

The instrument, not the age

Why the next advancement in breast screening will be worn rather than booked

In June earlier this year, MPs debated a petition signed by 106,000 people asking the NHS to screen women for breast cancer from the age of 40, every year.

Ministers replied that the evidence does not support it.



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Shadrack Osei Aboagye, winner of the Silver Award in Engineering, STEM for Britain 2025, argues that both sides have diagnosed the wrong problem and describes the wearable alternative his team builds at Nottingham Trent University.

On 29 June, Westminster Hall debated e-petition 742179, calling on the Government to offer annual NHS breast screening from age 40. While cross-party support for the petition's intent was overwhelming, the Minister's defence was unyielding: dense breast tissue in younger women makes mammograms unreliable, risking an unacceptable surge in false positives, unnecessary biopsies, and overdiagnosis. Both arguments hold merit. With one in ten breast cancers diagnosed in women aged under 50, petitioners rightly pointed to a dangerous blind spot, however, with mammography's known physical limits, the Government rightly warned of the clinical harm. Yet the debate remains at a stalemate because both sides share a single, unexamined assumption: that screening must mean a mammogram.

That assumption deserves rigorous scrutiny. In women with the densest breast tissue, mammographic sensitivity drops to roughly 40%¹. Crucially, the one woman in ten who falls into this high-density category also carries up to four times the background risk. The gold-standard modality therefore performs worst precisely where the danger runs highest. Clinical research has tried to salvage this gap. The BRAID trial demonstrated that supplementary

contrast-enhanced mammography and abbreviated MRI detect 17 to 19 additional cancers per 1,000 women screened¹. Yet both adjuncts demand contrast media, imaging equipment time, and specialist radiologists; the three scarcest resources across NHS diagnostics. Adding six million younger women to that already heavily utilised pipeline could simply press the infrastructure too hard.

The women who never reach the scanner

Attendance figures expose a weakness that no imaging upgrade can resolve. Of the 2.75 million women invited for screening in 2024–25, 600,000 didn't attend². This deficit reveals familiar and complex inequalities in society: uptake is stalled at 65% in the most deprived communities compared with 75% in the least deprived. First-invitation uptake has failed to cross 70% since the national programme began in 1988, and women who miss that initial appointment rarely enter the system later. Physical barriers compound the problem. Rigid mammography units routinely exclude wheelchair users; a design failure NHS England is discussing with manufacturers. Technology developments will help with faster scanners and artificial intelligence readers improving diagnostic precision

once a patient is in the room. But the 600,000 women who never walk through the clinic door will still be missed.

Screening might become part of monitoring one's wellness, instead of based on crossing risk factor thresholds like age and family history. Most of us make use of and enjoy using digital technologies and rapid advances therein year on year. Wearable monitors informing the wearer about how themselves have been telling us an ever-increasing amount of wellness information for decades. The cost of these technologies continues to drop and low-cost wearable sensors handle monitoring as part of the items we wear everyday and through night in in some cases. Increasingly they are also used to provide a health alarm. The right wearable could inform the state and rate of change and provide early monitoring and suggest referrals only when anomalous tissue changes occur. Mammography suites and specialist staff can then focus their time and expertise exclusively where a developing condition has been detected. The logic turns around the failing model of today that depends on our most capital intensive hospital machinery to work through the whole healthy population once every three years.

A wearable monitor that can be used at home, worn occasionally but regularly (once per month or once per 6 months for example, could provide for monitoring before screening in order to provide an informed and on time screening only for those that need it. It certainly takes an interesting approach to addressing inclusion and enabling more people access health monitoring.

The research team at NTU are developing further what they still consider to be a viable route to the problem using electrical impedance tomography (EIT). The technology injects tiny, imperceptible alternating currents across surface electrodes to reconstruct internal tissue conductivity. Malignant changes cause measurable shifts in electrical properties, generating clear physiological contrast without ionising radiation or tissue compression. Importantly, the core hardware costs pennies on the pound compared to clinic-based imaging suites.

Mathematically, EIT suffers from low spatial resolution and will almost never reproduce the photorealistic images of a radiologist's workstation. But regular wellness does not require surgical precision, rather it requires an early warning system of change and rate of progression. By monitoring baseline drift within the individual person, wearable EIT should reliably flag when further clinical investigation is recommended. The technology does not compete with hospital mammograms or ultrasound; it aims to pick up the missed appointments and address the people currently not making use of the existing screening programme. It could go then go on to addressing monitoring younger people.

At Nottingham Trent University, we translate this principle into a wearable garment (see image). Conductive textile electrodes are embedded directly into bra fabric, bypassing gels, clinic couches, and scheduled appointments entirely. Our miniaturised instrumentation hardware uses active multiplexing, paired with an adaptive gain algorithm that stabilises signal quality against movement, perspiration, and fabric drift. This solves the long-standing contact impedance problem that has plagued wearable bioimpedance. Machine learning models then convert raw voltage data into meaningful images. Backed by the



Conductive textile electrodes embedded directly into bra fabric, with miniaturised instrumentation hardware paired with an adaptive gain algorithm that stabilises signal quality against movement, perspiration, and fabric drift.

Medical Technologies Innovation Facility and the Advanced Textile Research Group led by Professor Yang Wei and Professor John Hunt, the underlying electronics and reconstruction frameworks are validated in peer-reviewed IEEE literature.

Designing inclusion into the technology

Health equity informed our core engineering choices. The number of women living with learning disabilities who attend routine breast screening sit at just 47%, compared with 62% across the wider population – a 14-point deficit documented by NHS Digital³. Standard mammography demands that a patient stand upright, follow commands, endure tissue compression by a stranger, and grasp the procedure's clinical rationale. Each requirement presents an exclusion risk. A passive garment in the form of an everyday piece of clothing removes all four.

Through a Cancer Research UK funded project, we are co-designing the smart bra with women with learning disabilities, supported by Patient and Public Involvement and Engagement (PPIE) expertise from the University of Glasgow. We treat lived accessibility as a foundational engineering constraint. A diagnostic tool that only functions for compliant clinic attendees have already failed the vulnerable populations it must protect.

Moving this technology from the laboratory into clinical practice requires three immediate government decisions:

1. **Commit to a women's health wearables target.** The 10 Year Health Plan targets remote cardiovascular monitoring by 2028 with subsidised hardware for deprived populations. Creating a matching timeline for women's preventive technologies would de-risk capital investment and direct

translational research toward an approved NHS destination.

2. **Modernise screening validation cycles.** The AgeX trial's 18-year timeframe suits population-wide interval studies, not agile hardware innovation. The UK National Screening Committee, using NICE's expanded diagnostic remit, could build a dynamic assessment mechanism that evaluates home triage devices on their ability to stratify risk, rather than judging them against legacy mammography standards.
3. **Codify inclusion as a pre-market threshold.** Medical regulators already enforce strict safety baselines. Extending those mandates to require performance and usability data stratified by disability, tissue density, and body habitus would ensure health disparities are resolved at the prototype phase rather than perpetuated at scale.

A new route to earlier diagnosis

The National Cancer Plan commits England to diagnosing 75% of cancers at stage 1 or 2 by 2028, unlocking a 75% five-year survival rate by 2035. Delivering on those promises is impossible without finding disease in the populations currently being missed. The petitioners asked Parliament to offer younger women another hospital mammogram. A solution for both people and government might exist in the form of low-cost monitoring with zero radiation that reaches people in their own homes at the time when they are ready to use it.

References

- ¹ Gilbert F J et al (2025). BRAID trial. *The Lancet*.
- ² NHS England (2026). *Breast Screening Programme statistics, England 2024–25*.
- ³ NHS Digital. *Health and Care of People with Learning Disabilities, breast cancer screening indicator*.