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THE JOURNAL OF PRACTICAL MEDICAL IMAGING AND MANAGEMENT

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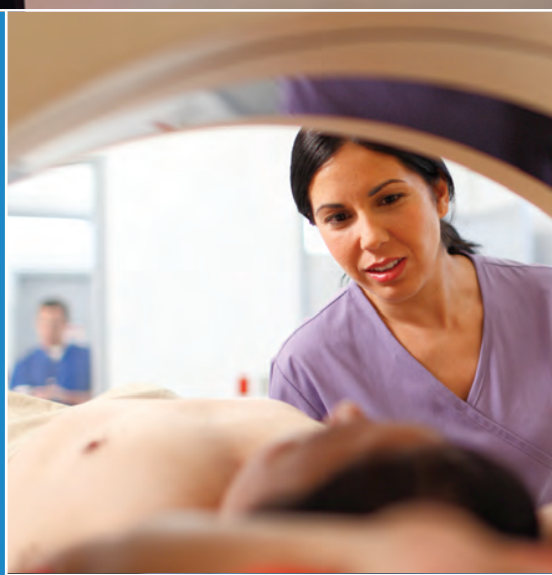

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President
O. Oliver Anderson

Publisher
Kieran N. Anderson

Executive Editor
Joseph F. Jalkiewicz

Contributing Editor
Claudette Lew

Art Director/Production
Barbara A. Shopiro

Contributing Faculty

Carlos Arellano
Senior Administrative Director
Radiology & Otolaryngology
Boston Medical Center
Carlos.Arellano@bmc.org

Brian Gordon, MD
Head of PET/CT & Nuclear Medicine
Quantum Radiology
bgordon@quantumrad.com

Amit Gupta, MD
Assistant Professor, Radiology
Division of Cardiothoracic Imaging
University Hospitals Cleveland
Medical Center
Amit.Gupta@uhhospitals.org

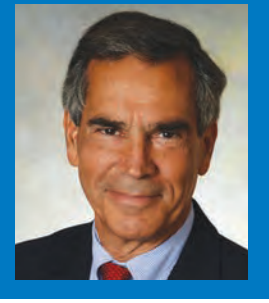
Januz (Jay) Kikut, MD
Medical Director & Division Chief
Nuclear Medicine & PET/CT
University of Vermont Medical Center
Janusz.Kikut@uvmhealth.org

Jeffrey H. Miller, MD
Radiology Chief
Phoenix Children's Hospital
jmiller@phoenixchildrens.com

Karson Morgan, MBA-HM, RT(R)MR
Director of Radiology
Central Valley Medical Center

Homer Pien, PhD
Senior VP, Chief Scientific Officer
Philips Healthcare
Homer.Pien@philips.com

Samantha Sizemore
Chief Operations Officer
Holston Medical Group
samantha.sizemore@myhmg.com



Chip Truwit, MD
Professor (E) & Chief of Radiology
Hennepin Healthcare
Chief Innovation Officer,
Upstream Health Innovations
Chip.Truwit@hcmed.org
@ChipTruwit

Working Smarter with Adaptive Intelligence

"The key component to Philips' Adaptive Intelligence is our deep contextual knowledge of the professionals across the entire imaging value chain, whose needs and environment drive the innovations we deliver."

Michael Arbaugh
Vice President
Diagnostic Imaging,
North America
Philips Healthcare
Michael.Arbaugh@Philips.com

With swiftly growing amounts of information being generated in health care, artificial intelligence (AI) tools are needed now more than ever to aid the transition to the data-driven management and computer-aided clinical decision support that can increase efficiency and ease the burden on care providers.

As Philips continues to advance our strategy of patient-centered innovation, we're keeping this transformation top of mind. We're striving to enhance the patient experience with new imaging technologies and software designed to distill and manage data, enabling radiologists to focus on delivering high-quality care and achieving the best possible clinical outcomes.

We're bridging the data gap with our own **Adaptive Intelligence,** which uses new software tools to manage the information required for today's comprehensive diagnostics. And we're developing smarter devices to improve efficiencies and increase operator ease. But the key component to Philips' Adaptive Intelligence is our deep contextual knowledge of the professionals across the entire imaging value chain, whose needs and environment drive the innovations we deliver. Through continuous collaboration with our customers, we're augmenting the role of the radiologist, enhancing value in the imaging suite, reducing costs and, most importantly, improving outcomes.

In the following pages, clinicians from a range of specialties and institutions across the U.S. share their experience with Philips' latest innovations. From our new MR suite with AI-embedded technologies such as Compressed Sense, to IQon "Always On" Spectral CT, and the entire suite of data-driven practice management tools on Performance Bridge, we're reinforcing our commitment to enhancing the patient and staff experience, simplifying data and insight gathering, and reducing the overall cost of care.

We would like to extend our thanks to all the clinicians and administrators included in this special supplement for their collaboration as we work together to improve outcomes. It is through these collaborations that Philips can help to meet the needs of all providers and empower them to deliver better care.

The Promise of Clinical AI: An Adaptive Future

Claudette Lew

Although some may believe the promise of artificial intelligence (AI) lies primarily in self-driving cars or automated fraud detection, AI also holds limitless potential for health care, ranging from personalized medicine based on genomics, to clinical decision support for optimized cancer treatment plans, to predictive analytics for population health management, and beyond. While challenges remain with regard to regulatory approvals, insurance reimbursement, and data sharing, healthcare experts are beginning to understand how AI can improve routine care tasks, support advanced analytics, and identify and collect the right data for the right application. With the costs of data storage decreasing and the amount of clinical data increasing, AI can serve as a transformative technology, enabling providers to identify opportunities for greater operational efficiencies, reducing care disparities, and achieving better patient health outcomes. Homer Pien, PhD, Chief Scientific Officer at Philips, recently discussed the company's Adaptive Intelligence approach to clinical AI and explained how Philips is developing the tools necessary to move health care, and radiology in particular, into the future.

***Applied Radiology* (AR): Why does radiology need artificial intelligence?**

Dr. Pien: Imaging exams are ordered to detect or track the progress of specific diseases. The pixel data captured in the exam is reconstructed into an image that is meaningful to the human brain. Radiologists have been educated to recognize, understand, and analyze the shapes, shades, and colors of these reconstructed images in order to render their diagnoses. Given the advances made in the various imaging modalities, and the high levels of sensitivity and specificity that are now possible, the limitless ways to process pixel data can generate staggering numbers of images for a radiologist to review. The potential for training a computer algorithm to recognize shifts and patterns in data more quickly than a human can help provide clinical decision support. As human beings, we're only able to utilize five to ten pieces of significant information in our decision making. Given the sheer amount of data in radiology, and the rest of medicine into which it is integrated, the user now has thousands and thousands of pieces of data to integrate. That's one of the main reasons that radiology needs AI.

The second major reason radiology needs AI is efficiency. An imaging department is relatively expensive to operate, and because of the repetitiveness of tasks and the large amounts of data, there are numerous opportunities for AI to help eliminate these inefficiencies. The need for operational efficiency in health care is critical; leaders are being pressured to do more with the huge volumes of data being collected—some of our customers

"From an efficiency perspective, Adaptive Intelligence is reducing the workload on radiologists, and more importantly, creating greater capacity for radiologists to work as part of an integrated care team to provide better care for patients."

Homer Pien, PhD
Senior VP
Chief Scientific Officer
Philips Healthcare
Homer.Pien@philips.com

When radiation treatment is indicated, the first step is to plan a radiation therapy session. This is not an easy task; the entire care team, from the physicist to the radiation oncologist, must often re-plan and restart the process until they are in agreement on the plan.

generate more than 2 million images a week—but just a fraction of that data is being used to improve the quality and efficiency of care. The lack of interoperability between IT systems also still inhibits their ability to do more with this data.

AR: What can be done to increase effectiveness and get better insights from healthcare data?

Dr. Pien: In its most theoretical definition, an artificially intelligent program can be trained to accept information about a problem, generate a list of actions it could take, and maximize its chances of achieving goals by using logic and probability to choose the path with the highest likelihood of success. The challenge in broadly applying this approach in clinical situations is that errors can potentially bring harm to a patient. However, if we shift our thinking and focus on solving a particular clinical problem, we can readily see how clinical AI can make a dramatic difference in patient care right now.

At Philips, we've combined clinical AI techniques with a deep, contextual understanding of what's relevant to produce Adaptive Intelligence. Combining AI and other methods with knowledge of the clinical, operational, or personal context in which they are used enables technology to do a better job of satisfying all those constraints more quickly and with fewer iterations. Incorporating the clinician's understanding of what is relevant, or what is likely to change because it's intrinsic to the physiology or the biology of the disease--this is the contextual understanding that Adaptive Intelligence really implies. Without it, one risks catastrophic failures, and we just cannot tolerate errors like that in health care.

AR: What are some clinical areas where Adaptive Intelligence can have the most impact?

Dr. Pien: Radiation treatment planning is one clinical problem that Adaptive Intelligence can help solve. When radiation treatment is indicated, the first step is to plan a radiation therapy session. This is not an easy task; the entire care team, from the physicist to the radiation oncologist, must often re-plan and restart the process until they are in agreement on the plan. It typically takes about 12 days from imaging to the first radiation dose. Adaptive Intelligence can enable us to reduce that time to 1-2 days by eliminating the manual planning iterations while accounting for all of the variables that go into radiation therapy planning. If you create a system that can configure the most optimal plan the first time, every single time, then you have a radical improvement in patient care.

Without Adaptive Intelligence, the difference between correlation and causation is extremely significant in a scenario involving AI. To identify something that's indicative of disease, we don't want to make a conclusion based on just one feature in an image, because the next set of images may not

have the same feature. To the degree possible, we want to understand whether it's causing that disease; whether it's part of the pathophysiological process, and we work very hard to elucidate that chain of events so that when we're designing a neural network, we're selecting those factors that are important to the patient's physiology. From an efficiency perspective, Adaptive Intelligence is reducing the workload on radiologists, and more importantly, creating greater capacity for radiologists to work as part of an integrated care team to provide better care for patients.

AR: How is Philips bridging the data gap to share the early successes of Adaptive Intelligence?

Dr. Pien: Philips strongly believes across the board that AI augments the role of radiologists and is not meant to replace them. AI and deep-learning networks are currently, and will continue to be, very narrowly defined, so if we train a program with 500 examples of lung disease, for instance, that's all it will do. But when a patient with lung disease experiences heart failure, and his enlarged heart is visible in the chest image, will it confound the neural network? Human beings are trained to identify and understand confounding factors, but it's difficult for an AI algorithm, and even more difficult to train that data properly.

Because cancer patients receiving treatment often develop other serious conditions, each patient's experience is different. If you are using similar patient data to develop a clinical algorithm, as we define disease in ever more precise terms, the number of patients in any one institution becomes smaller and smaller to satisfy all the permutations. You get to the problem of not getting a large enough sample size to train the network.

Philips is working with Dana-Farber Cancer Institute, one of the leading cancer treatment facilities in the country, to establish best practices in cancer care.

We're excited to introduce a new project that will help alleviate this problem and facilitate data sharing among our customers to promote better patient outcomes. For example, for some cancer patients, therapies can cost as much as $400,000. If the patient is not going to respond to that therapy, it's not only incredibly expensive, but there's also an opportunity cost. Not being on the drug that's most effective the first time is bad for the patient, bad for the hospital, and bad for everyone all around if you don't pick the right therapy the first time. So that's what we're building.

We announced earlier this year that we're working with Dana-Farber Cancer Institute, one of the leading cancer treatment facilities in the country, to establish best practices in cancer care. The Dana-Farber Clinical Pathways will be deployed through Philips' IntelliSpace Precision Medicine, providing clinical decision support to physicians via a patient-centric solution. The implementation will help oncologists quickly obtain the most appropriate

treatments, based on the unified view of the patient across diagnostic modalities and the embedded knowledge of Clinical Pathways, and can be delivered through existing electronic health record platforms. What we've been able to encapsulate is how they treat patients in terms of the clinical pathways they select. For example, if I am treating a Stage 3 lung cancer patient with a particular mutation, I can see how Dana-Farber's clinicians would treat a similar patient. This decision tree is completely embedded within our IntelliSpace Precision Medicine. This doesn't necessarily mean that Dana-Farber's approach is the correct way for other clinicians to treat their own patients, but it does offer a standard of care from an institution that is generally thought of as one of the top cancer centers in the U.S.

Ideally, we would have one treatment pathway that is better than another or leads to a lower cost than another. We're not there yet, but mapping the Dana-Farber clinical pathway is a very significant and exciting first step.

AR: What are some other areas where AI can help radiology?

Dr. Pien: In the very near term, we are developing solutions around repetitive workflow tasks, and operational tasks like scheduling patients, or better understanding why patients don't show up for their imaging exams to help predict which ones have the highest likelihood of not showing up. New tools can help radiologists and staff take action proactively so that these patients come to their exams.

Another example is examining patient follow up. At the end of every single radiology report is a set of follow-up actions to be taken. In a substantial portion of the reports that we've examined, the follow-up actions were never taken. Those are the things that create a lot of fatigue. When a clinician works hard to take care of a patient, we know what the next thing to do should be and the patient doesn't follow up. This is the sort of thing that causes frustration, and high costs to the healthcare system. When that patient finally does come back, they're in a much direr situation then if they had followed the clinician's instructions.

These are some of the things that cause patient dissatisfaction, that cause staff fatigue, and stress the healthcare system. Radiologist burnout is reaching an epidemic stage across the U.S. healthcare system. Changing the patient experience and improving staff experiences are highly compelling topics for AI to tackle. There are clinical things that we're working on, but a lot of our effort is also going into trying to make the radiologist more efficient, and to trying to make their jobs more fulfilling. With a greater impact, they can better integrate to other service lines, because radiology doesn't stand on its own, it's part of a broader context of diagnostics.

AR: How does health care move into the future using AI?

Dr. Pien: The true power of AI can only be realized by working hand-in-glove with healthcare professionals. The successful application of AI requires deep contextual knowledge of the clinical and operational context in which it's used and should involve seamless integration with other technologies. With all the data being collected in hospitals by new medical devices and equipment, and rising expectations for improved patient health outcomes, the case for AI adoption is compelling and every opportunity to make clinical and operational improvements should be explored.

Philips and Phoenix Children's Hospital: A Partnership of Innovation Helping To Ease the Burden on Staff and Positively Influence the Patient Experience

Claudette Lew

Despite ever-growing demands to increase efficiency and reduce exam variability, delivering high-quality patient care remains the goal of every radiology department. The drive to achieve that goal is evident at Phoenix Children's Hospital (Phoenix Children's), where the comprehensive clinical services and treatments are dedicated solely to children. Nevertheless, these pressures can take a toll on staff performance and patient experience. Phoenix Children's Radiology Chief, Jeffrey H. Miller, MD, understands how positive patient and staff experiences can assist in producing accurate clinical images; he looks to Philips for improvements in hardware and software that can address some of these challenges.

As part of a long-term strategic partnership announced in 2017, Philips and Phoenix Children's are working collaboratively on new research opportunities and innovations intended to make healthcare delivery more seamless and to address the specific needs of children. Philips' new, user-centric imaging technologies and scan protocols have helped the hospital positively impact patients experience and eased the burden on radiology staff.

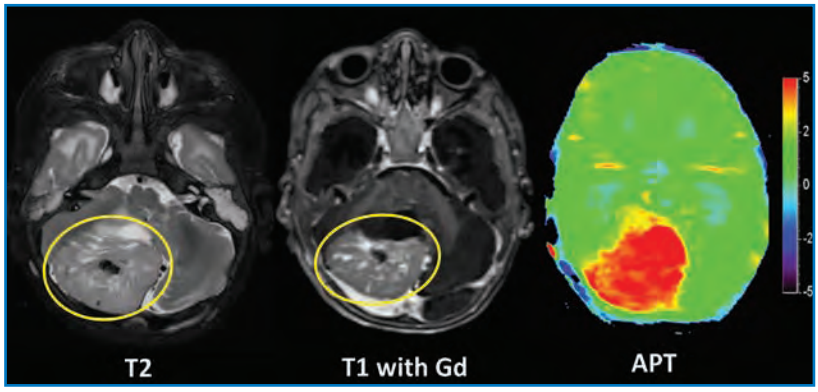
"Philips has taken a real interest in working collaboratively with us to help improve their products' design and technical capabilities, resulting in new tools that can help improve patient care," Dr. Miller said. "These tools allow us to more confidently make diagnoses. The time and energy they've invested to help us has really translated into our becoming better at what we do and has helped countless children get competent, reliable, and cutting-edge imaging studies."

Speed and efficiency in MRI

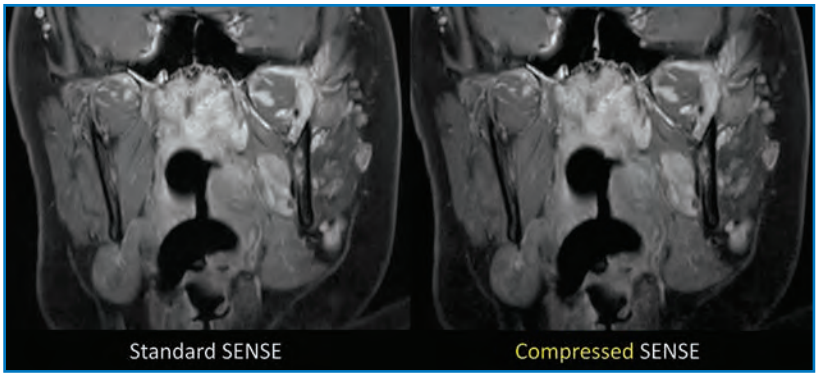
Magnetic resonance imaging (MRI) has historically been challenged by matters of speed, but the imperative to shorten MRI exams without impeding image quality has taken hold in the radiology community. Philips' Compressed SENSE, a breakthrough technology in MR acceleration

"Compressed SENSE is a very exciting new capability that can be applied to all MR imaging techniques and all sequences to help reduce exam time or to potentially increase the resolution of images that are acquired through routine means."

Jeffrey H. Miller, MD
Radiology Chief
Phoenix Children's Hospital
jmiller@phoenixchildrens.com



T2-weighted, T1 postcontrast and APT axial images of the brain of a 1 year old with a cerebellar medulloblastoma. The high signal intensity of the APT image correlates with the contrast-enhancing tumor seen on T1 postcontrast images. These APT findings are consistent with the highly cellular/proteineaous nature of this tumor



T1 postcontrast coronal images of the neck in a 4 year old with multifocal soft-tissue tumor nodules. The scan time of the standard image (LEFT) without compressed SENSE is 4:10 minutes; the scan time of the compressed SENSE image (RIGHT) is 1:47 minutes. The image quality and conspicuity of the tumor is preserved on the shorter imaging exam.

and productivity, enables technologists to perform 2D and 3D scans up to 50 percent faster with virtually equal image quality.[1] Compressed SENSE can be used in all anatomical contrasts and all anatomies.

"Compressed SENSE is a very exciting new capability that can be applied to all MR imaging techniques and all sequences to help reduce exam time or to potentially increase the resolution of images that are acquired through routine means," Dr. Miller said.

From a clinical perspective, the ability to alter the MR image resolution to evaluate for a specific disease or subtle change in a patient can have a big impact on patient care.

"We are always looking for techniques that will allow us to detect the slightest changes in the tissue and organs so we can potentially diagnose things earlier," Dr. Miller said. "For example, a major cause of seizures are malformations of the cortex. Detecting these changes is challenging because they are often very subtle. Often, we need extremely high-resolution imaging, which can mean very long scan times. But a technique that gives you higher resolution to start with can save you from having to perform even longer sequences and protocols to get to that same resolution."

Increasing diagnostic confidence in pediatric brain tumor imaging

In the United States, more than 28,000 children and teenagers are living with a primary brain tumor.[2] The type and classification of those tumors are dependent on the tumor's cell structure, composition, rate of growth, location, and other characteristics. They often appear in different locations and behave differently than brain tumors in adults.[3] Typically, identifying the degree of aggressiveness of these brain tumors is challenging. MR imaging is often used to estimate the grade of pediatric brain tumors, but uncertainty sometimes remains.[4–6] Differentiating between low-grade and high-grade tumors is not straightforward, even for the highly experienced radiologist.

Using Philips' novel MR 3D Amide Proton Transfer (APT) imaging technique, radiologists can evaluate normal and abnormal proteins in the brain. Dr. Miller said this feature holds promise for making

determinations about the aggressiveness or grade of brain tumors in children.

"We've been evaluating 3D APT in pediatrics for almost two years now, and we've learned a great deal how it can be helpful and applied in various situations," he said. "We're able to associate the findings on APT with areas of imaging findings on the brain that were nonspecific and not completely characterized by standard contrast enhanced studies, along with spectroscopy and perfusion. We've found that 3D APT has the potential to augment other standard and advanced MR techniques in identifying and characterizing equivocal abnormal imaging findings. One of these situations includes determining tumor versus postsurgical or post-treatment change, which can be a really tough diagnosis for radiologists. It's been helpful in identifying aggressive and non-aggressive components of tumors and has been useful in giving us expanded information about the nature and potential causes of lesions in the brain."

"It's a noncontrast imaging technique," Dr. Miller explained. "It creates images that are basically maps of protein distribution in the brain, so it leverages some of the novel technologies and software of Philips' scanners. The good thing about having this technique available is it will allow more clinicians to gather more data about how helpful it can be in a variety of patients."

Phoenix Children's and Philips plan to continue working collaboratively on innovations that make an impact on patient care, as well as reduce the burden on radiologists and their staff imposed by increasing demands.

"My main goal is to continue the great work that we're doing here for patient care," concluded Dr. Miller, "and to bring new imaging advances to the pediatric realm utilizing new techniques that we're getting from Philips to help improve and advance imaging diagnostics for our patients."

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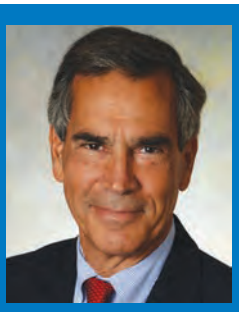
Enhancing Diagnostics and Patient Care with Spectral CT



"CT is often the difference between life and death, between getting to the diagnosis and not, when time is of the essence. And with the IQon we don't have to do anything differently because it's the detector that's different.'

Chip Truwit, MD
Professor (E) &
Chief of Radiology
Hennepin Healthcare
Chief Innovation Officer,
Upstream Health Innovations
Chip.Truwit@hcmed.org

Claudette Lew

Few radiologists could imagine current clinical practice without CT. This powerful diagnostic tool's ease of use and ubiquitous availability only fortify its significance. Nevertheless, traditional CT often still yields inconclusive findings that require supplemental testing to achieve a confident diagnosis.

Philips IQon Spectral CT was created to address that challenge. Since its introduction, the IQon Spectral CT has had a profound effect on clinicians' ability to detect and diagnose disease with a single exam, stratifying high energy and low energy photons simultaneously and using color to characterize the material content of critical structures. The ability to collimate by energy has elevated CT scanning beyond "tomodensity" to the new, yet predicted by Hounsfield himself, field of "tomochemistry." By harnessing the advances in this technology, clinicians have taken CT to a whole new level of enabling diagnoses and, in some cases, making diagnoses faster.

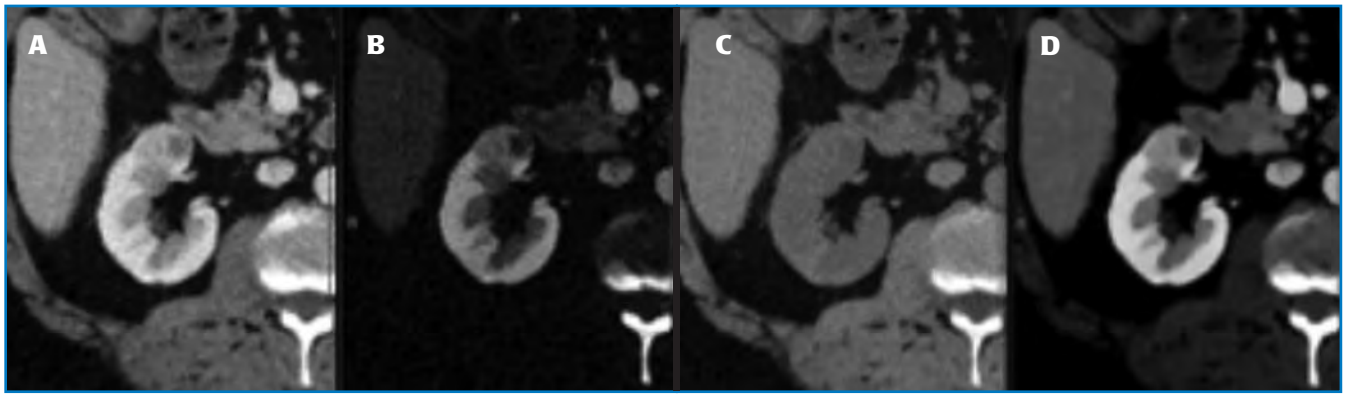
Contrast dose matters

The Philips IQon Spectral CT provides a more complete picture of the patient with its ability to visualize cardiac abnormalities and lung capacity, which can be crucial to planning successful surgeries, such as transcatheter aortic valve replacement. Additionally, it permits a more comprehensive risk assessment using lower amounts of iodinated contrast.

The patients receiving these types of treatments are typically older, often have comorbidities such as renal dysfunction, and are not amenable to routine open surgical procedures like an open sternotomy or aortic valve replacement, said Amit Gupta, MD, Cardiothoracic Radiologist at University Hospitals, Cleveland Medical Center, and Assistant Clinical Professor of Radiology, Case Western Reserve University School of Medicine.

"For our high-risk patients needing valve replacement who may be poor candidates for open surgical procedures," explained Dr. Gupta, "we can treat them by going through the femoral artery and placing the aortic valve endovascularly, rather than opening up that patient. That's why reducing the contrast dose is so important.

"Using the virtual monoenergetic images on the IQon Spectral CT, we are



Renal cell carcinoma: axial contrast-enhanced CT image of right kidney reveals focal lower attenuation mass. (A) Conventional iDose4 image. (B) Iodine density image shows normal renal tissue, but more subtle renal enhancement of anterior renal tissue, adjacent to lower-density, probable cystic component of the mass. (C) Virtual noncontrast (VNC) image renders the image invisible, confirming that this lesion enhances. (D) MonoE 40keV image accentuates the findings by focusing specifically on the energy characteristics of iodine. (Images courtesy of G. Punjabi, MD, Hennepin Healthcare, Minneapolis, MN)

able to substantially reduce the contrast dose for patients who may already be struggling with renal function, giving these patients less exposure and possibly fewer complications," he added. "So rather than doing a CT angiogram, chest, abdomen and pelvis with more than 100mL of contrast, we do it with only 50mL."

Instances of contrast dose extravasation also occur, though infrequently, and these patients will frequently need to be re-imaged, resulting in even more radiation exposure and a second dose of contrast. Chip Truwit, MD, Chief of Radiology at Hennepin County Medical Center (Hennepin), explained that he utilizes Philips IQon Mono-E spectral reconstruction in these cases.

"Using IQon Spectral CT technology, I never have to repeat that exam," Dr. Truwit said. "Typically, as many as 10% of our patients may experience extravasation due to fragile veins, and this is not unique to our facility. If we were using conventional CT, we would probably have to repeat the exam. With IQon Spectral CT, you just need to adjust the image to 40 keV and essentially, the study is salvageable. It saves time, cost, and patient dose, making it much better all around."

Sustainable changes

Dr. Gupta worked exclusively on clinical research before his facility received its clinical IQon Spectral CT in April 2016. Since then, he has replaced traditional CT with the IQon in a number of different protocols because of the benefits it provides.

"We've put our IQon Spectral CT to use beyond the mere evaluation of coronary stenosis and utilize it for more accurate plaque characterization and assessment of myocardial perfusion," Dr. Gupta said. "We've actually changed a lot of our protocols since we began using the IQon. All of our patients undergoing transcatheter aortic valve implantation (TAVI) will have their planning exam done with IQon Spectral CT, as well as those patients

Hennepin was one of the first facilities to experience IQon Spectral CT when it was introduced, uniquely placing the unit in the Emergency Department (ED) and using its advanced diagnostic capabilities to help clinicians stabilize patients.

University Hospitals Cleveland Medical Center received its clinical IQon Spectral CT in April 2016. Since then, Dr. Gupta has replaced traditional CT with the IQon in a number of different protocols because of the benefits it provides.

having WATCHMAN device placement for atrial fibrillation. These are always done on our spectral CT now."

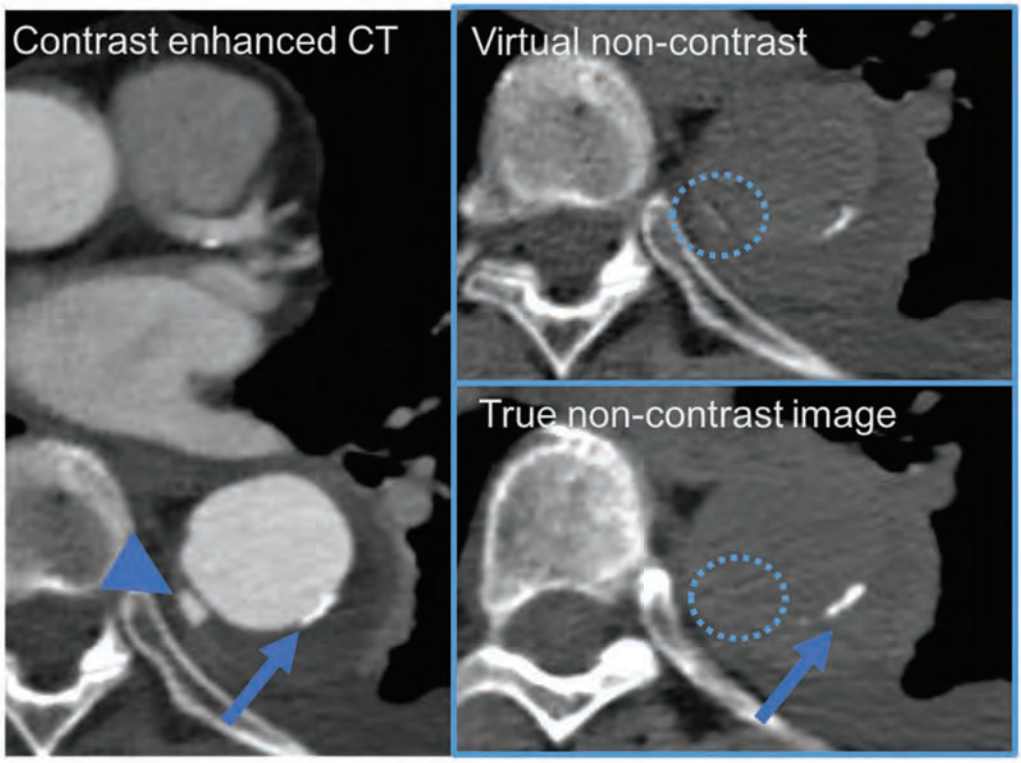
Hennepin was one of the first facilities to experience IQon Spectral CT when it was introduced, uniquely placing the unit in the Emergency Department (ED) and using its advanced diagnostic capabilities to help clinicians stabilize patients. When the opportunity arose, a second IQon Spectal CT was sited in Hennepin's new ambulatory facility.

"We're using the IQon Spectral CT now on every chest, abdomen, and pelvis case we can," explained Dr. Truwit. "It's definitely transformed our ED practice. CT is often the difference between life and death, between getting to the diagnosis and not, when time is of the essence. And with the IQon we don't have to do anything differently because it's the detector that's different. You get the spectral data on every patient and you decide when you need it. Now we're using IQon Spectral CT in our outpatient facility; we now scan over 70% of our CT patients using spectral. We're finding a better way to diagnose with CT so we don't have to go back and request a follow-up MR."

The difference between imaging and insight

The IQon Spectral CT has had a profound effect on diagnostic accuracy, said Drs. Gupta and Truwit, specifically in CT angiograms of the chest and aorta, where a true noncontrast image is followed by a contrast-enhanced image. Using spectral CT, a virtual noncontrast image can effectively be created by subtracting the iodine from the contrast-enhanced image. Clinicians can confidently diagnose cardiac disease while also reducing the number of scans.

"When you see a regional part of the lung that's not getting perfusion on the iodine map, it's pretty obvious that there is going to be a pulmonary embolus at the apex of the oligemic wedge," said Dr. Truwit. "Whether it's new or old is another question, but basically, we get to the right answer and then work our way back. When we're processing the spectral data, highlighting where the perfusion deficit starts



Virtual noncontrast images for a patient with suspected dissection of the thoracic aorta. The virtual noncontrast image essentially provides same information as the true non-contrast and is available retrospectively for every scan. The need for true noncontrast acquisition may be questioned in the future.

and look to the different slices, we'll see the blood clot jump across the table at us."

"IQon Spectral CT technology definitely gives me the ability to make a more confident diagnosis," said Dr. Gupta. "For example in case of atrial appendage occlusion (WATCHMAN) device placement, spectral CT helps in confidently finding the thrombus in the left atrial appendage, which is a contraindication to device placement. If you place a device when there's a thrombus in situ, that thrombus may dislodge and embolize to the brain and cause stroke and other damage."

As additional clinical uses for IQon spectral CT technology continue to be proven, even more patients may benefit from more accurate and more timely diagnoses, resulting in better patient care.

Results from case studies are not predictive of results in other cases. Results in other cases may vary.

"Using the virtual monoenergetic images on the IQon Spectral CT, we are able to substantially reduce the contrast dose for patients who may already be struggling with renal function, giving these patients less exposure and possibly fewer complications."

Amit Gupta, MD
Assistant Professor, Radiology
Division of Cardiothoracic Imaging
University Hospitals Cleveland Medical Center
Amit.Gupta@uhhospitals.org

Boston Medical Center: Forging a Path to Data-driven Radiology Practice Management

Claudette Lew

"The thing we really liked about PerformanceBridge is that it gives the user flexibility to manipulate the data to be able to create customized dashboards and pull ad hoc information as needed."

Carlos Arellano
Senor Administrative Director
Radiology & Otolaryngology
Boston Medical Center
Carlos.Arellano@bmc.org

Situated in Boston's historic South End, Boston Medical Center (BMC) serves a large and diverse patient population. Standing by its stated mission to serve every patient with "Exceptional care. Without exception," BMC is committed to making forward-thinking investments in data-driven radiology practice management.

One big example: Philips' PerformanceBridge Practice.

Leveraging the useful insights, actionable data, and flexibility provided by PerformanceBridge Practice – a solution powered by the combination of technology, analytics, and professional services – BMC's Radiology Department has been able to improve its own operations and workflow, as well as impact performance of the entire facility, which receives more than 1 million patient visits per year.

A challenge and an opportunity

The patient community served by BMC is not just large, but also largely diverse.

- More than 60 percent of BMC patients speak a language other than English.
- Nearly 70 percent of patients are insured by Medicare or Medicaid.
- Nearly 60 percent of patients live in under-served communities.

"These realities greatly impact how BMC serves its community," said Carlos Arellano, Senior Administrative Director of Radiology and Otolaryngology. "We have a diverse patient population and while that is very rewarding, it presents challenges in terms of how we provide them with top quality care. Additionally, having our challenging payer mix, pushes us to be smart in the way we allocate resources across the hospital."

"Patient demographics, insurance, and visit data can all be used to optimize radiology operations," Arellano added, "whether it's to improve patient flow, scheduling tasks, turnaround time, or even to predict patient no-shows for radiology exams. We do this with the overall objective of providing a great experience for our patients and clinicians. Getting the data to fire on all cylinders can only be seen as an opportunity."

Accessing the data

BMC's 40 attending radiologists read more than 300,000 exams per year in a 24/7 operation, covering all modalities and supporting the largest Level 1 trauma

center in New England. Among the first challenges Arellano experienced when he was appointed to lead the department in 2016 was the lack of timely data analytics he believed was critical to support improvements within the department. He recalls the frustration he felt having to wait a week for the Radiology Information System (RIS) to issue a report, and then wait several more weeks just to get the data into a usable format. By the time the information was ready, he couldn't react in time.

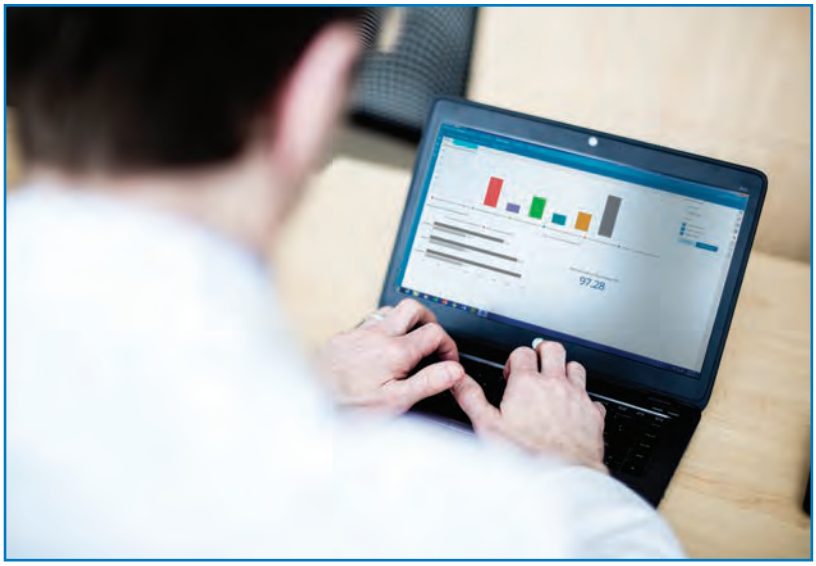
"It took three months to put something together that should have taken a couple of days," Arellano said.

Arellano's goal was to get the data he needed much more quickly and efficiently. At that time, data analytics tools for radiology were emerging from a variety of vendors, with each vendor taking its own approach. After completing a comprehensive evaluation of their options, Arellano's team chose to partner with Philips and leverage its PerformanceBridge Practice solution.

"The thing we really liked about PerformanceBridge is that it gives the user flexibility to manipulate the data to be able to create customized dashboards and pull ad hoc information as needed," Arellano said. "Especially for people like me, who are data driven, it's a much better experience because I don't have to rely on anybody to manipulate the data to get what I need. I can do it myself, designing it exactly the way I envision it."

Facilitated data gathering

Once Philips' PerformanceBridge Practice solution was up and running, Arellano's team identified the key performance indicators they would focus on analyzing. One of the first: turnaround time for CT requests from the emergency department (ED).



After completing a comprehensive evaluation of their options, Arellano's team chose to partner with Philips and leverage its PerformanceBridge Practice solution.

Data gathered with the solution showed that radiology had been relying on a clunky "push" system under which patient transport to and from the ED was coordinated through phone calls. Today, an ED nurse simply clicks a tab in the electronic medical record when the patient is ready for CT; the technologist then places an order for transport to pick up and take the patient to radiology, allowing the technologist to manage the CT flow more efficiently. Thanks to PerformanceBridge, CT turnaround time has fallen by 14 %—a significant workflow improvement in a department that performs 30–40 CT scans a day.

Actionable insights gathered via PerformanceBridge are also used daily to broaden the information shared with other departments in the hospital.

Leveraging the useful insights, actionable data, and flexibility provided by PerformanceBridge Practice, BMC's Radiology Department has been able to improve its own operations and workflow.

"We're being transparent with our partners in the hospital about our performance and in parallel identifying areas where we can affect a broader part of the operation," Arellano said. "For instance, if we see that the ED had 20 patients arrive throughout a particular morning, but all the CT orders were crunched into a 30-minute interval, we can go back to them and say, 'if you input the orders as they come in, it will make the whole operation run much more smoothly than if you add all the orders in at one time.'"

The future is near

Arellano and his team have been supportive partners and involved in product development, providing feedback to the PerformanceBridge design team. Working collaboratively, they are helping to inform new functionalities within the PerformanceBridge solution.

"Right now, we're working together on some artificial intelligence (AI) functionalities that are in development. We're identifying gaps between what the data can do and what we need in operations, and specifically, predictive analytics capabilities," he says.

One opportunity within radiology with a potentially high rate of return would be the ability to predict patient no-shows. Given the cost of many imaging exams, insight into a patient's history, along with certain demographics such as age, insurance, no-show history, and how far in advance an appointment is booked could serve as predictive indicators and identify which patients staff should call with appointment reminders. In terms of resource allocation, scheduling staff would focus their attention on patients with the highest likelihood of missing their appointment.

"In addition to focusing our resources more accurately in these situations and making those reminder calls," Arellano explained, "we can act on that information proactively, using data analyses to help us identify our patients that need us most and be able to provide the appropriate resources so they can get their exams. That's where PerformanceBridge is going, and that functionality helps us better serve our patients while keeping us running efficiently at the same time."

Central Valley Medical Center—Enhancing the Patient and Staff Experience

Claudette Lew

Central Valley Medical Center (CVMC), a critical access hospital, is a key provider of emergency healthcare and trauma services to the communities surrounding Nephi, Utah. Located near a major interstate and a popular recreation area, CVMC is the region's first hospital to install Philips' ProxiDiagnost N90 digital radiography and fluoroscopy, which offers state-of-the-art digital technology with improved image quality, low radiation exposure, and an intelligent design that enhances patient experience and helps CVMC deliver cost-effective care.

The need for meaningful design

Clinicians at CVMC use digital radiography and fluoroscopy for such procedures as cortisone injections into joints, contrast injections for shoulder arthrography, and swallow-function studies.

Karson Morgan, MBA-HM, RT(R)MR, CVMC's Director of Radiology, recounted some of the details that drove their selection of the Philips ProxiDiagnost N90 system. "Our last fluoroscopy system was from Philips, and there was no denying how well it was designed and how well it operated," Morgan said. "Aside from the improvement in image quality we expected with the ProxiDiagnost, we were also able to incorporate it into better resource planning and a better experience for patients and staff."

The ProxiDiagnost N90 digital radiography and nearby fluoroscopy was designed to maximize space for patient movement and size, and to promote component sharing with areas such as general X-ray.

"Philips was very mindful in designing the ProxiDiagnost system," Morgan noted. "We're able to do everything without compromising angles or space. And when we're not doing fluoroscopy, we use the room as a general x-ray room." Morgan explained that the new system was easy for clinicians to learn, as its operational interface, functions, and controls were the same as the previous system. "Our radiologists, who are not on site every day because they split time with another hospital, may have had a difficult time learning an entirely new system, but with the ProxiDiagnost, they were able to walk right in and know exactly what they were doing."

The system provides CVMC radiologists with outstanding image quality, medical-grade monitors, and a large digital

"Philips was mindful in designing the ProxiDiagnost system. We're able to do everything without compromising angles or space."

Karson Morgan, MBA-HM, RT(R)MR
Director of Radiology
Central Valley Medical Center

Central Valley Medical Center (CVMC), a Critical Access Hospital, is a key provider of emergency healthcare and trauma services to the communities surrounding Nephi, Utah.

storage capacity for images. The images can also be easily moved to CVMC's PACS to be shared with referring physicians and other members of a patient's care team.

"The monitors make it so much clearer for the radiologists to see during the exam," Morgan said, "and because of that, they are sometimes able to take fewer images. They don't have to move the patient as much because they're often able to see what they need from a single position. And patients are happier when they have a shorter exam."

Radiologists especially appreciate the ProxiDiagnost N90's fluoro grab function, which enables them to select a given image and create a higher definition of it to review when looking at the case later or writing the report.

Room to breathe

Traditional fluoroscopy systems generally make for a tight fit, potentially leaving patients with a less-than-pleasant experience. But Morgan explained that the new system gives staff and patients more room to move.

"Previously, the tower would come over the patient and the patient would have to make sure they didn't make contact with it when lying down," Morgan said. "When we were using the room for general X-ray, we had to make modifications to the tube or distance of the X-ray. One thing we love about the new system is that the tower goes all the way back and doesn't touch the patient. We don't have to alter our X-rays in any way because of the excellent spacing of the machine."

Collaborating for success

As the first customer to use the ProxiDiagnost N90, the CVMC team worked hand in hand with Philips to ensure that the system was meeting or exceeding expectations.

"Philips spent a lot of extra time making sure that we knew the system and that the system was running smoothly," Morgan said. "We met regularly over the first few months and reviewed every exam to maximize operational efficiencies of the system and they answered every question the staff had."

Digital PET/CT: Driving Clinical Insights To Help Improve Care

Claudette Lew

Digital PET/CT's key role in diagnosis, staging, and treatment follow-up is rapidly growing as innovations in the technology are bringing clinicians vast improvements in sensitivity, volumetric resolution, and quantitative accuracy. These advances offer the opportunity to manage dose, reduce scan times, and more accurately detect small lesions.

Philips' Vereos Digital PET/CT was designed to optimize the experience of every stakeholder, from patient, to technologist, to radiologist, and to provide the clinical insights needed to inform the care path and improve patient care. Clinicians are highly impressed with Vereos' ability to enhance small lesion detection in oncology and neurology, and to reduce the radiopharmaceutical dose needed for cardiology exams.

Setting a new standard with digital PET/CT

As healthcare continues transitioning toward outcomes-based reimbursement, responsibility falls on clinicians to provide clinically sound, cost-effective treatment. Faced with this challenge, providers are becoming more vigilant about replacing outdated imaging equipment in an effort to ensure long-term sustainability and competitive advantages. As a result, some institutions are making the move to digital PET/CT.

The University of Vermont Medical Center (UVMMC), which draws patients from both Vermont and neighboring New York, recently needed to replace an aging PET/CT system. After evaluating the options, the UVMMC team selected Philips' Vereos Digital PET/CT. Jay Kikut, MD, Medical Director and Division Chief of Nuclear Medicine and PET/CT at UVMMC, recalled their decision-making process.

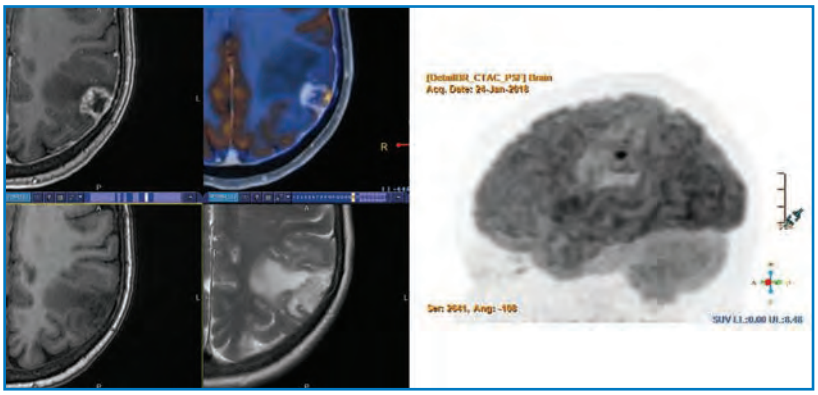
"We really had a bigger decision to make than just replacing outdated equipment," Dr. Kikut said. "We could have just replaced the old system with a similar, new system at a lower cost and move on, or consider investing in digital PET/CT, though the cost was higher. In the end, the investment in Vereos has given us a 50% improvement in sensitivity to detect and characterize small lesions. That's a very specific number."

The clinical case for going digital

Accurate staging is critical to patient care in oncology and tied heavily to the clinician's ability to detect small lesions. Whether the path is surgery, chemotherapy, or radiation therapy, all treatments are expensive and they are all determined based on disease staging.

"In the end, the investment in digital PET/CT has given us a 50% improvement in sensitivity to detect and characterize small lesions. That's a very specific number."

Jay Kikut, MD
Medical Director
& Division Chief
Nuclear Medicine & PET/CT
University of Vermont
Medical Center
Janusz.Kikut@uvmhealth.org



Clinical history: Status post-stereotactic radiosurgery for oligo-metastatic lung cancer. MRI with contrast and F18 FDG PET/CT performed several days later. MRI, MRI fused with Ultra High Resolution 1x1x1 mm Vereos PET and MIP PET images. PET identifies metastatic dural deposits "missed" on the MRI. Dural metasets were confirmed on subsequent surgery.

At the Wellstar Kennestone Hospital cancer center in Atlanta, GA, Brian Gordon, MD, is pleased with the improved sensitivity offered by Philips' Vereos digital PET/CT and the technology's impact on his abilities. Dr. Gordon is a nuclear medicine physician and radiologist who practices at Kennestone, which is among the highest-volume PET/CT centers in the state. Dr. Gordon's expertise is in both PET/CT imaging and nuclear medicine therapies for various cancers including thyroid cancer, skeletal metastatic disease, and prostate cancer.

"We're finding more of the smaller lesions that are FDG-avid with digital technology," Dr. Gordon explained. "Second, when we see a smaller lesion that is not FDG-avid and the primary is very actively metabolic, we are more confident that it is not cancer. It's important that the negative predictive value is higher."

Dr. Kikut added, "The bottom line is that we are better at classifying our oncology patients for the optimal treatment and getting the most cost-effective utilization of our services. You don't want to institute a treatment that's futile for the patient, because if the patient has metastases, then surgery might not be the patient's best option."

Digital PET/CT also positively impacts neurology. These small lesions are usually seen with MRI, but now they can be identified and diagnosed, while treatment is being followed with digital PET/CT.

"We have the ability to view to 1 millimeter pixel size because there is enough count density to be able to reduce the size while improving image quality." Dr. Kikut said. "In one case, there was an area of concern in the MRI that turned out to be negative, but an area that was not even recognized on the MRI was positive on the digital PET/CT scan, and the patient went for surgery."

Enhancing care while reducing PET dose

Reducing patient PET scan times can have a positive impact on image quality, patient comfort, and clinical throughput. The digital technology built into Vereos can help reduce scan times. Patients experience faster scans with minimal discomfort.

"If we evaluate all the aspects of a patient's care path, from the exam time to the comfort level during the scan to the physican's report, it's pretty exciting what nuclear medicine can do with Vereos technology," said Dr. Gordon. "For example, a traditional scan from the base of the skull to the lower pelvis or upper thigh region would take approximately 26-30 minutes. That same scan on the Vereos now takes about 16-18 minutes."

After evaluating the options, the UVMMC team selected Philips' Vereos digital PET/CT.

In addition to completing scans faster, Dr. Kikut emphasized the importance of Vereos' ability to keep dose as low as possible.

"For our nuclear cardiology cases, we're focused on reducing radiopharmaceutical dose for our patients while providing them the highest quality of care," he said. "The system allows us to complete an exam and then reconstruct the images to how they would look if the dose was reduced by 25%. We have a dose schedule that's dependent on the patient's size, but we're hoping to lower the dose 25% across the board. For some indications, a higher dose may be needed, but many physicians are interested in lowering doses for these patients. Many cardiology patients may actually have a normal exam, so being dose conscious is extremely important."

Dr. Kikut explained these dose reductions can also be employed in oncology for certain patients with highly metabolically active lesions, or for patients expected to make a full recovery.

The future is digital

The technological advantages gained from using digital PET/CT over traditional analog systems are allowing clinicians to better detect and characterize small lesions in oncology that can change patient management and potentially improve outcomes. This innovative technology also allows clinicians to reduce the PET dose needed for many exams, especially in cardiology. As the industry steadily moves toward value-based care, Vereos digital PET/CT is driving clinical insights so clinicians can continue to improve patient care.

"We're finding more of the smaller lesions that are FDG-avid with digital technology and when we see a smaller lesion that is not FDG-avid and the primary is very actively metabolic, we are more confident that it is not cancer."

Brian Gordon, MD
Head of PET/CT & Nuclear Medicine
Quantum Radiology
bgordon@quantumrad.com

Radiology Analytics: A Clear Path to Improved Performance

Claudette Lew

"Intellispace allows you to identify areas for change and allocate the right resources into areas with the highest impact. You can start seeing the change after the first quarter."

Samantha Sizemore
Chief Operations Officer
Holston Medical Group
samantha.sizemore@myhmg.com

A wealth of data is available in every imaging practice. Implementing analytics to unearth insights from this data can drive operational improvements and business planning in radiology. Typical business processes used in other industries committed to data-driven decision making rely on iterative, methodical exploration of information with an emphasis on statistical analysis.

Similar analytics methods are being utilized in radiology as the industry moves toward new payment systems and a higher demand for operational efficiencies and cost savings. Holston Medical Group (HMG) Chief Operations Officer Samantha Sizemore is committed to bringing more data science into decision making and operations by using Philips' IntelliSpace Radiology Analytics.

A physician-owned, multispecialty practice with 23 locations and 153 physicians, HMG serves more than 130,000 patients in Tennessee and Virginia. Using Philips' Enterprise Imaging platform, Sizemore has been able to quickly synthesize complex streams of information into readily accessible metrics, mining the data to find clinical and operational efficiencies.

Data reveals impact

Involved in Philips' early development of the Radiology Analytics platform, Sizemore recalled some of the drivers behind her need to access HMG's radiology data to run the business more effectively. She compared it to having blinders on. "You don't know what you don't know," she said, "but once you take those blinders off, you're able to clearly see all the areas where you can make improvements and truly impact your business."

Radiology Analytics combines deep clinical expertise with technological innovation to connect patients, care teams, and data across health systems. Access to the HMG data and these analytics helped Sizemore to improve workflow throughout HMG and allowed realignment of resources for imaging procedures, resulting in shorter wait times for imaging exams.

"The impact has been nearly instantaneous. Intellispace allows you to identify areas for change and allocate the right resources into areas with the highest impact. You can start seeing the change after the first quarter," she recounted.

Transforming from data collection to operational correction

One of the first areas Sizemore leveraged with Radiology Analytics technology was report turnaround time. Six years ago, she recalled, HMG radiologists were turning reports around in 48-72 hours. Once Sizemore had information that compared the timing of the studies with the resources for reading them, she could easily pinpoint inefficiencies and take action to correct them. She was able to share the data with the external group contracted to read reports for HMG and worked with them to make the adjustments that would better meet HMG's needs.

"I was able to see the turnaround time by modality and timing, and also better evaluate our process for dictation and reporting," Sizemore explained. "We could review by individual radiologist. With the changes and improvements we made, we are turning all reports around on average in 24 hours now, and some, within just two to three hours."

Though some changes may seem insignificant with respect to the entirety of a healthcare facility, one small change can have a big impact on patient care.

"One of the major positive impacts of this change," Sizemore said, "was the effect it had on our patients. We know that sometimes the worst part is not having the exam itself, but having to wait on the results. We can remove an enormous amount of anxiety from our patients' experience by improving our turnaround times. We can tell them they'll have their results the next day which manages their expectations and lessens the worry."

After turnaround times, Sizemore looked into scheduling allocations versus peak times for reading requests. She found that her ultrasound department was inundated with STAT echocardiogram requests on Tuesday afternoons. The sonographers who performed the echocardiograms were under stress and overburdened with work. Armed with a deeper dive into her data, she could see that many HMG cardiologists had more office hours than procedures on Tuesdays. As they were seeing more patients, the staff received more STAT requests during that time. Increasing staffing for echocardiograms on Tuesdays and decreasing staffing on days with fewer requests alleviated the burnout on the ultrasound staff and improved their working environment. Based on this data and resulting scenario, Sizemore was also able to extrapolate the same trend to other specialties and made similar resource adjustments to better balance staffing with request expectations.

Philips IntelliSpace Radiology Analytics simplifies data analysis so you can see the clear path to improved performance. User-friendly, predefined reports help uncover deeper details about your operations with less effort.

A physician-owned, multispecialty practice with 23 locations and 153 physicians, Holston Medical Group serves more than 130,000 patients in Tennessee and Virginia.

Analytics for the bottom line

Comfortable with using the intuitive Radiology Analytics interface, Sizemore began leveraging other data for a broader impact—a financial impact. Upon reviewing referral patterns of HMG physicians, she noticed that some patients were referred to HMG's outpatient diagnostic centers, and some were referred elsewhere. She then sought feedback to understand the issues surrounding external referrals.

"The responses provided insights to do things differently," Sizemore said. "In some cases, there were things we needed to improve upon, and in other cases, I was able to educate them on cost differentials they may not have been aware of."

If referrals remained within HMG, Sizemore's staff could be lifting some of the administrative burden by handling the pre-authorizations. She also pointed out that patients may appreciate the lower costs associated with an outpatient facility versus a large hospital center. The insights from the data allowed for a communication strategy that increased the facility's internal imaging referrals.

On the horizon

The learnings gleaned from HMG's data using Radiology Analytics have proven invaluable to Sizemore and her team. They are now working on analyzing their internal and external referral programs.

"I can identify our most active referring physicians and facilitate an open relationship to meet their needs," she said. "Maintaining those relationships and updating these and all of our customers and patients with information about some of the newest equipment we have or about a potential new outpatient center on the horizon is key to keeping Holston Medical Group on the cutting-edge. We need to be visible to our patient and referring physician community to remain competitive. The information we access with Philips' Radiology Analytics is helping us do that."

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