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Mini Review

Artificial Intelligence in Radiology-Breast Imaging and Beyond

Logan K Young*

6332 Gun Mount Court, VA 20121, Centreville, USA

***Corresponding author:** Logan K Young, 6332 Gun Mount Court, VA 20121, Centreville, USA

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Just as the adoption of full-field digital mammography (FFDM) over analog film improved breast cancer diagnoses in the early 2000s, and recent studies continue to suggest the efficacy of digital breast tomosynthesis (DBT) beyond FFDM even, the clinical signs thus far are pointing to artificial intelligence (AI) as the next frontier in breast cancer detection. Marrying unparalleled efficiency with an ever-improving accuracy often indistinguishable from its programmer, AI, machine learning, and predictive analytics provide a much-needed framework for patient education, while bolstering the entire enterprise of contemporary radiology, itself. Whereas AI-synched networks for breast imaging are currently limited in use in the United States, the practical need to integrate some aspect of automation into the screening environment remains. Distinct from the 2-dimensional mammogram with its average yield of 5 images, the granularity afforded by DBT results in much larger datasets, which, in turn, drastically increase the amount of time needed to analyze them.

To wit, in her remarks to the 2019 European Congress of Radiology in Vienna, Dr. Kristina Lång of Lund University in Sweden asserted that AI-assisted modalities promise not only to reduce radiologists' screen-reading workload, but may curtail screening costs and false positives, too. As per Dr. Lång's accompanying research, 9,581 double-read mammography exams from a subset of the Malmö Breast Tomosynthesis Screening Trial were evaluated by hierarchical learning software, assessing the risk of each exam on a scale from 1 to 10 (10 denoting the highest risk for malignancy). Her colleagues then analyzed this computer-aided detection to determine if normal exams could be reasonably excluded, as well as what kinds of cancers the AI may not have been able to detect at all:

a. 19% of screening exams were labeled as risk level 1 or 2. AI alone could safely read them.

b. 69% were labeled level 3 through 9, and 31% of the exams were cancer. They could be single-read exams.

c. 12% were level 10; 69% were cancer. These could be double-read exams.

"With further improvement of the software," Lång maintains, "an even greater exclusion of normal mammograms seems possible since the majority of the cancers with low-risk scores were clearly visible" [1].

One month later, the Journal of the National Cancer Institute published a more comprehensive study, co-authored by Dr. Lång, comparing stand-alone performance of an AI complex presently on the market to 101 practicing radiologists who interpreted digital mammography examinations in relation to other research. Trained and tested on more than 189,000 mammograms-9,000 with cancer versus 180,000 without any kind of abnormality-altogether, the machine learning system had an area under the ROC curve (AUC) of 0.840. Meanwhile, the average AUC of the 101 radiologists was 0.814. For the 28,000 interpretations included in this study, the performance of the AI proved statistically noninferior to that of the radiologists' average [2].

When it comes to how international patients perceive the use of AI in radiology, however, it seems that the radiologist still rates superior. Writing in the Journal of the American College of Radiology, Dr. Marieke Haan of the University of Groningen in the Netherlands and her colleagues acknowledged "several narrow task-specific AI applications have been shown to match and occasionally surpass human intelligence" [3]. Nonetheless, the 20 patients (median age, 64 years) Dr. Haan randomly surveyed after receiving outpatient CT scans of the chest and abdomen in the summer of 2018 registered an initial preference for a human to read their results-a proclivity Haan's researchers attributed to a diverse lack of understanding about radiology in general, AI at large, how radiology can combine with AI, the evaluation of scans by a radiologist versus a computer, the reception of results from a medical doctor versus a computer, and whether a machine should only answer queries from referring physicians or also conduct searches for incidental findings.

As Haan and colleagues concluded: "The six identified domains of patients' perspective on the use of AI in radiology could provide a framework for patient education, and for future quantitative research to investigate and match patients' expectations with the development and implementation of AI systems in radiology practice."

With expectations rising to the level of national decree, on February 11, 2019, President Donald Trump signed a 2,700-word executive order prioritizing the development and regulation of AI, including "the allocation of high-performance computing resources for AI-related applications through:

a. Increased assignment of discretionary allocation of resources and resource reserves; or

b. Any other appropriate mechanisms" [4].

Referencing Alex Azar, United States Secretary of Health and Human Services, yet absent of specifics pertaining to the health care sector-much less the state of 21st-century breast imaging-as a statement of policy, Executive Order 13859 did lend credence to the latest financial projections from Applied Radiology. In a scant two years, the marketplace for AI health care is estimated to top $6.6 billion. Moreover, come 2026, a full-on embrace of AI, machine learning, and predictive analytical applications could potentially save the United States health care economy up to $150 billion each year.

"As we move to value-based imaging, we continually try to optimize the quality of the images that we are capturing," says Rasu Shrestha, MD, MBA, Chief Innovation Officer for the University of Pittsburgh Medical Center and Executive Vice President of UPMC Enterprises. "AI has the ability to help intellectually guide us through the best ways to capture studies for the right subjects, whether that be an obese patient, a pediatric patient or anyone else" [5].

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