Artificial intelligence: optimizing the efficiency of screening protocols for women with dense breasts

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Introduction

Current breast cancer screening protocols place women with dense breasts at a disadvantage:

- XM (X-ray mammography) is less accurate at detecting BC (breast cancer) in women with dense breasts[1]
- There is inconsistency in the use of supplemental modalities despite guideline recommendations for supplemental screening,[2] and there is restricted access to supplemental modalities
- MRI (magnetic resonance imaging) is more accurate at detecting BC in women with dense breasts.[3] However, it is also associated with a higher number of false positive screening results[4]

Studies have shown that AI (artificial intelligence) can lead to:

(1) Reduction of errors in the screening pathway through enhanced diagnostic accuracy (sensitivity and specificity) of MRI[3,4]

(2) Reduction in false positives for Fp-MRI (Full-protocol MRI) and Ab-MRI (Abbreviated MRI) for BI-RADS (Breast Imaging Reporting and Data System) 3 and BI-RADS 4 lesions[5]

(3) Average sensitivity improvement of 4% for Fp-MRI and Ab-MRI for BI-RAD 3 lesions[6]

(4) A potential reduction in radiologist workload through effective triage of negative examinations[7]

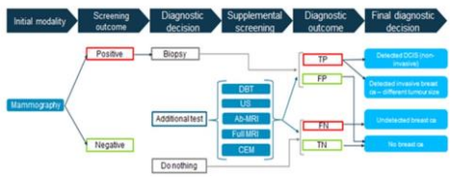
This analysis explores the potential for AI technologies to improve health economic outcomes by improving screening accuracy when using supplemental Fp-MRI in women with dense breasts

Methodology

Heath economic and clinical outcomes were modelled with a decision tree linked to a Markov chain:

- The decision tree was used to examine the initial diagnostic outcomes of breast cancer screening
- A Markov model was used to examine the long-term outcomes of supplemental screening
- The population being modelled was adult women aged 40–75 years with heterogeneously and extremely dense breasts with intermediate breast cancer risk
- Patients underwent annual screening with mammography and patients who test negative to initial screening undergoing supplemental screening with MRI. **Figure 1** shows the model framework

***Figure 1**: Model schematic*



*Base case screening accuracy values for MRI {95%,92%}[8] and XM {59%,94%}[9] were used in the model and a 1% increment was applied to the literature derived values for FP-MRI to simulate the effect of **introducing AI within the screening pathway** and assess impact of improved screening accuracy on clinical and economic outcomes.*

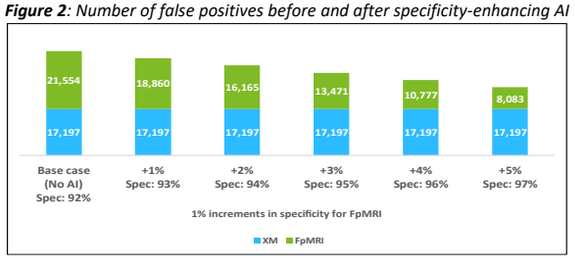
The cost of AI was not considered in this analysis.

Results

Results shown for a population of 10,000 women with dense breasts, when comparing base case (no AI) with the AI scenarios

- A 1% increase in specificity with AI yielded **2,694** fewer false positives for Fp-MRI (**Figure 2**)

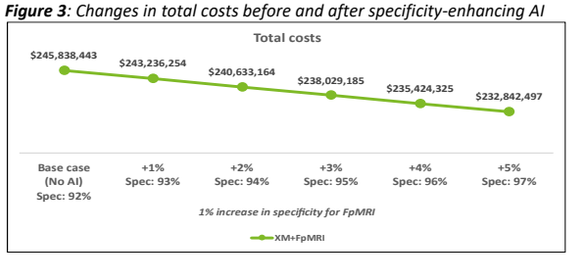
***Figure 2**: Number of false positives before and after specificity-enhancing AI*



Abbreviations: Fp-MRI, full protocol contrast-enhanced MRI ; XM, x-ray mammography

- A 1% increase in specificity for Fp-MRI with AI reduces total costs by **$2.6 million** on average (**Figure 3**)

***Figure 3**: Changes in total costs before and after specificity-enhancing AI*



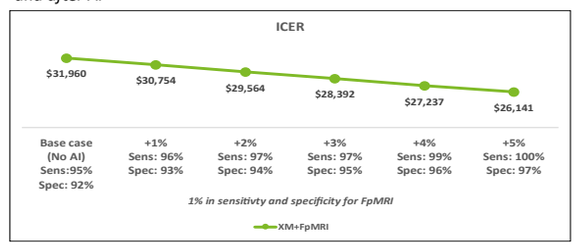
Abbreviations: Fp-MRI, full protocol contrast-enhanced MRI ; XM, x-ray mammography

AI was also applied to sensitivity of Fp-MRI (in 10,000 women), yielding:

- A 1% increase in sensitivity with AI will result in **1** less tumour related death for Fp-MRI
- A 1% increase in sensitivity with AI will result in **1** more cancer detected for Fp-MRI

- A 1% increase in sensitivity and specificity for Fp-MRI reduces ICER by **$1,164** on average (**Figure 4**). Reduction in ICER is mainly driven by reduced costs due to a reduced number of false positives.

***Figure 4**: ICER results for supplemental Fp-MRI as add-on to XM before and after AI*



Abbreviations: Fp-MRI, full protocol contrast-enhanced MRI ; XM, x-ray mammography

Conclusions

- Emerging AI technologies have the potential to enhance screening accuracy, which could lead to improved clinical outcomes, significant cost reductions and quality of life gains in women with dense breasts with intermediate risk of BC
- This analysis indicates that the application of AI can play a valuable role in optimizing supplemental MRI screening outcomes – overcoming sources of inefficiency – with the biggest impact being reduction of false-positive diagnoses and their consequences
- Different AI technologies will have different impacts according to the specific profile of each screening modality. While the present study is focused on Fp-MRI, other studies have also shown beneficial results when applying AI to XM, leading to sensitivity improvements in women with low and high breast density and reducing the reading time with the use of AI[10]

References

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