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ARTIFICIAL INTELLIGENCE IN HEALTHCARE

There is no question that artificial intelligence is moving quickly in the healthcare industry. Even just a few months ago, AI was still a dream for the next generation: something that would start to enter regular care delivery in a couple of decades —maybe ten or fifteen years for the most advanced health systems.

But research has progressed more quickly than anyone could imagine, and AI tools are now becoming much more sophisticated—and much more widely used—for supporting high-quality patient care.

At the 2019 World Medical Innovation Forum, hosted by Partners HealthCare, researchers, clinicians, and developers took time to celebrate this rapid-fire progress and the unprecedented opportunities for improving the care of patients with both routine and rare conditions.

But they also tempered their enthusiasm with reflections on the challenges of integrating meaningful Al-driven insights into every aspect of routine care.

From aggregating data and eliminating bias to developing the workflows and infrastructure that make AI possible, the healthcare industry still has many obstacles to overcome before machine learning becomes commonplace for clinicians and patients. Capitalizing on the opportunities for artificial intelligence in healthcare will require a concerted effort from across the care continuum and a willingness to embrace innovation as artificial intelligence approaches its inflection point in healthcare.

"We are at a turning point in terms of how we can use data to support improvements to the healthcare system," says CMS Administrator Seema Verma. "The timing is right for true digital transformation."

"Artificial intelligence is maturing. Data interoperability is starting to improve. The drivers of consumer-focused healthcare are getting stronger. This is just the beginning of how we envision Al impacting the healthcare industry. There are so many ideas about lowering costs and improving health outcomes, so it's a very exciting time for digital innovation."

To see success in this exciting area of analytics, institutions will need to reframe the way they think about the big data that will become increasingly vital for cutting costs and improving outcomes: what types of data are useful, how to manage that data, and how to apply actionable insights to patient care.

SUPPORTING IMMEDIATE IMPROVEMENTS TO CLINICAL CARE

The time frame for artificial intelligence has shortened significantly thanks to advances in infrastructure, data storage, and algorithm development.

No longer the exclusive provenance of researchers and academics, artificial intelligence is quickly filtering into the everyday clinical setting.

From supporting radiologists to enhancing the impact of the patient's voice in her own care, AI is already having a meaningful impact on the quality and accuracy of care.

Connecting human intelligence and clinical expertise with the unparalleled data processing power of deep learning algorithms and advanced neural networks is opening up a new frontier for precise, personalized diagnostics and treatment—but not just for rare cancers or one-in-a-million genetic conditions.

Using AI to expand the health system's capacity to conduct effective screenings, reduce pain points in the care process, and augment clinical decision-making can help the industry save billions of dollars each year and more importantly, potentially save an untold number of lives. "Our current tools to predict future risks are simply not accurate," said Constance Lehman, MD, PhD, chief of the breast imaging division at Massachusetts General Hospital (MGH) and a professor of radiology at Harvard Medical School.

"For breast cancer, the emphasis is still on latestage diagnosis because we are not screening as comprehensively or as well as we should be."

Even patients who do get mammograms at recommended intervals are not receiving uniformly high-quality care from radiologists, she said.

"Human interpretation of images is highly subjective. We don't have enough people to read these images, and we don't have enough people who can do it to the highest standards," she stated.

Forty percent of certified breast imaging radiologists perform outside of recommended ranges for acceptable specificity, Lehman's earlier research has shown. Even agreement around one of the most important fundamental predictors for breast cancer, the density of the tissue, can vary wildly.



Some radiologists designate less than 10 percent of breast tissue as dense, said Lehman, while others will label more than 80 percent of mammograms in the same way.

Deep learning can help providers do more with less—and do it more accurately.

"Deep learning can use full-resolution mammogram images to accurately predict the likelihood of a woman developing breast cancer. Importantly, it is accurate across all races. Existing models are worse than chance at predicting breast cancer in African-American women. We need something better than that."

An algorithm trained on more than 70,000 images consistently outperformed the commonly used risk model, even when the tool lacked additional data on the patient and only had access to the image itself.

With more than two million new breast cancer diagnoses each year, improving the health system's ability to identify individuals at risk and provide early treatment to those with cancer could have a drastic impact on outcomes for hundreds of thousands of women.

Lack of education and awareness among breast cancer patients are some of Lehman's biggest foes, but artificial intelligence is already helping her win the battle. "No matter what clinics I work in, we see women who are so surprised when we tell them they have breast cancer," she said. "It happens in women who have no history of it in their family, who eat right and exercise. And it happens in women who have an incredibly high risk who come in with advanced cancers, some of which have already metastasized. The most common response I get is, 'I just didn't know.'"

"Artificial intelligence is maturing. Data interoperability is starting to improve. The drivers of consumer-focused healthcare are getting stronger. This is just the beginning of how we envision AI impacting the healthcare industry."

"This is the year we are going to change that. This is the year we can start to use artificial intelligence to inform women of their risk with a level of accuracy that we have never had before. We are going to get rid of that feeling of 'I didn't know; I never heard.' And as a result, we are going to save lives."

"That is the promise of AI in healthcare, and that is achievable right now with the technology and the data we have today."

DEVELOPING TRUST AND ACCEPTANCE FOR AI TOOLS AMONG END USERS

Trust and acceptance are two of the biggest obstacles for artificial intelligence, especially among physicians who tend to be wary of any changes to their workflows.

"There is enormous hype around artificial intelligence, and we do need to be cautious when discussing what is possible now and what will be possible in the near future," said Katherine Andriole, PhD, Director of Research Strategy and Operations at MGH & BWH Center for Clinical Data Science and Associate Professor of Radiology at Harvard Medical School.

"It's important to set expectations and acknowledge that there are major challenges ahead of us that will be difficult to address."

One of the first challenges is education. Some healthcare stakeholders still need to be disabused of the notion that AI is a job-killer, or that it's intended to replace human clinicians with robot equivalents.

"I don't believe that AI will replace anyone at scale," she said. "It is definitely a different way of doing your job, but it should end up being a better way. It should be an augmentation to the clinical skills and judgment of someone like a radiologist, who reviews thousands of images every day, making critical and nuanced decisions about each one."

"We don't expect AI to take over that process—we expect it to augment the workflow and provide some additional guidance that makes a good radiologist into a better radiologist."

Machine learning tools are intended to catch the types of issues that may otherwise fall through the cracks, she continued.

"An algorithm might say, 'Oh, I see a potential fracture here, or some bleeding over there—did you look in those places? Do you agree that there's a problem, or is it really okay?' That's decision support, not decision-making. I don't know a single person who couldn't benefit from a safety net like that sometimes."

Any organization looking to purchase a product that purports to have an AI foundation will need to assess the tool for accuracy and flexibility carefully.

"Most AI tools that are being demonstrated to prospective customers have been trained on a specific patient



population that doesn't always represent the same patients that you will be treating," she said.

"One of the problems with training machine learning algorithms is the concept of overfitting. You can train a model to exactly recognize the training set that you use, and it becomes so convinced that the data represents everything it needs to know that it can't be generalized to different sets of data. So may look like it's working well during that sales meeting, but you need to try it on your own data to see if it is truly capable of meeting your specific needs."

Andriole suggests having a clinical champion involved in the vetting process, even if that person is not an expert in machine learning or data science.

"Clinicians are so valuable during the evaluation process," she stressed. "They have the subject-matter expertise to say, 'Hey, I know this patient looks like she has this condition, but I've seen mimics like this before, and I know it's this other problem. The algorithm isn't picking that up."

Vendors should be open to letting potential clients put a product through its paces and should not shy away from helping providers run their own data through the algorithm.

"Any vendor should be willing to let you import your own data and have your clinical staff poke and prod at

the details. If the vendor isn't willing to do that, I would be a little concerned that they don't have that kind of faith in their own product and its ability to work on 'wild' data, as it were," said Andriole.

Making informed decisions about artificial intelligence will help healthcare organizations find the right applications for machine learning within their current care processes without overselling the capabilities of these tools.

"You can train a model to exactly recognize the training set that you use, and it becomes so convinced that the data represents everything it needs to know that it can't be generalized to different sets of data."

"When AI becomes less of a mystery, and less of an eerie magic box that is going to take your job, then you can start thinking about its strengths and weaknesses in a more measured manner," said Andriole.

"That's when you can start identifying use cases that will have a real impact on quality and outcomes, like triaging stoke types in the ED or improving the process of predicting risk by using machine learning to read EEGs."





CREATING A NEW PARADIGM FOR SUCCESS IN AN AI-DRIVEN WORLD

Bringing artificial intelligence into the clinical setting will require wholesale changes to the way the healthcare industry—and its consumers—view data on a conceptual level, said Calum MacRae, MD, PhD, chief of cardiovascular medicine at Brigham & Women's Hospital (BWH).

"In other industries, data sharing is de facto," he said. "When you use Uber or Google, you are contributing data to the model and helping those companies refine their algorithms and improve the ability for you and all other consumers to use the model going forward. There is a sense that people hold onto their health data because they don't get anything in return."

"If we could tell patients that we are using their clinical data and their TV viewing data to predict the risk of dementia," he continued, "would that not be worth allowing us to get access, in a secure environment, to both of those things? But nobody is making those arguments. That's a huge missed opportunity."

MacRae was not the only presenter at the World Medical Innovation Forum to express frustration with the inability to access data on the scale required to train AI robustly.

Nearly every session featured some mention of the need to educate patients about contributing their data to research and the challenge of unlocking data siloes created by competing business incentives, legacy technologies, and a reluctance to expose organizations to any level of risk.

"What we need is the equivalent of a USB port for data," said Alistair Erskine, MD, MBA, chief digital health officer at Partners. "Right now, there is no way for me to go into a healthcare organization, plug my algorithm into a standardized interface, and be sure that it will work in the same way no matter where I go."

"Part of that is because there is no universal model for data in healthcare; part of it is because of the transactional health IT systems we have. But if we could build those standards and lock down the security of the data so that the risk is lower than it is right now, we could make progress in leaps and bounds."

MacRae doesn't believe that the problem can be completely attributed to cumbersome technologies or outdated regulations, however. The attitudes of the healthcare industry itself are also to blame. "It actually requires an active effort to stop the technologies, approaches, and ideas from outside of healthcare," he said. "We've done that partly because we're conservative, partly because we're afraid, and partly because the risks are legitimately high. But we have to break out of that mentality soon; otherwise, we're going to keep having an 18th-century healthcare system in a 23rd-century world."

"I believe that one of the core professional mandates for physicians is to lead us there in a way that is responsible and truly beneficial to the patient. If we don't do that, we are compromising our long-term vision for how healthcare should evolve."

"What we need is the equivalent of a USB port for data. Right now, there is no way for me to go into a healthcare organization, plug my algorithm into a standardized interface, and be sure that it will work in the same way no matter where I go."

Artificial intelligence may be uncannily adept at identifying cancers or flagging high-risk patients, but it can't necessarily determine how humans define success for an Al implementation. A financial return on investment may be part of it; an improvement in clinical quality measures might be another. But the real metric for providers is whether or not artificial intelligence helps them inform patients better about their personal risks, catch developing conditions earlier, and empower consumers to make the right choices for their own individual care.

"I'm looking forward to having the 'easy button' for evidence-based medicine," said Erskine. "When a patient comes into the hospital, I want to be able to push a button and find every other patient in the history of my data repository that is just like them."

"As a clinician, sometimes I think that I make decisions based on my heart or my gut: things that don't have evidence that I can point to."

"But the truth is that the evidence does exist, and I'm not making these decisions based on nothing. It's just that the evidence is buried somewhere so deep in the data that I can't find it within the time I have to treat that person. Artificial intelligence can do that for me."



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