Harnessing AI to Enhance HER2/neu Breast Cancer Assessment:

A Collaborative Effort at Qatar University

Dr. Semir Vranic, Associate Professor of Pathology, College of Medicine

Dr. Rafif Abdulaziz Mahmood, Assistant Professor of Pathology, College of Medicine

Dr. Muhammad Enamul Chowdhury, Assistant Professor of Electrical Engineering, College of Engineering

Qatar University

Qatar University's College of Medicine and College of Engineering have partnered to advance the field of breast cancer diagnostics using pioneering artificial intelligence (AI) technologies. Their recent work, published in "Expert Systems with Applications (IF 7.5)," highlights a deep learning-based framework developed to automate HER2/neu assessment in breast cancer. This interdisciplinary collaboration showcases the power of combining medical expertise with AI innovations to tackle one of the key challenges in breast cancer pathology.

The Role of AI in Pathology

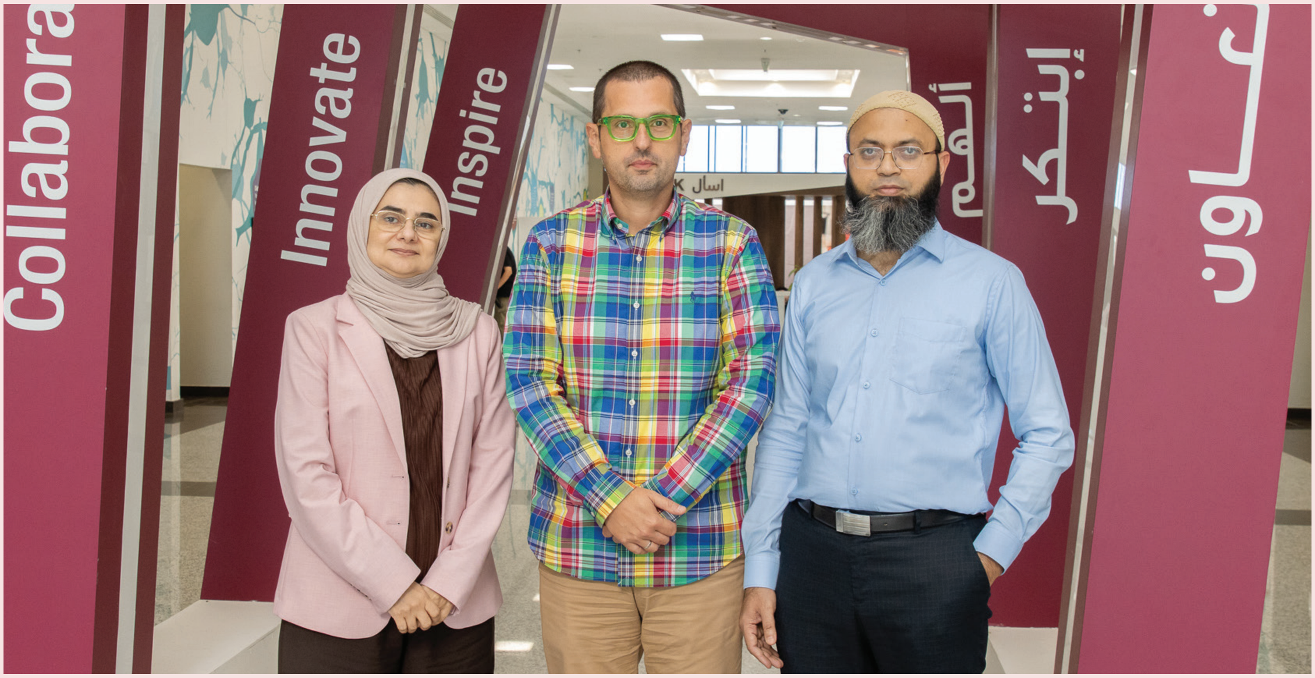
AI is rapidly transforming pathology by offering tools that can assist pathologists in diagnosing diseases with greater speed, accuracy, and consistency. In traditional pathology, the evaluation of tissue samples, such as those used in cancer diagnostics, relies heavily on manual analysis, which can be time-consuming and prone to inter-and intra-observer variability. AI models, particularly deep learning, have shown tremendous potential to reduce these variabilities by learning intricate patterns in tissue samples and automating diagnostic tasks.

In areas like cancer diagnostics, AI can assist in identifying malignant cells, classifying tumor grades, and even predicting treatment responses. AI's ability to process vast amounts of data and recognize subtle visual cues in histological images allows pathologists to make more informed decisions, particularly in cases where human judgment may vary. By augmenting human expertise, AI can enhance diagnostic accuracy and efficiency, enabling pathologists to focus on complex cases and improving overall patient care.

Challenges in HER2 Assessment in Breast Cancer

HER2/neu, a protein found on the surface of certain breast cancer cells, plays a crucial role in determining treatment options for patients. HER2-positive breast cancers, which account for 15-20% of cases, are typically more aggressive but respond well to targeted therapies like trastuzumab and pertuzumab. As such, accurate assessment of HER2 status is vital for effective treatment planning.

The standard method for evaluating HER2 is



From the left: Dr. Rafif Abdulaziz Mahmood, Dr. Semir Vranic, and Dr. Muhammad Enamul Chowdhury.

immunohistochemistry (IHC), where pathologists visually assess the intensity and completeness of cell membrane staining. However, this manual method has limitations, including subjective interpretation, variability between pathologists, and challenges in cases with heterogeneous staining. Fluorescence in-situ hybridization (FISH) is often used as a follow-up test for equivocal cases, but it is time-consuming and costly.

Automating the HER2 assessment using AI can address many of these challenges by providing more consistent and objective results. The AI-based framework developed by Qatar University uses deep learning models to analyze digital whole slide images (WSIs) of stained tissue samples. It automatically identifies tumor regions and classifies HER2/neu scores (0, 1+, 2+, and 3+), offering a more reliable alternative to manual scoring. This approach significantly reduces variability and improves the speed and accuracy of HER2 assessments, allowing for faster diagnosis and treatment decisions.

Overcoming Challenges and Future Directions

While AI shows great promise in pathology, several challenges remain with its implementation. One key issue is ensuring the generalizability of AI models across diverse populations and healthcare settings. AI systems trained on specific datasets may not perform so well on images from different laboratories or patient populations. Additionally, regulatory and ethical considerations around AI adoption in clinical practice, such as ensuring transparency and interpretability of AI decisions, must be addressed.

In the case of HER2/neu assessment, AI has the potential to enhance diagnostic accuracy and reduce inter-observer variability, but further validation is needed to ensure that AI models can handle complex cases, such as those with borderline staining or tumor heterogeneity. Qatar University's collaborative work serves as an important step in this direction, demonstrating how AI can be successfully integrated into clinical workflows to complement human expertise.

As AI technologies continue to evolve, they will likely play an increasingly central role in pathology, aiding in disease detection, diagnosis, and personalized treatment planning. The collaboration between Qatar University's pathologists and engineers/AI experts underscores the immense potential of interdisciplinary approaches in healthcare innovation, driving improvements in patient outcomes and shaping the future of medical diagnostics.