The Future is Bright for Collaboration Between AI and Breast Imagers

Mary Beth Massat

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Michael Linver, MD, FACR, FSBI
X-Ray Associates of New Mexico

Artificial intelligence (AI) is gaining credibility in breast imaging.

Whether it is a study showing that AI outperforms human readers[1] or one showing that a combination of AI and radiologist assessment improves diagnostic accuracy,[2] AI is being recognized for its potential to help address a wide range of challenges in breast imaging.

"In radiology, we have challenges with access to quality care, human error, and radiologist burnout," says Constance Lehman, MD, PhD, director of Breast Imaging and co-Director of the Avon Comprehensive Breast Evaluation Center at Massachusetts General Hospital.

"Although X-ray technology has been around for a very long time, a minority of humans in the world have access to quality radiology technology," Dr Lehman says. "And we need to fix that."

AI may help address these disparities by providing access to specialists and helping to raise the overall quality of care, says Dr Lehman, lead author of a 2016 study by the Breast Cancer Surveillance Consortium (BCSC) that assessed screening digital mammography trends in the US.

According to the study, sensitivity and cancer detection rates have increased since BCSC's 2005 and 2008 reports, likely reflecting digital mammography's improved performance over screen-film mammography, as well as access to pathology data. However, abnormal interpretation rates have also increased.

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The authors found these increases "particularly concerning, given that recall rates have continually failed to meet the recommendations of the ACR and other expert panels going back to the initial report in 2005, despite calls for attention to this matter."[3]

"We found that 40 percent of certified specialized breast imagers operated outside of the recommended guidelines associated with false-positive exams," Dr Lehman says. "That's … something that we really need to address. AI can help reduce the variation in the human ability to perform consistent and accurate interpretations."

Michael Linver, MD, FACR, FSBI, emeritus director of Mammography at X-Ray Associates of New Mexico, agrees, and he expects the potential for AI to aid breast cancer screening and diagnosis to continue growing.

"AI is well suited to breast imaging due to the nature of what we do. We are only looking for one basic disease," says Dr Linver, who is also Program Co-Director of the annual "Mammography in Santa Fe" course. Breast imaging, he says, is unlike chest or abdominal imaging, which can be used to identify multiple possible diagnoses and targets.

"What's problematic as a breast imager is that more mammograms are read by non-specialists than by specialists. [The non-specialists] don't have the same level of expertise, and that means they need a little help," he adds. "That's where CAD (computer aided detection) and AI are

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particularly useful to help them achieve the next level of expertise, where they can perform a lot closer to specialists."

Serving as an assistant to help radiologists interpret breast imaging studies more accurately is likely to come soon, says Christopher Comstock, MD, FACR, attending radiologist and director of breast imaging clinical trials at Memorial Sloan-Kettering Cancer Center.

"We will need a physician's involvement for oversight and to interpret the complexities of each patient," Dr Comstock says. "There is a saying that computers won't replace radiologists, but radiologists with computers will replace radiologists." He analogizes the relationship to that of a pilot and the plane's autopilot capabilities. While technology may often "land" the plane, the pilot must still oversee the landing process.

"We can really benefit from more quantitative analysis of findings," Dr Comstock says. "Humans can take into consideration several features and put together components of the image for the interpretation. Computers can recognize and analyze more information, such as patterns and associations, faster than a radiologist."

Artificial intelligence may also help streamline workflow by previewing and prioritizing mammograms based on suspicious findings.

"There are several studies showing there is a subset of mammograms that could be triaged by AI. [However,] I think it is premature to do that," says Linda Moy, MD, FSBI, Fellowship Director for Breast Imaging at New York University (NYU) Langone Medical Center. Dr Moy was involved in a study finding that the combination of AI and radiologists could more significantly improve breast cancer detection than either one alone.[4]

Another issue is whether patients and referring physicians will accept a diagnosis based only on algorithms or AI, Dr Moy notes, adding that external validation by clinicians and scientists is required to continue pushing the field forward. While screening mammography demonstrates a great need for AI assistance, Moy says, AI can help clinicians read digital breast tomography (DBT) and breast MRI studies containing a large number of images.

AI in Image Capture

Some experts predict a growing role for AI in image capture.

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Dr Moy explains that AI may also help decrease radiation dose in DBT by creating so-called "synthetic images." Generated by a DBT 3D data set, these images can be used to replace standard 2D images. Synthetic CT images are also being created from MRI data, potentially obviating the need for additional imaging. There are also technologies that create synthetic MR images from an MRI dataset, such as diffusion weighted images, which can shorten the MRI scan time.

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Christopher Comstock, MD, FACR, Memorial Sloan-Kettering Cancer Center

With an estimated 75% of U.S. breast imaging centers now using DBT, the need for AI to help specialists read more efficiently is growing, says Dr Linver, adding that a screening tomosynthesis exam typically takes him two to three times longer to read than a screening mammogram.

"If we can use AI to decrease the pool of images, where only the valuable potential pathology information is presented to the radiologist, then that would be a huge step forward and make a difference in our efficiency," he says.

The picture is less clear with respect to AI's value in breast MRI. Although AI may be able to help radiologists read through voluminous MRI data, Dr Moy believes multi-center validation studies are more difficult to perform because comparatively fewer imaging centers perform breast MRI, resulting in less data to train an AI-based breast MRI algorithm.

However, with abbreviated breast MRI protocols becoming more widespread, Dr Comstock foresees an opportunity for AI to help quantify the data from breast MRI, which also delivers kinetic and compositional information; different MR sequences provide different information for interpretation.

"Since there is so much more information, I think it's only natural that CAD and AI are needed more," Dr Comstock says, noting that AI has the potential to offer more robust analyses of multiple sets of data at one time through a trained network that has looked at thousands of cases on a level that is not easily achieved on a case-by-case basis.

"I think it can only improve the accuracy of the interpretation," he says.

Risk Analysis

Beyond imaging, AI may also garner a role in radiomics and radio-genomics, where Drs Comstock and Moy believe AI could help breast specialists go beyond diagnosing and treating breast cancer to predicting breast cancer risk and treatment response.

"There is another layer where we can analyze treatment effect," Dr Comstock says. "There is a whole other realm of AI in terms of analyzing the entire environment, including patient history, genetic testing, pathology, therapy, and how they navigate through the healthcare system to potentially improve outcomes."

"Radiomics and radiogenomics can broaden the scope of how we can interpret images beyond the (traditional) normal or abnormal finding on any imaging test we perform," agrees Dr Moy. "The whole concept of precision medicine is not just treatment of cancer but the treatment of a particular person and what works best for them."

Indeed, Dr Moy points to a growing body of research showing a relationship between a patient's genetic profile and their response to treatment. Precision medicine, she asserts, can encompass lifestyle changes to improve overall health and potentially reduce the likelihood of developing cancer or enhancing treatment response.

Through a collaborative effort of MGH and the Massachusetts Institute of Technology, Dr Lehman has led efforts to develop and evaluate AI algorithms to improve breast cancer risk prediction. For example, the team has used an algorithm to evaluate breast density on mammograms and predict risk of developing breast cancer. The model performed well at MGH and has since been validated at other centers. The most recent findings will soon be published, Dr Lehman says.

"Commercially available risk models to predict future risk of breast cancer for an individual woman just don't work that well," Dr Lehman says. "It's an uncomfortable truth, but most … women diagnosed with breast cancer have no currently known risk factors, other than being female. Second, there are patients who were identified as high risk who never developed breast cancer. Third, what was really shocking to us is how poorly the commercial models performed in racial and ethnic subgroups."

Most models, she says, were developed in Caucasian women but are also being applied to Hispanic, Black, and Asian women.

"So poor sensitivity, poor specificity, and racial and ethnic biases of existing risk models plague us," Dr Lehman says.

Despite Some Challenges, AI's Future Is Bright

One hurdle still standing in the way of widespread adoption of AI in breast imaging, says Dr

Comstock, is that many such developing technologies may not be applicable across different practices and population groups.

"The challenge is wide validation of these different systems so that the radiologist has a clear understanding of what that information, or score, means," he says. "How does the information impact the decision to biopsy or not? How will it change actual patient care and practice decisions? It needs to be clear for the users who adopt the technology how to use the specific tool."

AI will also need to be seamlessly incorporated into reading environments. Dr Comstock indicated historically many centers have needed separate workstations in addition to their PACS workstation to interpret DBT and MRI CAD studies. He believes most radiologists, like himself, don't want yet another workstation for AI-assisted interpretations.

Data sharing issues also need to be addressed, says Dr Moy, who was recently involved in the RSNA's AI COVID-19 Task Force to identify institutions interested in sharing data. Many institutions in China had already signed contracts with vendors for chest X-ray or chest CT data to develop AI solutions.

"We need to share our data anonymously and safely, and from multiple areas of research," Dr. Moy says. "That requires buy-in from multiple centers."

Fourth, AI algorithms developed on modern digital systems may not deliver the same or similar results on older technology.

"Some AI tools have been developed on very high quality images from select specialized centers, and the results didn't translate into general practice where the quality of the images was not as high," Dr. Lehman says.

Finally, quality assurance is vital, Dr. Lehman says. Whether the "reader" is a computer or a human, "In the end, it's an answer given to a patient or referring physician. We still need to have that quality oversight," she says.

Dr Linver agrees. "Anytime we rely on a machine, we had better be sure it is basing a decision on valid, good data, otherwise it is potentially dangerous. Breast imagers want to be more efficient in the ability to get through the cases but not sacrifice accuracy."

Despite these challenges, the experts consulted for this article believe the future of collaboration between AI and radiologists is bright.

"It's an exciting time as we enter a new era in breast imaging," Dr Linver says. "While we've decreased the death rate from breast cancer by 40 percent in the US in the last three decades, some countries in Europe have decreased it by as much as 60 percent because more specialists read mammograms. This is the greatest potential for AI, to brings us all to the level of experts in breast imaging and make breast cancer a less lethal disease."

"We can imagine a day when we have more time to provide higher-quality care to our patients," Dr Lehman says, and "when we're using these tools to free up more of our time to focus on those things that require human intervention and allow the AI tools to do what they do best."

References

1. McKinney, S.M., Sieniek, M., Godbole, V. *et al.* International evaluation of an AI system for breast cancer screening. *Nature* 577, 89–94 (2020). https://doi.org/10.1038/s41586-019-1799-6
2. Schaffter T, Buist DSM, Lee CI, et al. Evaluation of Combined Artificial Intelligence and Radiologist Assessment to Interpret Screening Mammograms. *JAMA Netw Open.* 2020;3(3):e200265. doi:10.1001/jamanetworkopen.2020.0265.
3. Lehman CD, Arao RF, Sprague BL, et al. National Performance Benchmarks for Modern Screening Digital Mammography: Update from the Breast Cancer Surveillance Consortium. *Radiology.* 2017;283(1):49-58. doi:10.1148/radiol.2016161174.
4. Wu N, Phang J, Park J, et al. Deep Neural Networks Improve Radiologists' Performance in Breast Cancer Screening. *IEEE Trans Med Imaging.* 2020;39(4):1184-1194. doi:10.1109/TMI.2019.2945514.

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