Artificial Intelligence for Prostate Cancer Radiology and Pathology — and Perhaps the Two Combined

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Artificial intelligence algorithms can contribute to prostate cancer care on both the radiology side — by assessing cancer risk and identifying suspicious structures for targeted biopsy — and on the pathology side by analyzing histology data to detect and grade prostate cancer. Researchers at UCLA are currently working on an artificial intelligence system that would fuse radiology and pathology data to create a diagnostic tool that could function as an "imaging biopsy."

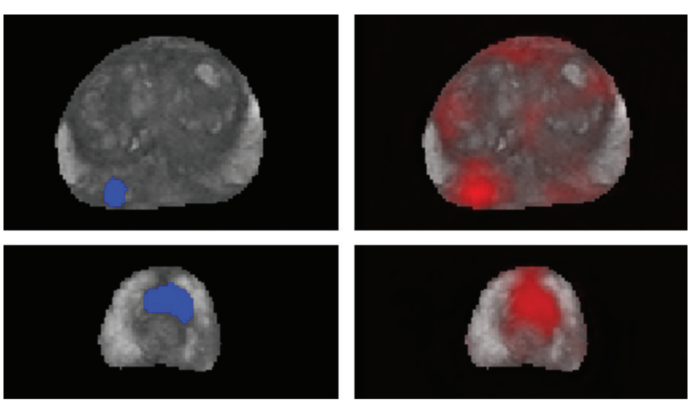
Radiology AI can apply elite expertise to every scan

Radiologists express their suspicion of prostate cancer using the PI-RADS scale, assigning a numerical score of 1 through 5, with higher scores indicating increased cancer suspicion. Low PI-RADS scores express lower confidence that a region of interest (ROI) visible on mpMRI (multi-parametric magnetic resonance imaging) is cancerous.

"Because PI-RADS scores rely on the judgement and experience of the radiologist, there can be inter-rater disagreement in assigning these scores," states Corey Arnold, PhD, Associate Professor of Radiological Sciences, Pathology & Laboratory Medicine and Bioengineering, and Director of UCLA's Computational Diagnostics Lab. "One of the goals in applying artificial intelligence to prostate cancer imaging is to bring greater consistency to these scores." Using AI algorithms trained on data sets that were annotated by radiologists who are among the leading specialists in prostate cancer, the level of analysis performed by general radiologists might be elevated to match the expertise available at major academic medical centers. Using artificial intelligence, all radiologists — generalists and specialists — can benefit from a system able to add an overlay to the image indicating suspicious ROIs (Figure).

AI applied to pathology to ease and speed a time-consuming process

Pathologists perform histological analysis of biopsied tissue to establish a definitive diagnosis of prostate cancer, assigning Gleason scores to characterize cancer grade. At UCLA, template plus targeted biopsies are frequently performed using MR images fused with ultrasound guidance to direct the biopsy. Each core is examined microscopically to establish cancer presence and grade. It is a time-consuming process that could be made considerably less burdensome by using AI algorithms that have been trained to process digitized histology data and automatically detect and grade cancer.



Radiologist drawn regions of interest for cancer suspicion (left column) with corresponding AI predictions (right column).

Pathology results from each needle location can be mapped back onto the mpMRI image to place histology data within the MR space. "We can use this information to train algorithms to predict Gleason scores from mpMRI alone," says Dr. Arnold. "Furthermore, as each biopsy reveals the underlying pathology at a location within the prostate, we are also developing algorithms that apply pathology data from all the areas sampled to analyze the mpMRI pixels between biopsy locations, potentially allowing for more accurate diagnosis of the entire gland." If successful, these techniques could allow low-risk men to avoid or delay unnecessary biopsies. While less invasive that surgery, prostate biopsies are unpleasant procedures that are not without risk, facts that are particularly relevant to men with low-grade cancer in active surveillance programs, which typically specify a biopsy every six to 12 months.

Beyond diagnosis: predicting aggressive prostate cancer

Many men with low-risk disease do not require treatment; however, a subset of these cancers have the potential to become lethal. There is currently a lack of robust methods to distinguish these two cohorts, leading many men to undergo unnecessary definitive treatments (e.g., surgery), which include the risk of adverse outcomes. Dr. Arnold's team is investigating fusion techniques that employ artificial intelligence to combine all relevant patient data to better predict cancers that will transition from indolent to aggressive. "We're looking at ways to combine clinical, radiology, pathology, and genetic data into a single multi-scale, multi-modal model that can predict cancer aggressiveness," says Dr. Arnold. Such a technique could help better inform patients regarding treatment decisions. "Some men diagnosed with low-grade prostate cancer are not comfortable living with the disease and elect for treatment over active surveillance," he explains. "A more precise model could offer patients another data point to reassure them that their individual risk for disease progression is low."