

Artificial Intelligence in Mammography: The Way Forward for Population Screening

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Cite this editorial as: Majeed AI. *Artificial Intelligence in Mammography: The Way Forward for Population Screening*. *Ann Pak Inst Med Sci*. 2021; 17(3): 204-205. Doi.10.48036/apims.v17i1.496

Background

Breast cancer is the most common cancer among women. Per GLOBOCAN estimates, 684,996 women died of breast cancer in 2020. It is becoming a looming epidemic in Pakistan. Every one in nine women suffers from this disease. Mammography is an established effective tool for screening and detection of breast cancer in females above 40 years of age. In this regard Digital mammography has shown more promising results than conventional mammography. In the modern era of digitalization, computer aided detection (CADe) and diagnostic (CADx) algorithms have remained an area of interest in 2000's, however it showed reduced specificity without increasing sensitivity. A step forward is the research driven by incorporation of Artificial Intelligence utilizing deep learning algorithms in automated breast cancer detection with development of commercial products. The accuracy of these products have been tested on retrospective datasets, comparing it with experienced breast radiologist's performance showing significant coherence.

The methods of machine learning deployed in artificial intelligence used in mammography include pixel level and patch level analysis. These methods require annotated training sets, where the malignant lesions are outlined and marked on the image or the image patch consists solely of the pathology. Obtaining such datasets remains the main obstacle in this kind of learning as image tagging is a time consuming and tiring job that engages expertise of experienced radiologists. To avoid this problem, people utilize transfer learning technique that uses already trained deep learning CNN, making few

changes for its fine tuning and apply it as a new application. In Pakistan, the Federal Breast Cancer Screening Center is a state of the art facility that is providing free screening and diagnostic mammograms since 2015. Thousands of mammograms have been performed and reported. The method is to utilize our abundant indigenous data for training of the application instead of using foreign annotated data sets with the hopes that such trained tool will have far better results.

Utilization of AI in digital mammography to formulate a sustainable diagnostic tool for detection of breast cancers, trained on our population data set. This will reduce the burden on human resources (radiologists). This will also reduce the delay in reporting, providing timely diagnosis. Moreover, the whole effort will result in formulation of a commercial product that can be shared with other centers nationwide and subsequently be used for international liaison as well.

Way Forward: Prospective evaluation

Litjens et al. published a comprehensive layout of introduction of deep learning central neural networks (CNNs) in breast imaging. The differentiating features between the new AI based image classification algorithm and CADe is the ability of CNNs to learn the lesion features during its training whereas in CADe, these features are added as input by human programmer.

Artificial intelligence methods that use pixel or patch level analysis utilize annotated images. Outlining the lesions on mammogram images require expertise of trained radiologists. The image annotation is cumbersome job, therefore many of the researchers utilize transfer

learning mode. This technique utilizes already trained deep learning CNNs, making few changes in it while keeping rest of the characteristics constant.

Kooi et al. has developed methods for detecting asymmetries in both breasts and comparing with older examinations. This has further improved AI accuracy.

Currently the top AI algorithms are utilizing CNNs. The new AI technology is expected to perform better than CAD, particularly in reducing the number of false positive results hence improving its sensitivity. Companies have even generated commercially available FDA approved algorithms which have been tested on UK and USA populations. These algorithms are behaving as second opinion replacing the second radiologist opinion in certain centers.

Key Considerations for Clinical Evaluation

The significance of computer systems incorporation in detection of breast cancers cannot be over-stressed. The performance of the new algorithms is significantly improved in comparison to the older conventional algorithms. Further research is needed in assessing the stand-alone performance of new AI algorithms however its use in assisting breast cancer detection is already established.

The methodology of this research is based on the different stages. In the first stage the mammograms of the patients will be acquired from PIMS. The radiologist will annotate the mammograms on image level. In the second stage, image preprocessing steps will be performed which will be helpful to improve the performance of the proposed diagnostic system. Finally, the state-of-the-art machine learning algorithms will be used to develop our prediction model. Some well-known testing methods such as sensitivity, specificity, accuracy, area under the receiver operating characteristic curve will be used to evaluate the performance of our proposed system.

The Breast Imaging Pathway and AI

Image acquisition through modalities such as mammograms is the first crucial step. Pakistan Institute of Medical Sciences (PIMS), being the premier national institution for medical and healthcare has excellent facilities in this regard. The images thus acquired would be tagged by the technical personnel at PIMS indicating the presence or absence of the disease. The tagged medical images thus obtained would be taken by the AI

team present at Medical Imaging and Diagnostics (MID) Lab, National Center of Artificial Intelligence.

The system will also have online image transfer facilities for radiologists to comment from home so that there is patient diagnosis available round the clock. This telemedicine facility will enable our premium center, Pakistan Institute of medical Sciences which has the model screening unit of the Federal Government to liaison with other facilities in the country. This will result in a nationwide early diagnostic tool which can subsequently be used for international liaison as well.

To develop an artificial intelligence (AI) based system to assist the radiologists in breast cancer management. The system will provide a better understanding of disease to the doctors. The novel computing approaches such as deep learning and image processing will be used to overcome the work flow.

Further Readings

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