

Using Artificial Intelligence to Achieve More Timely and Accurate Breast Cancer Diagnosis

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While screening mammography has been shown to reduce breast cancer-related mortality, interpretation of screening exams is imperfect. Nationally, one in eight cancers have been found to go undetected by radiologists and 10 percent of all screening exams are called back for diagnostic workup, with a majority being false-positive results. Improving the interpretation of screening mammograms would minimize potential harms and enhance benefits to the population of women being screened.

As part of the multi-institutional Athena Breast Health Network, UCLA established a breast screening research registry, which collects clinical, imaging, pathology and cancer outcomes data on women who have undergone mammography screening. This registry provides a unique resource for developing novel artificial intelligence (AI) and machine learning (ML) algorithms that uncover patterns in clinical and imaging data from a large group of patients to predict the development of breast cancer. A project called the Tissue Countdown to Cancer is currently under way to determine if AI/ML can be applied to seemingly normal mammographic images to identify subtle variations in appearance that could be indicative of cancer formation.

“At UCLA, we perform a large number of breast screening exams annually that could be used to help us build and validate a prediction model,” says William Hsu, PhD, associate professor of radiology and member of the Medical & Imaging Informatics group. “We’re hoping our model can be used to achieve a more timely diagnosis of cancer, inform management of patients with elevated risk due to genetic predisposition, and reduce diagnostic uncertainty of the radiologist.”

Routine screening mammograms provide a series of views of a patient’s breast over time. Features that would not appear to be significant in the context of a single image may yield more information when viewed as part of a sequence. The model is applied to subtle changes in the breast tissue from scan to scan paired with other clinical findings such as BRCA1/2 mutation status. The output of the model is a visualization that can be overlaid atop a mammogram to identify regions of the image that are more likely to develop cancer over time.

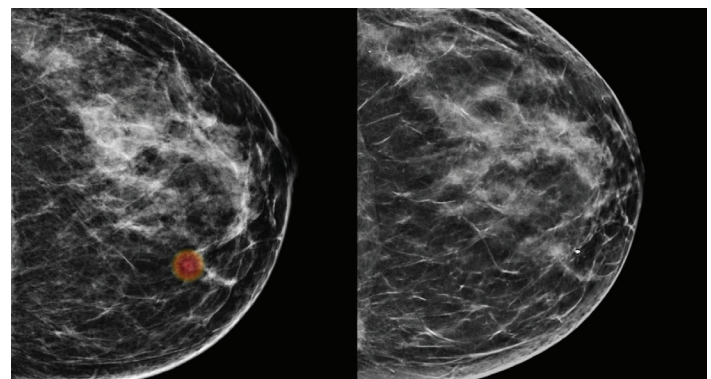
The project is based in part on the idea that changes in the cellular, tissue, organ and systemic environments precede the development of cancer and help create the conditions in which cancer cells grow. To the extent that these environmental changes can be detected through analysis of screening images, the information can be used to help determine the most appropriate response to evidence of possible cancer growth.

In building their models based on multiple series of images, researchers can use AI to identify differences between successive images — such as small, subtle regions of breast tissue becoming more varied or denser in appearance. As their models grow more

sophisticated, researchers hope they will yield more advanced predictive capabilities. They are exploring the use of deep learning models — an evolution of machine learning that employs many layers of data transformation to extract more meaning from input data. “At the end of the day, we’re trying to generate a probability map that can be visualized and overlaid on the screening image. Each pixel in our map represents the likelihood that observed changes in that part of the region may be a precursor to a malignancy,” states Dr. Hsu. “We’re trying to give radiologists a little more information to help them identify anomalies earlier and decide whether action or closer follow-up is needed.”

Dr. Hsu is working with a multidisciplinary team, which includes Anne Hoyt, MD, section chief of Breast Imaging at UCLA; the UCLA Integrated Diagnostics program, which is a collaboration between the departments of radiology and pathology that involves a team of radiologists, clinical translational researchers, information scientists; and Arash Naeim, MD, the UCLA site-lead for the Athena Breast Health Network.

“Our goal is to help radiologists gain greater confidence in what they are seeing in screening images,” explains Dr. Hsu. “As they are faced with the task of reviewing a growing number of images as screening technology improves, our hope is that these models can help them focus in on areas that may be of particular concern to increase the number of cancers detected while addressing longstanding concerns such as callback rates.” 



Two mammograms, taken seven months apart. The 2D mammogram (left) was originally found to be negative. A spiculated mass, later found to be invasive cancer, was identified in the 3D mammogram (right). Our AI/ML approach will highlight suspicious areas in the normal-appearing image using a probability map (color overlay).