

Biosensors in breast cancer prevention pathways

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A wide range of emerging technologies are showing considerable potential for improving healthcare through enabling personalised approaches at different stages of care and disease prevention pathways.

Currently, health promotion and screening are the predominant vehicles for breast cancer prevention and, in the main, are targeted at large sub-sets of the population. This means they do not take into account detailed biological characterisation of individuals or provide tailored prevention pathways.

We know that the development of breast cancer is influenced by many different factors, which are likely to vary between individuals, and that breast cancer is not one disease but has many sub-types with different outcomes. Can we create prevention pathways that take these factors into consideration?

In this series of briefings we provide some perspectives on particular technology areas to stimulate discussion on the vision for the future. These perspectives have been developed together with experts in these fields with the aim of stimulating discussion about the 20 year horizon.

There is some way to go in gathering the scientific knowledge and technical capabilities sufficient to optimising the impact of these technologies. Nevertheless, it is important to reflect on their potential in order to visualise how prevention pathways could differ in the future and how health systems will need to adapt to move towards more personalised prevention pathways.

We'd like to thank Dr. Esther Lips, Dr. Pedro Estrela, Professor Brian Caulfield, and Professor Jonas Almeida for their work on these think pieces.

What are biosensors?

Biosensors are integrated devices that detect and/or quantify biomolecules. They typically contain a biochemical recognition element coupled with a transmission method (transducer) that generates signals that are interpreted and conveyed to the individual through a user-friendly biosensor reader device. The biochemical receptors may use enzymatic, immune, DNA or whole-cell detection methods, and may be transmitted by electrical, optical or thermal signals.

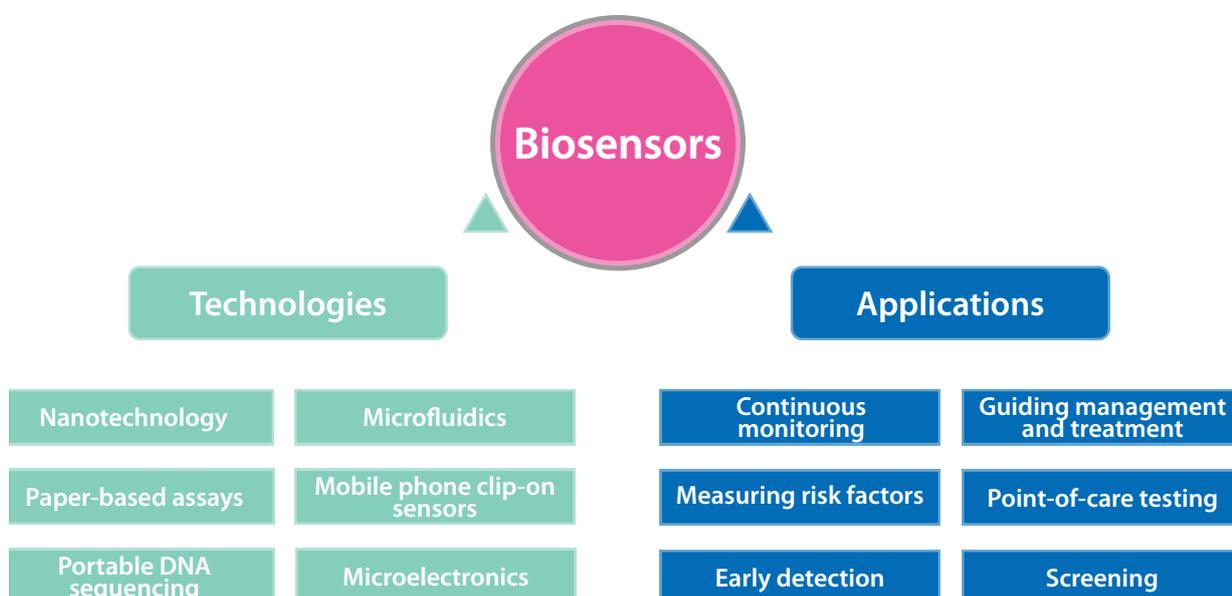
What are they useful for?

Biosensors enable identification and monitoring of biological, chemical or physical biomarkers. As such, they play an important role in aiding the identification of those at increased risk of disease, screening, diagnosis and guiding management and treatment of patients.

There are many different types of sensors already in use by individuals and healthcare systems. Thermometers, pregnancy tests, blood-oxygen saturation monitors and glucose sensors are examples of biosensors that have been used for many years by health systems and individuals.

The future for biosensors

Progress in nanomaterials and wireless technology in particular are enabling advances in the miniaturisation and connectivity of implantable biosensors. This has led to a proliferation in the development of devices for near patient testing and monitoring. Several techniques, such as electrochemical sensors, can be used for the development of portable, low cost, easy to use devices.



Biomarkers in breast cancer prevention pathways

Early diagnosis

Current screening and early detection techniques have limitations. New advanced biosensors could provide solutions through their capability to analyse a wider range of biomarkers or by provision of new modalities for detection. The correlation between different biomarkers is still in its infancy and considerably more work needs to be done in this field. Nonetheless there is clear evidence that blood tests (and possible urine tests) that measure a panel of biomarkers, either proteins, microRNAs, or circulating tumour DNA can provide accurate early detection of breast cancer and be good tools for routine monitoring of those at increased risk or in treatment.

Continuous monitoring

In principle, the continuous monitoring capabilities offered by biosensors could be used to detect biomarkers for pre-clinical disease in presumptively healthy individuals. However, until gaps in our knowledge and understanding of disease-specific biomarker patterns are addressed, this remains a more distant prospect for biosensor technology.

One of the main limitations of non-implantable sensors for continuous monitoring is the availability of biomarkers in fluids such as sweat or dermal interstitial fluid. Many chronic diseases biomarkers are not present or present only in very low concentrations in fluids than can be extracted through the skin.

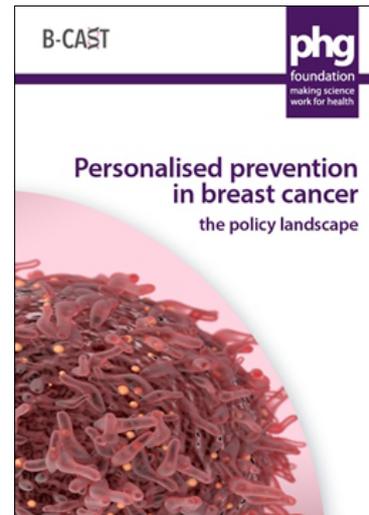
Beyond disease-specific applications, biosensors could be used to continuously measure biological risk factors, such as those which are common to a number of preventable and non-communicable diseases such as cardiovascular disease and cancer. Communicating quantifiable biological risk factors to individuals via apps and wearable devices (mHealth) has the potential to empower individuals to engage with their health and modulate their disease risk to enable a more personalised approach to disease prevention.

Points of reflection

How can biosensors help personalise prevention pathways? Can we see a future in which they provide a rapid, simple and cost-effective route for early diagnosis or monitoring? How will our ability to monitor a range of biomarkers more easily impact on prevention of breast cancer?

- In which settings (i.e. primary care, screening etc.) are emerging biosensors likely to have the most impact over the next 20 years?
- Are we going to see a future where continuous monitoring becomes part of the prevention pathway for breast cancer?
- What type of biomarker information is likely to be most relevant in different settings?

A vision for the future starts with an understanding of the present. We have undertaken an analysis of current approaches to breast cancer prevention, and the discourse around personalised breast cancer prevention, with focus on primary and secondary prevention programmes.



About our work for B-CAST

As part of a European Commission (EC) funded research project, Breast Cancer Stratification (B-CAST), PHG Foundation is leading work on examining the potential for developing personalised prevention for breast cancer within national health systems. Building a better understanding of the influence of different risk factors on specific subtypes of cancer can, ultimately, help clinicians target treatments and prevention strategies to deliver improved health outcomes for patients.

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