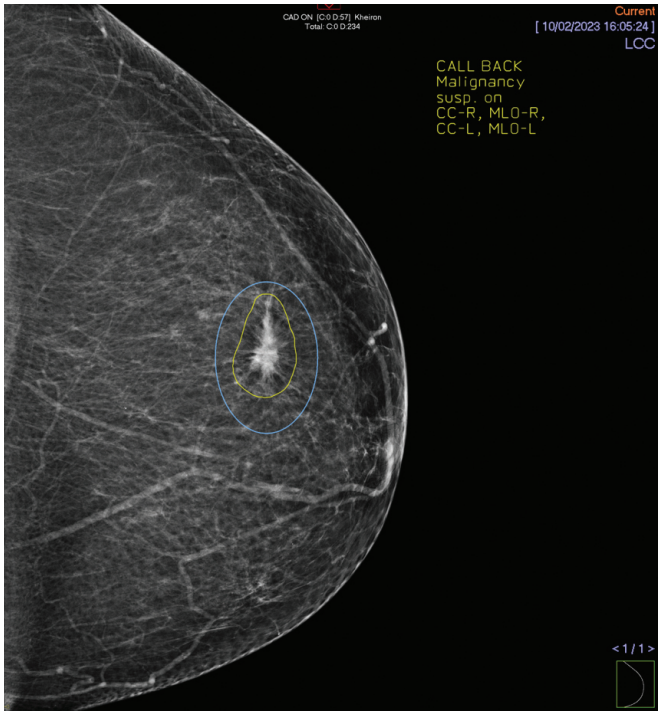

Figure 4
Image with AI annotation.

provided comfort to some. However, in contrast, often individuals did want to be reassured that two radiologists would still be assessing their images in addition to Mia.

Overall, patient engagement was high, with less than 1% of ladies opting out. Some of the feedback included reasons such as: a lack of interest in research; further investigations; likelihood of overdiagnosis; and anxiety around the process.

Administrative and clinical operating protocols

Sheets of frequently asked questions were created and maintained for use by mammographers and reception personnel, in person at reception and online. This was incredibly helpful because these employees are frequently the first people that screening participants interact with, and their enthusiasm and promotion for the AI study helped to address misconceptions and resolve them.

As women had the option to opt out of having their images analysed by AI as part of the evaluation, the administration process included a form completed by reception when they were informed of a patient's wish to opt out and this information was recorded on the breast screening IT system.

The GEMINI study process is detailed in **figure 3**.

After every mammogram was read and had a final decision made, any cases that had mammograms called normal by the human readers but had a positive AI finding were transferred to the evaluation file on the intranet, which was accessed for additional review by the clinical team on Mondays, Wednesdays and Fridays.

A 72-hour administrative hold was placed on results for these cases. If the human readers agreed with the AI and changed the opinion to a callback, these clients were then sent a letter from the centre inviting them back for GEMINI-specific assessment sessions. Our experience was that this amounted to around two additional assessment places a week.

The administration team was key in maintaining the bookings and record of investigations of these additional clients and collation of biopsy results for the multidisciplinary team where they were discussed under a separate GEMINI heading.

During assessment visits by the GEMINI participants, they were shown their images with the AI findings as part of the discussion. All investigations and results are kept on the evaluation file, which will be transferred to the research team at the University of Aberdeen at the end of the evaluation for analysis.

Challenges

As part of the conditions of the AI award and current guidance from the UK National Screening Committee, AI cannot currently replace any part of the screening process and so the use of AI as detailed above was in addition to the normal pathway. This resulted in additional workload during the period of the evaluation.

There were technical challenges encountered in the process, particularly with data links between the AI and the breast screening IT system and both PACS systems, acute and breast screening. The GEMINI clients who required assessment were treated separately to breast screening clients by both administration and in the recording of their images on PACS. Two clients per assessment allowed the time to ensure images were replicated on both PACS systems for future rounds of the screening programme, although commonly these tasks would overflow into the following day and required staff to 'clean up' administrative issues before starting a new set of clients the following week.

Conclusion

One of the first live prospective evaluations of AI in the UK with mammography was performed on over 10,000 participants in our centre in the North East of Scotland. The experience in the centre has been overwhelmingly positive with high engagement from the patients as well as all colleagues in the centre. This has been reinforced by the minimal workload increase and additional cancers picked up by virtue of the GEMINI evaluation aiding earlier diagnosis and treatment.

Reference

1, *C F de Vries, S J Colosimo, R T Staff et al on behalf of the iCAIRD Radiology Collaboration. Impact of different mammography systems on artificial intelligence performance in breast cancer screening. Radiol Artif Intell 2023;5(3):e220146. doi: 10.1148/ryai.220146*

2, *www.nhsgrampian.org/about-us/innovation-hub/our-projects/current-projects/gemini*