

Thinking inside the box with AI and ML: A new kind of “insider intelligence”

Mary Beth Massat and McKenna Bryant

The healthcare artificial intelligence (AI) market is projected to reach \$6.6 billion in 2021, with AI applications potentially creating up to \$150 billion in annual savings for the U.S. healthcare economy by 2026. It's no wonder that 39% of healthcare provider executives are planning to invest in AI, machine learning (ML), and predictive analytics.

There are more options than ever, as healthcare companies embed AI in diagnostic imaging systems to streamline the data capture and analysis process, with dramatic implications for some of society's most pressing medical challenges.

“There has been a remarkable embrace of everything and anything AI related to imaging and beyond,” says Rasu Shrestha, MD, MBA, Chief Innovation Officer for the University of Pittsburgh Medical Center (UPMC) and Executive Vice President of UPMC Enterprises, both in Pittsburgh, PA. “Right now, we are seeing the peak of the hype cycle with AI, to the point that many companies had something on AI to showcase in their booth at this past

RSNA. It is important, however, that we are careful to not throw everything into the AI or machine learning bucket.”

He adds that it's also important to understand the specific needs within workflow and around the augmentation of human capabilities utilizing technological advancements that are being made in AI and ML. The use of AI in imaging modalities could assist with quality issues related to imaging, particularly in the use of contrast, and could help with identifying appropriateness of the study and guide image capture on a modality.

“As we move to value-based imaging, we continually try to optimize the quality of the images that we are capturing,” he explains. “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.”

However, it is important for the industry to take a step back, perhaps hit the AI reset button, and consider the broader implications of embracing AI, Dr. Shrestha says. He suggests there is a need for more data science training embedded into the curriculum of medical schools, residencies and fellowships, as well as more focus on delivery mechanisms and workflows

in clinical practice...and not just on an application.

Dr. Shrestha believes that AI will help advance some of the broader strategies within healthcare, such as personalizing an individual's care or quantifying the value of a specific task, such as segmenting and tracking a lesion over time and then correlating those actions to improved patient outcomes.

“AI will help us get to personalized medicine sooner, but it is not the silver bullet,” Dr. Shrestha cautions. “It is really important to understand that AI, like anything else, is an enabler. How we capitalize on it to achieve our broader ambitions and goals is very important.”

The other element of AI as an enabler to personalizing care is to shift the conversation and focus from utility to experiential. Dr. Shrestha often discusses the user interface and the user experience being of paramount importance, perhaps even more important than the algorithms on the back end.

“If we go that extra mile, and the app that is created ties to that broader context of value generation or value quantification, then we are moving beyond where we are right now, which is the proliferation of AI as point solutions across the board,” Dr. Shrestha says. “I urge us all to think more broadly and

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more holistically on how AI can impact workflow and truly add value to the overall strategies that we are developing in our imaging departments and health-care facilities.”

AI in medical imaging systems

At the 2018 edition of the Radiological Society of North America’s scientific exhibition in Chicago in December, many companies showcased how they’re holistically implementing AI in their diagnostic imaging systems to not only more effectively address wide-ranging clinical conditions, but also to simplify physician workflows and departmental throughput.

Worldwide, more than 50 million people suffer a traumatic brain injury (TBI) each year, and it’s estimated that approximately half the world’s population will be subject to one or more TBIs during their lifetime. Yet attempts to personalize treatment can be hampered by qualitative approaches to characterize the nature and severity of TBI.

To address this global issue, icometrix has received an additional FDA 510(k) clearance for icobrain, which now also includes icobrain tbi for computed tomography (CT) images. Leveraging deep-learning algorithms, icobrain tbi is the first CT product to be applied clinically to patients with traumatic brain injuries. Icobrain uses deep learning to quantify clinically important metrics, including hyperdense volumes, cisternal compression, and midline shift to better characterize and management of TBI in an acute clinical setting.

“The development of this product quantifying CT scans of TBI patients in routine clinical practice helps in the standardized interpretation of acute non-contrast CT scans,” said Bart Depreitere, MD, PhD, neurosurgeon at University Hospital Leuven (Leuven, Belgium). “Up until today, TBI was always assessed with the naked eye, but this is now complemented by AI technology to provide valuable metrics fol-

lowing clinical guidelines for improved patient care.”

Other products fuse AI and diagnostic imaging to create a wholly new system. The Aquilion ONE™ / GENESIS Edition premium CT system from Canon Medical Systems USA, Inc. features the company’s Advanced Integrated Clear-IQ Engine (AiCE), pending 510(k) clearance, a groundbreaking Deep Convolutional Neural Network (DCNN) image reconstruction for CT that uses deep learning technology to differentiate signal from noise so that it can suppress noise while enhancing signal.

The algorithm forges a new frontier for CT image reconstruction with its ability to learn from the high image quality of Model Based Iterative Reconstruction (MBIR) to reconstruct CT images with superior spatial resolution and low contrast detectability, three to five times faster than traditional MBIR.

With AiCE’s deep learning approach, thousands of features learned during training help to differentiate signal from noise for improved resolution. AiCE applies a pre-trained DCNN to enhance spatial resolution while simultaneously reducing noise with reconstruction speeds fast enough for busy clinical environments.

“In AiCE, the algorithm looks for patterns of noise and learns what those patterns are doing, then detects and subtracts noise from the image to improve signal, making the images much more pristine,” explained Dominic Smith, senior director, CT, PET/CT, and MR Business Units, Canon Medical Systems USA. “With AiCE technology, we haven’t just raised the bar, we’ve set a new standard for image reconstruction in CT.”

FUJIFILM Medical Systems U.S.A., Inc. is launching REiLI, pending 510(k) approval, the company’s global Medical Imaging and Informatics AI technology initiative. Under the REiLI brand, Fujifilm is developing AI technologies that strongly support diagnos-

tic imaging workflow, leveraging the combination of deep learning in its AI technology with Fujifilm’s image processing heritage.

“The REiLI AI platform demonstrates how we’re designing the future of radiology workflow using big data to support clinical decisions,” said Johann Fernando, PhD, Chief Operating Officer of FUJIFILM Medical Systems. “With just the push of a button, radiologists will be able to apply AI algorithms to a patient study, which will help them make clinical decisions.”

Through two strategic partnerships, Guerbet is leveraging AI in its diagnostic and interventional imaging care products.

An ongoing collaboration with IBM Watson Health allows Guerbet to deliver Watson Imaging Patient Synopsis, a radiologist-trained artificial intelligence (AI) tool that extracts relevant patient information, summarized into concise, single-view reports to better inform diagnostic decisions.

“This new software is artificial intelligence based to support clinical decisions for doctors, enabling them to access patient history in one page. It not only collects information and structures it, it also highlights the most important parts. Now the doctor and radiologist can have a clear understanding of the patient without scrolling through pages and pages in the digital record. It’s a major development in the decision support system,” said Massimo Carrara, Guerbet Vice President for North America.

The company’s commercial partnership with Imalogix will allow it to help optimize diagnostic and interventional imaging care. The Imalogix™ Platform gives healthcare organizations the tools to understand and manage the process, quality and safety related to diagnostic imaging and interventional procedures, and meet evolving regulatory standards surrounding radiation dose management with ease.

The commercial partnership combines Guerbet’s leadership in diagnostic

and interventional imaging with the cloud-based human and machine-intelligence capabilities of Imalox™ to proactively identify areas that impact care delivery to reduce variability and improve the quality, safety and efficiency of care around radiation dose management.

At RSNA 2018, GE Healthcare unveiled new applications and smart devices built on Edison, a next-generation intelligence platform that helps accelerate the development and adoption of AI technology and empower providers to deliver faster, more precise care. It expands on GE Healthcare's 200+ imaging applications with new technologies to improve scan consistency, help clinicians detect and prioritize acute cases, and extend the lifecycle of devices.

"Edison provides clinicians with an integrated digital platform, combining diverse data sets from across modalities, vendors, healthcare networks and life sciences settings," said Kieran Murphy, President and CEO of GE Healthcare. "Applications built on Edison will include the latest data processing technologies to enable clinicians to make faster, more informed decisions to improve patient outcomes."

As a holistic and integrated digital platform, Edison combines globally diverse data sets from across modalities, vendors, healthcare networks and life sciences settings. Clinical partners will use Edison to develop algorithms, and technology partners will work with GE Healthcare to bring the latest advancements in data processing to Edison applications and smart devices.

"Edison brings together data from many different sources, both inside and outside the hospital infrastructure, from multiple modalities, from multiple vendors, from multiple hospital networks – even clinical group trials and genomics. Edison brings all that data in and packages it in a way that helps clinicians guide diagnosis, speed up treatment, deliver better outcomes and increase

patient satisfaction," said David Seda, Chief Marketing Officer, Vice President, Healthcare Digital.

Devices with Edison include:

AIRx (510(k) pending) — An AI-based, automated workflow tool for MRI brain scanning designed to increase consistency and productivity, AIRx is designed to provide automated slice prescriptions to help reduce previously redundant, manual steps. AIRx features a pre-trained neural network model that leverages deep learning algorithms and anatomy recognition based on a database of over 36,000 images sourced from clinical studies and reference sites.

Critical Care Suite (510(k) pending) — Hosted on the Optima XR240amx mobile X-ray system, a first of its kind AI-embedded imaging device, Critical Care Suite is designed to identify cases of pneumothorax at the point of care to enable prioritization of image review. Critical Care Suite will employ a suite of AI algorithms to identify this potentially life-threatening condition in chest X-Rays with high accuracy (>0.95 AUC). The AI algorithms are designed to share the output through an onscreen notification. When a pneumothorax condition is identified, the point-of-care notification alerts the clinical team, enabling prioritization of image review. The AI results are sent to PACS for review of the critical findings by a radiologist.

Automated Lesion Segmentation on LOGIQ™ E10 ultrasound — This increases productivity through automation, helping eliminate measuring lesions manually by segmenting an identified breast, thyroid or liver lesion and automatically providing a trace of the lesion and corresponding area. This feature helps ensure consistency among different users, or even the same user, for documentation and follow-ups.

CT Smart Subscription — This application provides continuous access

to the latest CT software, extending the lifecycle of the device and making it more valuable over time. Applications can be selected based on a hospital or health system's unique needs, with options ranging from intracranial hemorrhage and stroke detection to routine dose reduction and optimization to cardiac function assessment.

"There's a lot of hidden meaning in the deep data, but it takes a significant sophistication to extract the value. AI gives us an opportunity to see patterns that we don't see and change the way we care for patients, which can ultimately improve outcomes," said Rachael Callcut, MD, MSPH, a partner in the development of Critical Care Suite, Associate Professor of Surgery at the University of California San Francisco (UCSF), a surgeon at UCSF Health and Director of Data Science for the Center for Digital Health Innovation.

By leveraging the power of deep learning and cloud supercomputing, Arterys delivers an AI- and Cloud-powered solution for rapid analysis of cardiac MR images. Arterys Cardio AI's newest deep-learning features include: quantitative delayed enhancement segmentation of myocardium and identification of reference points where users can obtain scar quantification and extent enhancement on a 17-segment AHA plot; and semi-quantitative perfusion of the myocardium, identification of reference points and co-registration that users can create a blood pool ROI to obtain signal intensity graphs and semi-quantitative values, such as upslope and time to peak, on a 17-segment AHA plot. Both solutions are for research only in the U.S. due to contrast agents used.

Arshid Azarine, MD, head of cardiovascular imaging in the Department of Radiology at Saint Joseph Hospital in Paris says that with the Arterys solution, his team spends less time with post-processing. "Review of some complex cardiac MR cases that once took an hour or longer with manual processing can



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now be done in as little as 10-15 minutes. Thanks to powerful cloud computing, we gain more time to address our patients' needs and can more easily collaborate on their care with colleagues and experts from around the world,” Dr. Azarine says.

NVIDIA continues to expand its ecosystem of partners to apply AI to healthcare. With the release of the Clara Software Development Kit (SDK), part of the open NVIDIA Clara platform, developers can deploy AI, visualization or any computer-intensive application in any GPU platform they have. Imaging companies such as FujiFilm, United Imaging and Canon have deployed NVIDIA DGX supercomputers as the AI infrastructure to accelerate their development of AI including enhancing the quality of image acquisition.

The works-in-progress CT CoPilot from HealthLytix, a precision health company and developer of quantitative medical imaging solutions that leverage machine learning, integrates into existing workflow to improve radiologist efficiency, measurement accuracy and clinical confidence. The solution automatically generates consistent views of head CT studies and provides automated quantitative measurements and subtraction series to increase conspicuity of changes between exams.

For Nikdokht Farid, MD, Associate Professor of Radiology, Neuroradiology Division, University of California San Diego, CT CoPilot “quickly and automatically provides correctly aligned images, which enables me to read head CT scans faster and more confidently. It has increased my productivity and has

become indispensable in my interpretation of head CTs.”

According to HealthLytix, studies performed at UCSD using CT CoPilot demonstrated a 23% improvement in reader certainty when determining increased ventricular volume and a 14% improvement when determining decreased ventricular volume. Other related research showed that CT CoPilot reduced the average radiologist interpretation time by 73% when assessing for change in ventricular volume, without sacrificing clinical accuracy.

With a focus on improving medical efficiency and the patient experience, Subtle Medical received FDA clearance for SubtlePET, an AI-powered technology that enables hospitals and imaging centers to enhance images from faster scans. The company says this can improve patient experience during imaging procedures and also boost exam throughput and provider profitability. The technology leverages deep learning algorithms that integrate seamlessly with any OEM scanner and PACS to enhance images during acquisition without any interruption or alteration in the imaging specialists' workflow. It improves the quality of noisy images acquired with shorter scan times.

According to Michael Brant-Zawadzki, MD, FACR, senior physician executive, Hoag Hospital, Newport Beach, CA, “We have been able to dramatically increase PET scan efficiency and provide a superior patient experience. SubtlePET technology allows us to scan a patient four times faster than normal, yet maintain equal image quality, not otherwise impacting work flow. This creates

immediate ROI benefit for our hospital and a compelling value proposition.”

Several medical imaging companies are working to integrate MaxQ AI's Accipio platform into their CT systems to support an acute care physician's ability to identify and prioritize brain bleed stroke or head trauma. Intracranial hemorrhage detection software, Accipio Ix, will be integrated as a function of GE Healthcare's CT Smart Subscription offering, enabling GE CT users to download the solution to their scanners from the cloud. Samsung NeuroLogica will now offer Accipio IX as an additional tool for its OmniTom mobile 16-slice CT scanner and its mobile stroke unit and other emergency vehicle equipped with a CereTom CT scanner. The company also announced a distribution agreement with the EnvoyAI subsidiary of TeraRecon for Accipio Ix, making it available to TeraRecon's installed base of customers.

Accipio Ix, which received FDA clearance in early November 2018, leverages AI technology to automatically analyze non-contrast head CT images and detect intracranial hemorrhage to identify and prioritize patients with a brain bleed for the treating physician. The solution natively integrates into CT systems and PACS and can be installed on-premise or via a cloud-based download.

“The Accipio platform is not about enabling radiologists to read more, rather it is designed to impact the quality and speed of treatment in cases of acute stroke or hemorrhage,” says Gene Saragnese, CEO, MaxQ AI. “How we use AI matters; we need to use it to augment human caregivers and extend clinical resources.”