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Improving Early Breast Cancer Detection with Artificial Intelligence: A Promising Approach

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Breast tumors are heterogeneous and respond differently to treatments, making an accurate diagnosis and effective treatment challenging. This diversity can be attributed, in part, to variations in transcriptional programs that are responsible for the biological diversity of human cells and tumors.[1-4] A recent survey has revealed that cancer is a major threat to modern civilization, with breast cancer being the most prevalent type affecting women worldwide. Genetic factors, life choices and environmental factors are all believed to contribute to the high incidence of breast cancer among women from all socioeconomic backgrounds. Furthermore, traditional methods of breast cancer detection and diagnosis often involve invasive and painful biopsies. As a result, there is a pressing need for improved methods of detecting breast cancer that can help to reduce the use of invasive and painful biopsies. Presently, artificial intelligence (AI) is revolutionizing many aspects of our lives with its versatile application. Importantly, AI has shown significant potential in the field of medical screening, where its use can lead to more accurate results in a faster and more efficient manner. A group of researchers from MIT has recently developed an AI model that can accurately predict the risk of lung cancer.[5] Computational radiology is another flourishing area which is mainly used in carrying out processes such as lesion detection, or recognition of patterns for lesion detection and classifying lesions according to Breast Imaging Reporting and Data System (BIRADS) and systematic reporting (diagnosis). This process also involves extracting imaging biomarkers for modelling therapy responses based on predictive and prognostic values. Apart from computational radiology, machine learning (ML) and deep learning (DL) are also essential components of AI that are used to analyse the profile of breast cancer patients. ML algorithms are used to store and process large datasets, which are then used to train predictive models and interpret generalizations.[6,7] DL, on the other hand, utilizes advanced neural networks to identify complex patterns in medical images that are difficult for human to recognize.[8-10] It has also been hypothesized that DL-based tumor segmentation exhibit better and accurate prediction of triple negative breast cancer minimizing manual interventions.[11,12] Overall, the use of AI in breast cancer screening and diagnosis holds great promise for improving patients' outcomes by providing more accurate and personalized care. AI is being applied to breast cancer screening in several ways, including object detection (segmentation) and tumor classification as either benign or malignant.[13,14] However, with recent advancement of AI, radiomics has emerged as another widely used technique in combination with AI systems. Radiomics involves extracting quantitative features from medical images, such as mammograms and MRI scans, using pattern recognition algorithm.[15-18] This algorithm analyse the images and provide a set of numbers that represent the quantitative features. These features can then be used to develop predictive models that can help clinicians identify patients who may be at high risk of developing breast cancer or who may benefit from certain treatments. Using AI and radiomics together, clinicians can more accurately detect and classify breast tumors, leading to earlier detection and better patients' outcomes. Additionally, these techniques

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can provide a more personalized approach to breast cancer screening and treatment, as the quantitative features extracted from medical images can help identify which patients may benefit most from specific treatments. In 2011, Dr. Shimauchi and their research team successfully demonstrated the efficacy of a computer-aided system in improving breast cancer prediction and diagnosis.[19] Interestingly, personalized care is just one aspect of the broader trend towards precision medicine that allows more tailored and individualised treatment plans applying AI. The concept behind the radiomics is that the extracted features reflect different genetic and molecular activities. Machine learning techniques are then used to analyse these features and gain insight into disease outcomes. There are two approaches to machine learning in radiomics: unsupervised and supervised. Supervised learning involves training AI algorithms using pre-existing data archives, while deep learning utilizes a multi-layer neural network process images and condense them into numerical features for use in supervised machine learning.[20] AI-based algorithms have been implemented in breast cancer treatment, including early detection through the use of data obtained from established techniques like radiomics and biopsy slides. This approach is part of a global effort to create learning algorithms that improve the accuracy of mammograms by reducing the occurrence of false positives. Recently, on March 5th 2023, The New York Times reported that AI software has been successful in detecting breast cancer through mammograms.[21] Dr. Éva Ambrózay, a renowned radiologist with over twenty years of experience, noticed that several areas marked in red on a scan were flagged as potentially cancerous by AI software at Bács-Kiskun County Hospital, located outside of Budapest. These areas had been missed by doctors. Based on the AI's findings, the patient was referred for a biopsy. The advanced technology of AI was able to identify signs that were not detected by physicians. This example highlights the potential of AI as a valuable tool in early cancer detection, particularly in breast cancer. It has already shown impressive results and has the potential to revolutionize current methods of early detection and diagnosis. The question that arises is where to draw the line between AI and human intelligence.

Moreover, AI depends on data gathered from diverse populations, but socio-economic disparities may impact the data quality.[22] Therefore, studies accessing the effectiveness of AI must adhere to predetermined outcomes and meet specific standards of credibility. To gain acceptance, AI machine must be replicable and reproducible independently, similar to other scientific findings. This requires a common code that is available to everyone, which can only be achieved if data is equally shared[23]. Importantly, AI can address challenges linked to early diagnosis by analysing vast amounts of medical imaging data, detecting subtle patterns, and assisting in making more precise and prompt diagnosis. However, the AI models employed for cancer management mainly emphasize image data, indicating a lack of utilization of electronic health records that house patients' medical histories across different hospitals. To address this challenge, hospitals globally need to integrate user-friendly software systems and easily accessible databases. One of the major challenges in the use of AI is developing trust among doctors to make decisions based on AI techniques. To address this challenge, doctors require adequate training on the use of cutting-edge AI technology. Importantly, the widespread availability of mobile applications has made it increasingly convenient to collect data from individuals. However, the use of AI methods also comes with ethical risks, including data confidentiality, privacy violation, patients' autonomy, consent, and more. Additionally, the current application of radiomics in breast cancer screening and diagnosis is limited to day-to-day clinical practice. Many studies are retrospective with small sample sizes, which make them less credible than large prospective studies. Nevertheless, AI has the potential to revolutionize the clinical field of cancer by aiding radiologists in coming to conclusions.

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CONFLICT OF INTEREST
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