SPECIAL CT UPDATE

Radiology Today
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Phone: 610-948-9500 **Fax:** 610-948-7202
Editorial e-mail: RTeditor@gvpub.com **Sales e-mail:** sales@gvpub.com
Website: www.RadiologyToday.net
Subscription e-mail: subscriptions@gvpub.com
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INNOVATIVE APPROACHES

By Dave Yeager

Progress takes many shapes, especially in the field of medical imaging. Sometimes, it can take the form of a technological advance. Other times, it can be the refinement of a process. Occasionally, it's just a matter of presenting an existing entity in a new way. In this month's issue, we present a little of each.

First up, Jeannette Sabatini reports on an interesting project that was started by an interventional radiologist and a former IR technologist. The project, called the Interventional Initiative, produces documentaries and other promotional materials about IR to raise awareness of the specialty. As Gregg Alzate, MD, says in one of the documentary episodes, "No one can figure out what I do!" but the Interventional Initiative is trying to change that.

Also, Keith Loria looks at the latest trends in CT. While dose reduction is always on the agenda, advances that promise better visualization without added radiation are generating interest. With the pay-for-performance movement gaining steam and hospitals increasingly using CT as a first-line modality, better visualization will be at a premium in the coming years.

Next up, Kathy Hardy asks imaging informatics experts about their thoughts on the most effective ways to implement enterprise imaging. Her article about enterprise imaging strategies provides a road map for these efforts as well as some real-world examples. As access to images becomes a must-have in today's health care environment, even organizations that aren't ready to take the enterprise imaging plunge need to start thinking about it.

Finally, Beth Orenstein looks at research efforts to evaluate the use of MR-guided focused ultrasound in pediatric patients. MRgFUS is already approved for uterine fibroids, pain related to bone cancer, prostate cancer treatment, and essential tremor, but proponents believe it can have much wider applicability. Because it doesn't emit ionizing radiation, it may prove to be especially useful for treating pediatric patients.

Enjoy the issue.
david.yeager@gvpub.com

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BUSY INTERSECTION

Specialties Converge With 3D Printing

By José Morey, MD, and Justine Kemp

3DHEALS, a 3D printing innovation platform, recently brought collaborators from several different specialties together in San Francisco. As founder Hui Jenny Chen, MD, said in her welcoming remarks, "One of the goals of creating this is to see if people from different backgrounds can work together to innovate instead of innovating in a silo." The conference covered the potential and developments of 3D printing, featuring several panels from different specialties, including dentistry, orthopedics, and prosthesis. Chen also noted the significant growth of 3D printing over the past five years, citing the exponential growth of publications related to 3D printing found in PubMed.

3D printing has several applications, from developing personalized parts for a patient to providing simulations to surgeons and residents before surgery. These applications have the potential to drastically reduce health care costs. Paul D'Urso, MBBS, PhD, FRACS, founder of Anatomics, discussed the potential cost savings. By having personalized tools and parts for a patient, the need for extraneous equipment in the operating room decreases, helping reduce waste and costs. Sanjay Prabhu, MBBS, DCH, MRCPCH, FRCR, codirector of SimPeds3D Print Service at Boston Children's Hospital, cited a 7:1 value when using 3D printing for simulations. By having surgeons and residents practice on a simulation before a procedure, morbidity, mortality, and malpractice suits decreased. Thus, for every dollar invested in the 3D printing simulation lab, the hospital saved $7.

Lifelike Models

The conference also aimed to evaluate and discuss the future of 3D printing and its potential intersection with other technologies. Bioprinting and organogenesis are hopeful targets for 3D printing. Keith Murphy, CEO of Organovo, discussed the current implications and future goals of the company, defining bioprinting as "the deposition of human, living cells into a 3D matrix to make a tissue."

Currently, the company has produced liver and kidney tissues, with pharmaceutical companies being major clients. The primary points of use for these tissues include preclinical safety testing of new treatments, disease modeling, and future organ transplant. For the liver tissue, bioprinted models are superior to animal models or harvested hepatocytes, Murphy explained, because their microarchitecture resembles the liver and a "chemical signal interplay" occurs in the tissue matrix. Also, these models survive much longer than individual hepatocytes that have been harvested.

Organovo is now using bioprinting for therapeutic use. Currently, there are limitations in growing full organs due to issues in producing adequate vascularization for the tissues. However, the company is working to make small bioprinted liver tissues that yield approximately 10% of the function of a normal liver. The goal is to use this tissue to give patients some liver function while waiting for transplant.

The conference concluded with potential ways in which 3D printing can intersect with other technologies, such as artificial intelligence, virtual reality, and robotics. Eythor Bender, CEO and cofounder of UNYQ, demonstrated how 3D printing and pressure sensor data are being integrated to make personalized, formfitting scoliosis braces. The data from the pressure sensors indicate whether the brace is touching the right spots on the body and treatment is being optimized.

There is tremendous potential for 3D printing, especially when several different fields have the opportunity to collaborate together. 3DHEALS will have its next meeting on April 20–21, 2018 (www.3dheals2018.com).

— José Morey, MD, is a senior medical scientist for IBM Research, a visiting assistant professor in the department of radiology and medical imaging at the University of Virginia, medical technology and artificial intelligence advisor for NASA iTech, chief engineering counsel for Hyperloop Transportation Technologies, a member of the Health Informatics Leadership Council at the VA, and director of informatics for Medical Center Radiologists in Virginia Beach, Virginia. Find him on Twitter at @DrMorey1.

— Justine Kemp is an MD/MBA candidate at the Tulane University School of Medicine and AB Freeman School of Business in New Orleans. Find her on LinkedIn at www.linkedin.com/in/justine-kemp-4408b0109.

ULTRASOUND FOR CHILDREN WITH ABDOMINAL TRAUMA

Despite evidence showing that the routine use of sonography in hospital emergency departments (EDs) can safely improve care for adults when evaluating for possible abdominal trauma injuries, researchers at University of California (UC), Davis Medical Center could not identify any significant improvements in care for pediatric trauma patients.

The findings, which resulted from a randomized clinical study involving 925 children with blunt torso trauma who were evaluated in the ED at the medical center, showed no difference in important clinical outcomes. The outcomes assessed were developed for the study mainly based on previous research in injured adults.

The study was recently published in the *Journal of the American Medical Association*.

Focused Assessment With Sonography for Trauma

The UC Davis team investigated whether the Focused Assessment with Sonography for Trauma (FAST) protocol could safely lead to a decrease in the use of CT scans for children and other outcomes. FAST is a bedside ultrasound examination using a portable ultrasound machine. It has not been routinely used in the initial ED evaluations of injured children. CT scans represent the "gold standard" in diagnostic imaging for clinicians, including the identification of intra-abdominal injuries, but they also pose a greater radiation risk for children than they do for adults.

"A lot of our work has looked at the appropriate use of CT scans in injured patients," says James Holmes, MD, MPH, a professor of emergency medicine and the study's lead author. "At least in the adult trauma population, there's evidence that you can use ultrasound to safely decrease CT use. One of the big questions has been whether that holds true for children, too."

Study Design and Objectives

Holmes and his colleagues identified a study cohort of hemodynamically stable children (meaning patients with no sign of blood circulation problems) who presented in the ED at UC Davis Medical Center with blunt torso injuries resulting from mechanisms such as motor vehicle collisions and falls greater than 20 feet. Four hundred and sixty patients were randomized to the FAST group and 465 to the no-FAST group, who received the same standard trauma evaluations but without ultrasound.

As in previous studies, the researchers wanted to determine whether the FAST protocol could significantly decrease the length-of-stay for patients in the ED, reduce hospital billing charges, and still identify injuries when compared with patients who did not receive a FAST examination.

"We were surprised that the routine use of FAST did not show any significant differences," says Nathan Kuppermann, MD, MPH, a professor and chair of emergency medicine at UC Davis and the study's senior author and coprincipal investigator. "The use of FAST compared with our standard trauma care did not decrease CT scan use [or] improve resource use, emergency department length-of-stay, safety, or hospital charges."

Length-of-stay times in the ED between the FAST group and the no-FAST group, for example, showed a minor differential of 6.03 hours vs 6.07 hours, respectively. The difference in savings between hospital charges for patients in the FAST group and the no-FAST group was about $1,200 out of total charges of more than $46,000. There also was no significant difference in "missed" intra-abdominal injuries between the two groups.

Working to Limit CT Scans in Children

Kuppermann and Holmes, who have led previous research studies designed to help emergency physicians safely avoid the use of CT scans for injured children, noted that even when an ultrasound gave physicians a better sense of the level of injury risk to a patient—and thus more confidence that serious injury risk was low—they still frequently ordered CT scans.

"In all of the cases where the risk was identified as 'low' [meaning the risk of serious intra-abdominal injury did not appear significant to the physician following the ultrasound] but where CT scans were ordered anyway, we didn't find one patient who actually had an intra-abdominal injury," Kuppermann adds. "While ultrasound appears to have the potential to decrease CT use in children, we wanted to determine whether it actually worked in practice."

Limitations of Study

The researchers noted that the new study does have certain limitations and should be cautiously interpreted. It was conducted at only one site—UC Davis Medical Center—which the authors say might have specific patient-care practices that influenced the results so that they may not be generalizable to other hospitals.

The relatively small size of the trial, despite randomizing 925 patients, also may "not have been adequately powered to detect small differences in outcomes" between study groups or in important subsets of children, particularly the youngest ones who are most susceptible to the radiation risks of CT scans, according to the authors.

Given the findings of the current study, the authors suggest a large, multicenter randomized clinical trial would more definitively answer the question regarding the usefulness of the FAST examination in children after blunt torso trauma.

— SOURCE: UNIVERSITY OF CALIFORNIA, DAVIS

ANONYMOUSLY YOURS

By Dave Yeager

Researchers at Mount Sinai Health System in New York have a new way to conduct randomized, double-blinded studies. In March, the Mount Sinai Department of Radiology and the Mount Sinai Translational and Molecular Imaging Institute (TMII) launched the Imaging Research Warehouse (IRW), a database that combines the clinical imaging and digital health records of more than one million patients in a deidentified format. David Mendelson, MD, vice chair of radiology at Mount Sinai Health System, a professor of radiology at the Icahn School of Medicine at Mount Sinai, and one of the IRW's creators, says the effort is intended to fill a gap in radiology research.

"One of the criticisms of the radiology literature, and medical literature in general, is that there really has been a paucity of double-blinded, randomized controlled clinical trials," Mendelson says. "One of the powerful pieces of this is the association of the clinical data with the imaging exams themselves. That's something that I think distinguishes this from many other current efforts."

Unmasking to Deidentify

Mendelson says the idea for the IRW goes back about six years. Mount Sinai researchers were often asking for deidentified images for studies, and Mendelson wanted to put a mechanism in place to make that type of data easily accessible. He proposed building a mirrored PACS with pseudoanonymized patient data—new identities, new medical record numbers, substitutions for any information that can be used to identify patients—and a secure crosswalk table so clinicians can backtrack to a patient if it's medically necessary. The mirrored PACS would be tied to the Mount Sinai Data Warehouse, a clinical repository.

Mendelson began to seek funding five years ago, but it wasn't until Mount Sinai's status as a hub for the National Institutes of Health's Clinical and Translational Science Awards (CTSA) Program was up for renewal two years ago that he found the vehicle for the IRW; the IRW funding was written into the CTSA proposal. Mendelson and Zahi Fayad, PhD, endowed chair in medical imaging and bioengineering, professor of radiology and medicine (cardiology), director of the TMII at the Icahn School of Medicine at Mount Sinai, and one of the IRW's creators, then put together a team to build and expand the IRW. In January 2016, Mount Sinai began building a mirrored PACS to house the deidentified imaging data.

Mendelson evaluated several programs that can deidentify data, but many don't perform well with bulk volumes of imaging. To solve this issue, Mount Sinai licensed a vendor neutral archive (VNA) from Vital Images and used the VNA's deidentification engine. The next step was to find the places in the DICOM metadata where vendors may have stored protected health information (PHI). Mendelson says there are 18 known fields where PHI is stored that are documented in academic literature.

"That's the easy part because everybody knows where they are," Mendelson says. "The problem was there are many miscellaneous/custom/private tags in the DICOM metadata that people can use to store data, and vendors frequently use these blank fields that are available to put some information that might be pertinent to the exam. So, we spent a year taking all of the modalities at Mount Sinai, one by one, sending exams through this engine, and looking for places where you might find PHI buried."

The researchers found a significant amount of hidden PHI, which was catalogued and deidentified. In addition, Mendelson has almost completed his evaluation of tools that remove pixel data, a necessity because some vendors enable pixel burning on the corners of exams to embed patient data; as long as it's known where each modality embeds those data, algorithms can be used to routinely remove them.

By then end of 2016, Mount Sinai was ready to make the IRW operational. The system went into production in March 2017. For the first two weeks, only brain MRs were fed into the system. Since then, all modalities except ultrasound have been incorporated, but Mendelson expects ultrasound to be added soon. The IRW is available at Mount Sinai's main campus but will eventually be available to all Mount Sinai users.

For Who? For What?

Mendelson envisions a wide range of applications for the IRW. For example, a researcher who wants to understand the correlation between lesions and radiation dose related to low-dose chest CT can do that. Although the dose will be low in all cases, variations among machines made by different vendors can make quantifying dose difficult. The quantitative imaging information embedded in DICOM metadata coupled with patient data allow investigators to examine the question without clinical bias.

"Now, when you're doing this clinically, all you care about is low-dose CT and whether there is a nodule or not. But, if you're a research person who wants to make strides in further dose reduction, what you really need is the detailed data about how the exam was conducted: milliamperage, kilovoltage, slice thickness, all of those parameters which are fixed," Mendelson says. "I can give that to you now while blinding you to who the patient is, but you can look at a thousand chest CTs, and you'll know exactly what the technical parameters were, you'll know exactly what the radiation dose was, and you can begin to conduct research about how to lower dose and maintain lesion conspicuity, on that basis."

Mendelson says there are many use cases that will immediately benefit from the IRW. A significant one is genomics. The phenotypic information provided by imaging exams is needed to correlate the associations between genomic findings and how diseases manifest, he says.

Another important use case is machine learning and artificial intelligence (AI). The growing need to train AI algorithms makes large patient databases invaluable. Mendelson says there are still some details to work out, but the IRW will possibly be able to assist with these efforts.

"As much as we intended the IRW for basic, core research, there are all of these machine learning companies springing up, now—it started with IBM, when they purchased Merge a couple of years ago—and they all want as many images as they can get to train on," Mendelson says. "Their problem is getting those images, and there are a lot of issues to be solved about who can release images. Potentially, our library of deidentified images is very useful for this. We're going carefully, but we have people starting to do machine learning within Mount Sinai so that's one venue, and we would probably carefully entertain outside partners, going forward."

Mendelson emphasizes, however, that whatever the use case may be, the IRW can play a role.

"I think the initial notion [of researchers] was that just having images is enough," Mendelson says, "but images that have been annotated and curated with clinical and pathologic data offer the richest value for research and machine learning."

— Dave Yeager is the editor of *Radiology Today*.

TO CT OR TO CTA, THAT IS THE QUESTION

By Melody W. Mulaik, MSHS, CRA, FAHRA, RCC, CPC, CPC-H

CT angiography (CTA) uses CT technology to examine a patient's blood vessels. It can detect stenosis, aneurysm, vascular trauma, and congenital anomalies of the vascular system. CTA provides the same sort of information as catheter angiography but without the need for an invasive procedure. It can also provide information that is not provided by catheter angiography, including images of the vessel wall and the vessel's relationship to other structures.

Even though the technology for CTA has been in place for many years, there are still questions about coding, documentation, bundling edits, and medical necessity. The biggest areas of concern are related to exams of the head and thorax.

Coding Guidelines

The CPT codes for CT do not list specific structures that must be evaluated. This is because each CT study is tailored for each patient's circumstances. In the case of a patient who is undergoing multiple CT scans or a follow-up scan, "the field of anatomy scanned may be less than the usual anatomic field for a particular body part" (***Clinical Examples in Radiology***, Fall 2014). This allows the radiologist to minimize the patient's radiation dose, and it does not affect the code assignment.

The CT scan codes are defined in terms of contrast use. There are three codes for each body area—one for a study without contrast, one for a study with contrast, and one for a combined study (without contrast followed by with contrast). For example, the codes for head CT are 70450 (without contrast), 70460 (with contrast), and 70470 (combined). The codes for diagnostic CT scans without contrast require only general physician supervision. The codes for diagnostic CT scans with contrast and combined require direct supervision.

The CTA codes include examination of the arteries (CT arteriogram) and/or the veins (CT venogram) in a specific anatomic area. Only one unit of the CTA code should be assigned, even if the exam includes both the arteries and the veins.

CTA is performed using intravenous contrast. The CTA codes are defined as "with contrast material(s), including noncontrast images, if performed." This means that if a noncontrast scan is performed prior to contrast administration, it is included in the CTA study and is not separately reportable. According to ***CPT Assistant*** (August 2011), "Although in many circumstances, noncontrast imaging is not required as a prelude to CT angiography, any noncontrast imaging performed during the same session—whether for localization or diagnostic purposes—should not be separately reported." Because they are performed using contrast material, CTA studies require direct physician supervision.

CTA requires and includes 3D angiographic rendering. ***Clinical Examples in Radiology*** (Fall 2011) states, "Only when 3D is documented should the coder assign a computed tomographic angiography (CTA) code, as CTA requires 3D postprocessing." A study that includes only 2D postprocessing should be coded as a CT scan rather than a CTA.

In addition to the term 3D, other terms such as maximum intensity projection, shaded surface rendering, and volume rendering may also be used to describe 3D postprocessing. However, multiplanar reconstruction is a 2D postprocessing technique. (See ***Clinical Examples in Radiology***, Fall 2013.)

The ***ACR Radiology Coding Source*** (May/June 2009) states that the imaging facility must keep a permanent archive of representative 3D images from the CTA. The ACR notes that "the axial data set from which 3D images are created is insufficient for the reporting of a CTA study."

CT and CTA on the Same Date of Service

In most cases, it is not appropriate to charge for a CT exam in conjunction with a CTA. There is some degree of overlap between the exams because data acquired during a CTA exam include images of nonvascular structures—bones, soft tissues, etc. These nonvascular structures must be eliminated from the images during postprocessing to create the images of the vessels.

According to ***Clinical Examples in Radiology*** (Summer 2008), performance of a CT and CTA on the same body area on the same day would be infrequent. It might occur, for example, when a CT scan shows a tumor in the pancreas, and

a subsequent CTA is performed. In order for both exams to be billed, the CTA must involve a "new data acquisition." In other words, the patient must be scanned a second time, and a new data set must be acquired. In this situation, both exams may be charged.

In order to charge for both exams, there must be an order from the treating physician for both exams, both exams must be medically necessary, and both must be separately and completely documented.

CT/CTA Head

Head CT (70450, 70460, 70470) involves contiguous slices from the vertex of the skull to the foramen magnum, including the orbital roof. CT is the preferred initial test in acute head injury, severe headaches of sudden onset, and suspected intracranial hemorrhage, as well as for uncooperative patients.

CT is considered medically necessary for headache when it occurs after a head injury, suggesting the possibility of hemorrhage; when it is unusual in duration, frequency, or intensity, or does not respond to medical therapy; or when it is characterized by sudden onset and unusual severity, which may suggest the possibility of hemorrhage from aneurysm or arteriovenous malformation.

CTA of the head (70496) is often performed to evaluate for aneurysms in patients with known or suspected intracranial hemorrhage.

A CT perfusion scan is sometimes performed on the head as well. A CT cerebral perfusion study is a specialized protocol used primarily to evaluate stroke patients. The patient is given an intravenous bolus of contrast, and continuous imaging is performed while the contrast makes its first pass through the brain. Color-coded perfusion maps are created, and mean transit time is calculated. Based on the results of the cerebral perfusion study, the physician can determine the appropriate intervention.

CT cerebral perfusion studies are reported with Category III code 0042T. Under the Medicare Physician Fee Schedule, this code is classified as a physician service (PC/TC indicator 0) and has no technical component. It is contractor-priced (status C), meaning that each Medicare contractor can set coverage guidelines for the service. Under the Outpatient Prospective Payment System, code 0042T is a packaged service (status N).

While there are variations by facility, a common stroke protocol is CT head, CT perfusion, followed by CTA if the findings support the study. In this situation, only the CTA of the head and the perfusion study may be reported, but keep in mind that the facility will not receive separate payment for the perfusion study. On the physician side, there may be some payers who provide separate payment, but, unfortunately, this is rare and not widespread.

The biggest coding concern is that organizations—physician or facility—should not unbundle the CT and CTA and bill for both studies with a modifier unless the previously outlined criteria are clearly met. It should be a rare exception, and the documentation must clearly support both codes.

CT/CTA Thorax

Chest CT (71250, 71260, 71270) is performed to evaluate abnormalities of the lungs, mediastinum, pleura, and chest wall. It typically includes sequential slices obtained from the lung apices through the posterior costophrenic sulci. The exam may be extended to the adrenal glands if a diagnosis of primary bronchogenic carcinoma is known or suspected. Potential abnormalities of the pulmonary hilum may require contiguous sections (with contrast). A pulmonary nodule will require contiguous slices throughout the nodule (without contrast).

Code 71275 represents CTA of noncoronary chest vessels such as the aorta and pulmonary arteries. This study is frequently performed for pulmonary embolism (PE).

Documentation of CTA thorax is problematic for many organizations. Like other CTA codes, code 71275 requires 3D postprocessing. PE studies without 3D postprocessing should be reported as CT of the thorax (71250–71270).

Many times, organizations will set up a PE protocol in their ordering system. Technically, this could represent either a CT or a CTA, so it is critical that there is documentation within the organization that makes this clear to the referring physicians and all departmental staff. Most organizations do intend this to be a CTA, but there are still a few facilities that use CT as their default protocol. One other key point to note is that many payers have dictated they will provide payment for a CTA thorax but not a CT thorax for a PE evaluation. This is the first widespread occurrence of payers actually dictating protocols for an exam that did not require advance preauthorization. This statement is based on the assumption that the exam is being ordered through the emergency department vs a scheduled service that required precertification/preauthorization.

Summary

Ideally, the right exam is ordered, the facility performs what was ordered, the radiologist's dictation clearly defines what was performed, the exam is correctly coded, and appropriate reimbursement is provided the first time the claim is submitted. It sounds straightforward, and, arguably, it should be. In reality, it is not always that simple.

Take the time to evaluate the coding practices for these exams/protocols within your organization, to ensure appropriate orders, documentation, and coding. Compliance is always worth the time and effort.

— Melody W. Mulaik, MSHS, CRA, FAHRA, RCC, CPC, CPC-H, is president and cofounder of Coding Strategies, Inc, and president of Revenue Cycle, Inc, which provide specialty-specific auditing and educational services for physicians, hospitals, and billing companies nationwide.

THEY COULD BE HEROES

By **Jeannette Sabatini**

This is the story of today's real superheroes ... the inspired doctors who are saving lives and treating clots, cancers, disease, stroke ... all without a scalpel.

That's the excerpted intro to ***Without a Scalpel***, a documentary series about patients undergoing minimally invasive, image-guided procedures (MIIPs) and the "superhero" interventional radiologists who treat them. Cocreators Susan Jackson, RT(R)(CV), a former interventional technologist with an MBA and a marketing background, and Isabel Newton, MD, PhD, an interventional radiologist, started the nonprofit organization to raise awareness about MIIPs and the interventional radiologists who perform them. They say the organization's mission has been successful, which is especially important since many people remain clueless about MIIPs as a treatment option, including patients, referring physicians, and hospital executives. In the words of Gregg Alzate, MD, an interventional radiologist who is featured in the first episode of the series: "No one can figure out what I do!"

The organization, called the Interventional Initiative (II), has drawn attention to the advantages of MIIPs through engaging and user-friendly educational tools, including the documentary series, a website, infographics (see examples on page 14), social media channels (Facebook and Twitter), and video podcasts that teach the value of individual MIIPs with quick yet personal patient stories. The series is currently distributed via on demand platforms (Amazon Video, Vimeo Films, Tubi TV, realeyz Indie Films) through Kinonation, a digital distribution firm based in Santa Monica, California. The II partnered with a production company called Evolve Media Production to make the series. Jackson is cofounder and CEO, and Newton is cofounder and chairperson of the board. Newton also is a physician-scientist practicing in the field of IR at the VA San Diego Healthcare System and the University of California, San Diego.

Small Miracles

Since the II's inception in 2015, teams of professionals on both the medical and creative sides have worked hard to accomplish what Alzate says has been needed for years: "to restart the rebranding of what [interventional radiologists] do." What interventional radiologists do is explained this way in the documentary: "Traveling through the blood vessels like highways, they penetrate the microcosmos of human anatomy, offering big solutions without big incisions, expanding the realm of the possible, giving hope where there was none."

A basic, though less poetic, explanation is offered on the II's website: "By using medical images like X-rays to see inside the body, specialized doctors can treat major diseases through a pinhole." These diseases and conditions include those that affect the brain, lung, chest, liver, gallbladder, stomach, intestines, kidneys, back, bones, legs, stomach, and intestine. They also can be used to treat health conditions that affect women (eg, infertility, fibroids, bleeding after childbirth) and men (eg, infertility, enlarged prostate).

"There are so many advantages to MIIPs," Jackson notes. "These procedures often offer lower complication rates and a shorter recovery time. They get people back to their normal lives quicker."

Newton adds: "People leave with a Band-Aid. You can cure cancer in an hour or less and take somebody who is completely incapacitated and make them walk again. It is nothing short of small miracles."

With so many benefits, one would expect to see MIIPs featured in articles published by other radiology organizations or in the mainstream press, but that is rarely the case, says Alzate, who is the chief of vascular radiology and IR at Sharp Memorial Hospital, San Diego Imaging. For that reason, he is excited about the II's work, including the ***Without a Scalpel*** documentary series. In his 30 years of practice, Alzate says this is the first time he has witnessed the production of something as important as this, the "simplest visual example of what we do."

"We needed to do something that nobody else was doing to get the attention of health care consumers," Jackson says. "It had to be entertaining and engaging. So we started making the documentary series."

Documentarians highlight the benefits of interventional procedures.

The Human Side of IR

Two of many planned episodes are now available, and a third is in the production stages. Episode 1: Bloodless, focuses on the stories of three women who suffer from blocked blood vessels; Episode 2: The Cancer Snipers, released in May, features the story of cancer patients; and Episode 3 will focus on women's health, featuring procedures such as uterine fibroid embolization and conditions such as pelvic congestion syndrome.

"Our goal for making the documentary was to use the vehicle of compelling patient stories to educate the public," explains Newton, who serves as director and a contributing writer. "People connect with these stories in a palpable way. The episodes will depict the gamut: people with rare diseases who have been told that they have no other option, people who are facing amputation who leave on their own two feet, patients who are struggling to preserve their quality of life in the face of a difficult cancer diagnosis."

The documentary also portrays the human side of being an interventional radiologist, which serves to personalize the overall experience of undergoing a MIIP. In the first episode, viewers see the personal side of Alzate and one of his patients, Margarita. Viewers are taken to Margarita's bedside in the hospital. Her leg is raised, and her toes are exposed; they have gone black from gangrene. Her daughter rubs her hand in an effort to calm both of their fears, since such cases typically require some form of amputation.

Later, we join Alzate on the job at Sharp Memorial Hospital. He is performing a MIIP to treat Margarita's blocked blood vessels. We watch the same screen he watches as he uses an angioplasty catheter to perform the MIIP that will save Margarita from an amputation.

Eventually, we join Margarita at a ceremony within a large auditorium filled with cheering people. Her daughter tells us that within a week of her MIIP, Margarita was well enough to go to the ceremony, where she became an American citizen.

Putting a Face on Radiology

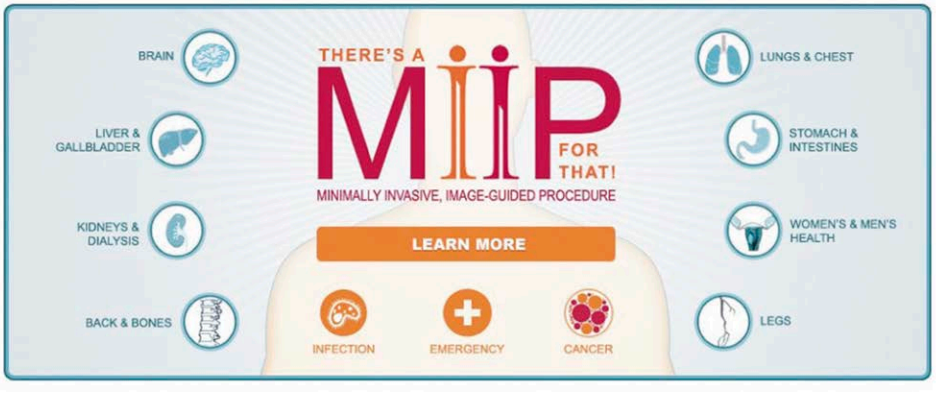
Usually unrecognized by the public, interventional radiologists have long been working in the shadows, but ***Without a Scalpel*** is trying to change that. This effort benefits diagnostic radiologists, too, Newton says: "Good interventional radiologists are focusing more on complete patient care, and many see this as a way of bringing a face back to radiology. By personalizing the services we provide, we add value, and patients are less likely to be sent out to remote sites where services are less expensive. I think this is the key to the continued success of IR, and radiology in general. We have to provide more personalized care to our patients."

Although better recognition could bring more business to interventional radiologists—and that is a good thing—that end result is not the reason the II does what it does, Newton and Jackson say. "I am not lining my pockets," Newton says. "The goal of the II is not at all self-serving. We do this as a nonprofit. It is entirely a public service-type mission because patients actually do worse when they don't understand their options."

Jackson adds: "We are not telling people that this is the choice they should make. We are just saying, if patients have this information, they can make a better choice for themselves or for their family."

Patients who are better informed should be able to discuss MIIPs with their referring physicians, but referring physicians do not always know enough about MIIPs, according to an II survey. "Some of that [lack of awareness] is due to the fact that this is one of the most rapidly innovating fields of medicine, and it has been for decades. Even primary care physicians have trouble keeping up with the breadth of diseases that can be treated in this way," Jackson explains.

The survey also proved that hospital executives need to know more about the procedures. "If they do know that IR exists, they couldn't tell you the breadth of procedures or the value of those procedures to the hospital, and they certainly don't use those value points to market their hospital systems and their centers of excellence," Jackson says. "To me, as a marketing professional, that is a miss."



— IMAGES COURTESY OF THE INTERVENTIONAL INITIATIVE

Not the Last Resort

Alzate believes some professionals put their own financial gain first before suggesting MIIPs as an option. "If general surgeons insisted on exploratory laparotomy for cancer diagnosis, there would be a raging scandal. They gave that up in the face of a MIIP called percutaneous biopsy, which is highly effective and efficient and saves countless lives," he explains. "They gave the money up for collective health."

Professionals should never play dumb for their own financial gain, Jackson and Newton stress. "The truth of the matter is informed consent means that these physicians are obligated to discuss all options with patients so that patients can be informed to make their own decisions," Jackson says. "But, unfortunately, that does not always occur when it comes to these minimally invasive procedures."

Surgeons may worry that MIIPs will put them out of business, but Newton says that is not likely to happen. "Everything can't be solved with one tool; you can only treat people by having the full complement of tools in your toolbox," she says.

Jackson adds: "It's not an either/or kind of thing; minimally invasive procedures sometimes complement surgery or are sometimes done pre- or postsurgery."

According to Newton, many professionals know about MIIPs and their advantages but still do not make room for them at the treatment table. "We are basically the S.W.A.T. team that gets pulled in, do our thing, and then we get out. We are not there for the glory, but when we get called in at the 11th hour every time to do the really difficult thing, why shouldn't we be called at the first hour to do it when it's easy?" Newton notes. "When you do something and it can really help someone in dire circumstances, it shouldn't be the option of last resort."

Fortunately, medical students will come out of school with a better understanding of MIIPs since Newton, who serves as program director for the research residency, also conducts lectures at medical schools. In addition, medical students seem to have taken a liking to the documentary. "Through social media, we have gotten feedback saying that medical schools have had watch parties where they viewed ***Without a Scalpel*** or the trailer," Jackson says.

The II was started with little funding and continues to rely on support to fund its many projects. "We are not trying to promote any particular physician or trying to sell products; we are trying to educate the public," Newton says. "That gives us a lot of moral responsibility and artistic license, but it also makes it difficult because it makes us dependent on donations and successful fundraising."

According to Newton, the II has had enormous support from the worldwide IR community. The documentary is supported by the Western Angiographic and Interventional Society. "Because we are recognized by those who support our mission, it deepens the value of what we are doing," Newton says. "This is a passion project supported by a lot of people."

— Jeannette Sabatini is a freelance writer based in Malvern, Pennsylvania.

IMAGING ACROSS *the* SPECTRUM

By **Keith Loria**

The CT market is stable, if not growing, in 2017. Hospitals will continue to invest in CT technology as imaging use increases and CT is used as a first-line imaging device, especially in emergency departments. CT scanners are fast, continue to offer lower doses, and can prove to be total-cost-of-ownership solutions to providers. Dose reduction is still key, but image quality, resolution, and improvements in workflow are becoming more important to customers.

Matthew Dedman, marketing director for CT at Siemens Healthineers North America, sees a great deal of CT industry interest in dual or multienergy—also called spectral—CT, which allows for more confident diagnoses by delivering functional and quantitative information from traditional CT scans, and new workflow concepts, including technology that will bring significant efficiencies and standardization of results to CT imaging. He has also seen interest in mobile stroke imaging that equips ambulances with hospital-quality CT scanners.

The gradual shift from fee-for-service to value-based payment systems is driving a shift in the industry to focus more on improving clinical and economic outcomes for customers and patients. Health care providers want to be able to diagnose patients the first time they scan them. When they choose CT for their imaging needs, they want to be able to determine what the next steps in a patient's treatment should be. This is one reason why spectral/multienergy technology, which can reduce indeterminate findings, is getting a lot of attention from the CT community.

"Because spectral results bring new layers of clinical information and better characterization of diseases for a more definitive diagnosis, this technology has moved past the academic level on a path to becoming a standard of care for CT imaging," says Lakshmi Gudapakkam, general manager of diagnostic imaging at Philips.

In addition, Jamie McCoy, GE Healthcare's molecular imaging chief marketing officer, has seen a lot going on in the digital space—what he calls a cross-imaging opportunity for community-based care to be shifted into clinics.

"We think there will be a 50-times data growth in health care by the year 2020, and there's a lot of buzz about the role digital offerings will play in diagnostic imaging," McCoy says. "There's a lot of activity in artificial intelligence and deep learning, and we expect to see more of that in the imaging space." He adds that a number of trials have revealed some compelling outcomes around CT for cardiac use, and he thinks those studies may drive growth in the cardiac CT space.

A Spectrum of Choices

Here is a look at what some of the major manufacturers currently have available:

Carestream

Helen Titus, Carestream's worldwide marketing director for ultrasound and CT, notes that the company has recently introduced its Carestream OnSight 3D Extremity System, which uses cone beam CT technology originally developed for the dental and ear, nose, and throat markets, to provide 3D imaging of extremities.

"It's designed for use by orthopedic specialists who can now capture 3D images, diagnose the condition, and consult with patients in the same office visit," Titus says.

Spectral imaging and other advances offer new possibilities for CT.

— IMAGE COURTESY OF CARESTREAM HEALTH

Carestream's OnSight 3D Extremity System

— IMAGE COURTESY OF SIEMENS HEALTHINEERS

Siemens Healthineers' SOMATOM go.Up

Technological advances for Carestream's OnSight 3D Extremity System include metal artifact reduction software, iterative reconstruction that helps improve image quality, and the ability to offer a significantly lower dose than traditional CT systems. It also includes a streamlined diagnostic process.

"The OnSight 3D Extremity System equips orthopedic specialists to care for a wide range of diseases and conditions that occur in an aging population as well as recreational and professional athletes who suffer injuries," Titus says. "This system also avoids the need for a whole-body CT scan that is more expensive and delivers a higher radiation dose to patients."

GE Healthcare

GE Healthcare's McCoy says the company offers the Revolution CT with GSI XTream, which provides clinical capabilities through the convergence of coverage, spatial resolution, temporal resolution, and spectral imaging. The GSI Xtream extends GE's Revolution CT platform with its wide collimation and 50 cm field of view to deliver the only volume spectral CT. McCoy says this technology has significantly improved Revolution CT's workflow.

"We're seeing [the] clinical impact of being able to detect smaller lesions as well as to add [the] additional information that GSI or dual energy brings by also being able to characterize the lesion," he says.

Philips

While conventional images often produce ambiguous data that can require additional testing, spectral images provide a more in-depth look at pathology, often helping to increase diagnostic accuracy. Gudapakkam says the Philips IQon Spectral CT provides on-demand spectral results through its proprietary detection-based solution, meaning clinicians don't have to select whether they want spectral results for a patient up front.

"Spectral results are available for every patient scanned on the IQon, which helps to increase diagnostic confidence [and reduce] the need for downstream testing," he says.

The IQon Spectral CT reconstructs data by capturing high and low X-ray energies at the same time and in the same space—breaking down energy-specific information into slices that highlight specific materials contained in tissues. Additionally, the IQon Spectral CT is equipped with the Spectral Diagnostic Suite, which includes a Spectral Magic Glass and Magic Glass on PACS app.

"While Spectral Magic Glass allows you to view and compare several different spectral results at the same time for a specific region of interest, the Magic Glass on PACS app provides the ability to review and analyze spectral results from anywhere in the organization via an organization's PACS system," Gudapakkam says. "On the IQon, spectral results are always on and can always be reviewed and analyzed on-demand on PACS, anytime, anywhere."

Siemens Healthineers

Siemens Healthineers recently launched its SOMATOM go. CT platform, which for the first time brings a mobile, tablet-based workflow to the operation of a CT scanner. Dedman notes that this drastically changes the historic CT technologist workflow that involves spending a majority of time in the control room at the CT console.

"Now, the technologist can spend the majority of the time in the scan room, tableside with the patient, walking them through what's happening with the procedure, what the breathing commands will sound like, what the IV contrast will feel like when it comes in, and just comforting the patient throughout the exam," he says.

Additionally, with a wide detector that provides up to 64 slices, the SOMATOM go.Up offers faster scanning and tin filtration, which is particularly important for lung imaging, eg, to screen for lung cancer. It also uses some of the lowest radiation doses achievable for a CT of this class.

Toshiba

Toshiba Medical launched its Aquilion ONE GENESIS Edition at RSNA 2016—a compact premium scanner with sharper resolution and First MBIR, which can improve high-contrast spatial resolution up to 129% while reducing radiation dose up to 85.3%.

— IMAGE COURTESY OF PHILIPS

Philips' IQon Spectral CT

— IMAGE COURTESY OF TOSHIBA AMERICA MEDICAL SYSTEMS

Toshiba's Aquilion ONE GENESIS edition

"The system is fast, with reconstruction times up to 80 images per second, and small, fitting into a footprint of only 204 square feet [19 square meters]," says Tim Nicholson, senior manager of market development for the CT business unit at Toshiba America Medical Systems.

In April, Toshiba Medical also launched its newest midtier-value CT solution, the Aquilion Lightning 80, with slice flexibility ranging from 40 to 80 to 160. Further rounding out its platform, less than a year ago, Toshiba Medical launched the Aquilion Lightning 16/32, an entry tier solution.

"Customers are wanting high-end technology advancements on all their CT systems," Nicholson says. "For instance, SEMAR [Single Energy Metal Artifact Reduction], iterative reconstruction, and workflow enhancements are all things that our customers are asking for and that we have made standard across our product line of CT systems."

Impact of Recent Legislation

Starting in 2018, the Centers for Medicare & Medicaid Services (CMS) has mandated appropriate use criteria and clinical decision support when ordering Medicare outpatient advanced imaging. This is expected to dampen CT procedures modestly in the long term, but it helps establish radiology as a leader in promoting evidence-based imaging care and patient safety while demonstrating to the C-suite and CMS/Medicare that radiology is doing its part to control costs and increase collaboration.

"However, the current uncertainty surrounding health care legislation and the potential for fewer insured citizens has caused concern amongst providers," Nicholson says. "Patients will still need imaging exams, but without providers knowing how they'll be paid, vendors will be pressured to offer a total-cost-of-ownership solution that can help decrease operational costs."

But, because of CT's critical use as a first-line imaging modality, Dedman thinks proposed legislation probably won't have a significant impact on the industry.

"It is ingrained into so many care pathways, particularly for those patients who come into the emergency department," Dedman says. "If anything, I think recent legislation has increased the utilization of CT. In 2013, for instance, it was recommended for low-dose lung cancer screening, opening up the modality to screening procedures for the first time. We've seen that trend continue more recently with the recommendation that CT be used for colon cancer screening as well."

The Future of CT

Most agree that the market will continue to grow in the future. Carestream's Titus believes future imaging systems may include new features like data analysis tools and automatic measurements, and, in the coming years, she expects to see an increased volume of extremity exams, as musculoskeletal conditions and injuries affect patients of all ages.

Moving forward, Gudapakkam believes spectral/multienergy technology will continue to evolve, providing the ability to obtain more information from images—an important factor as the industry shifts to population health management.

"Spectral detector CT will be able to routinely deliver anatomical information as well as the ability to characterize structures based on their material makeup, within a single scan," he says. "This will change and improve clinical pathways to personalized medicine."

Many also anticipate that the biggest change in CT will be driven by artificial intelligence, computer-aided diagnosis, data integration, and expanded analytics for both clinical purposes and productivity.

"Vendors will continue to develop solutions for lower dose, improved resolution, and improved workflow that will remain important in busy environments in which CT systems are typically found," Nicholson says. "Additionally, using big data and artificial intelligence, [the utility of] CT exams will continue to grow, and the market will see improvements on how big data is used to change clinical pathways and improve care."

— Keith Loria is a freelance writer based in Oakton, Virginia.

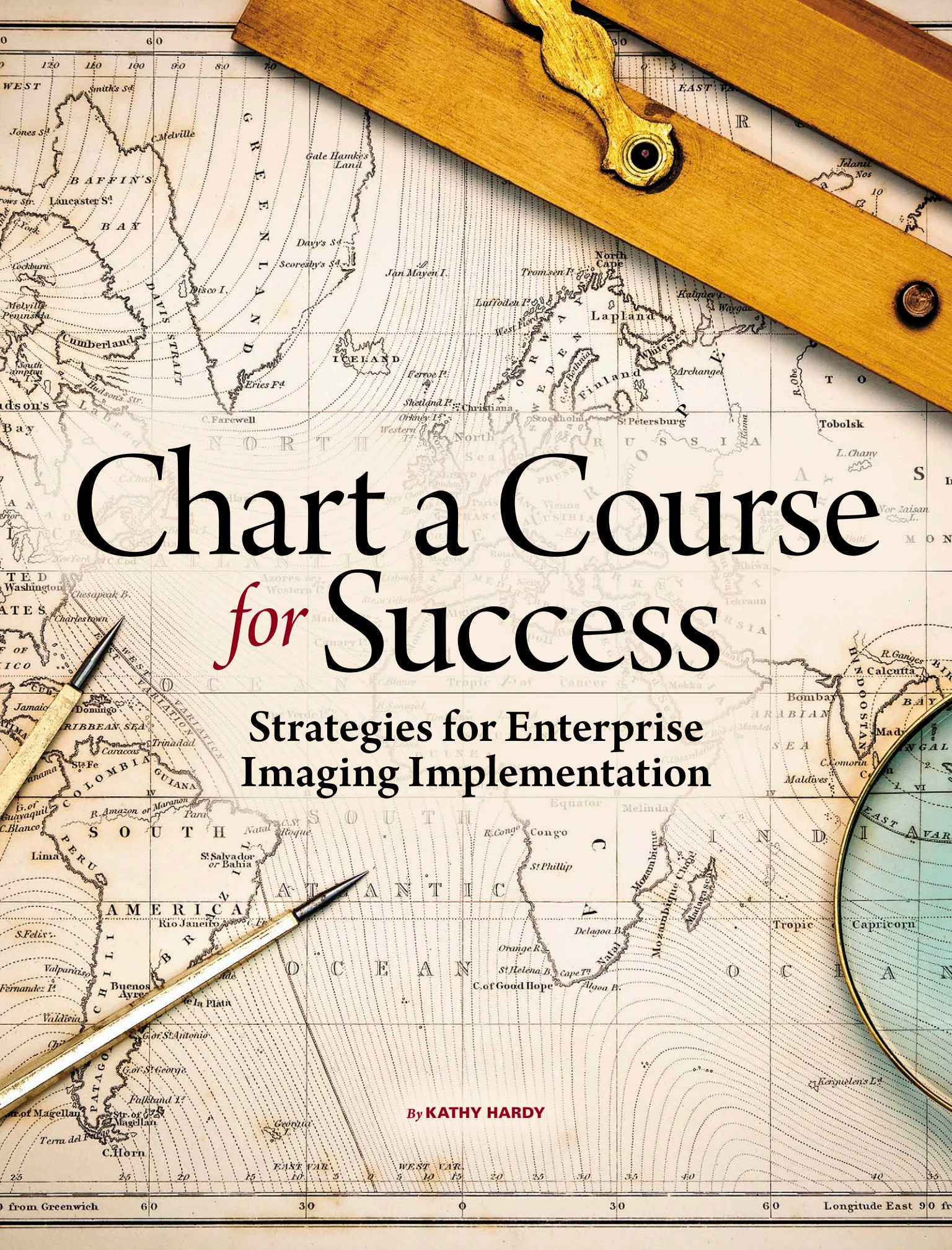


Chart a Course *for* Success

Strategies for Enterprise Imaging Implementation

By **KATHY HARDY**

An ***Enterprise*** sailed the seas during WWII, flew into orbit as the first space shuttle, and carried Captain Kirk to the final frontier. In health care, clinical specialists and executives are now using a different type of enterprise to chart a course of unified data collection, storage, and sharing. With images being generated in radiology and beyond, medical facilities are developing and implementing comprehensive enterprise imaging strategies that will lead them to consolidated patient data.

"Imaging is not just for radiology," says Eric Rice, chief technology officer of Mach7 Technologies. "You need to also consider the specialties where images are generated by patient encounters: dermatology, endoscopy, or wound care. Any clinical media generated via patient encounters across all specialties create the complete imaging picture. All should be included in the consolidation of patient data within an enterprise imaging strategy."

Need a Good Map

As with any successful voyage, it all begins with a map. In the case of an imaging enterprise, the route provides details for what needs to be linked.

"It's not about the size of the facility but, rather, the number of areas being linked together that determines the project size," says Paul Shumway, senior vice president at Novarad. "The area to be navigated could be a large organization with many sites to link together or a small organization with many departments that need to be connected."

As Rice notes, an enterprise strategy needs to travel "deep and wide" to serve the specific needs of each site. Strategies need to account for not only cross-department consolidation but also singular departments which may span sites, as well as disparate information systems accumulated from mergers and acquisitions.

Shumway believes some people are being misled about where to start. "People often think it's more about the archive than the workflow. You need the archive, but it's not everything to just get a VNA [vendor neutral archive]. You need to address workflow."

Logistics aside, those with experience in establishing an imaging enterprise say it's vital to create a governance and policy strategy. Consider who is going to be involved in defining and managing the enterprise imaging strategy. While there is an expectation that there will be points of debate during the process, defining a strategy for how questions will be resolved helps planners reach consensus.

"Create a council with key leaders throughout the enterprise to guide the project, provide oversight, communicate with decision-makers, and coordinate with other projects related to enterprise imaging," says Louis Lannum, senior strategic solutions consultant with Agfa Healthcare. "This team of champions also helps support and obtain buy-in throughout the organization."

An enterprise imaging plan impacts all specialties that function within a health care organization, as well as all facilities associated with that group. Resistance can develop as individuals from different groups bring their own department biases with them. With that, it's vital to build a governance program around the entire entity, which includes thought leaders and decision-makers who are willing to be governed, to come up with one strategy that serves the imaging and data needs of the collective group of health care providers.

Oftentimes, members of the governance team look to radiology as a mature imaging department. With that, best practices used by radiologists can be modified for use in the enterprise. As Lannum describes it, radiology, teamed with image-dependent cardiology, working in conjunction with IT, can bring enterprise proponents from other departments to form a team of individuals who can visualize a system that melds together all data and imaging within a health care organization.

"Your governance reflects the culture of your organization," Lannum says.

Learn by Example

While director of enterprise imaging at Cleveland Clinic, Lannum oversaw the incorporation of the facility's enterprise imaging system. The project began with a VNA that was purchased for radiology storage. By increasing storage and adding a workflow engine, they began integrating with departmental systems. In the end, all images were captured in the VNA and users could access them through an image viewer that integrated with the clinic's EHR system. Point-of-care imaging programs were also added to the enterprise.

"You can have over 70 departments producing some type of image in a large medical facility," he says. "You need to do an assessment of your imaging processes. Look at who captures images, how those images are being stored, how departments and facilities are sharing images, and whether metadata is being collected."

Managing Workflow

The next step is to select the architecture. This is where the parties involved need to consider how they manage workflows. In radiology, nothing happens without an order. Other departments capture images as the result of a procedure.

"Regardless of how you capture the image, you need to have a workflow that will mesh with data already contained in your [EHR]," Lannum says. "When you have an image-capturing event, it's not always front of mind what data you want to associate with that event."

Standardization

When developing a strategy to consolidate imaging, Rice says there needs to be consistency in the data that are collected. Things like the number of digits in a patient ID number, procedure descriptions, prior hospital visits, and how billing is handled all need to be localized across the enterprise—department to department and facility to facility.

When talking about standards for an enterprise imaging system, Lannum says it's about the metadata. Each department or facility within a hospital network is collecting the same data. However, they're labeling those image capture events differently.

"In an enterprise imaging strategy, you need to develop standards on nomenclature, anatomy, etc," he says. "It's extremely important to standardize all aspects of image and data naming. Not only is this helpful in diagnostics, but capturing enough of the metadata can also help to drive business analytics down the road."

When to Start

A good time to start the process is when a hospital is installing or upgrading an EHR system or PACS replacement. Users are already demanding access to images and other data. Including an enterprise imaging system helps make more data available to physicians.

"The conversation starts with the specialist or specialty IT departments, often radiology, and from there, up through to the CIO," Rice says. "Some hospitals have formed enterprise imaging departments with a director that reports up through the CIO. The CIO defines the strategies with the director of enterprise imaging."

Making the Pitch

Getting buy-in from the C-suite can be a challenge, Shumway says. It comes down to showing the value of an enterprise system.

"Maintaining little archives of images throughout the hospital is costly," he says. "You can show them how consolidating imaging from all aspects of the patient care process reduces costs. It helps with CPT codes. It also helps with reimbursement, as physicians can better diagnose patients' conditions with access to their entire image history. Better diagnosis also leads to fewer readmissions."

Much of the cost-savings comes from operating multiple image storage mechanisms throughout one hospital, as well as among multiple facilities within one health care organization. Consolidating image storage and sharing cuts down on printing costs, as there is no longer a need to pass along hard copy versions of images. The same can be said for the elimination of burning CDs or saving images on SD cards.

Lannum recommends taking a clinical approach when pitching the benefits of enterprise imaging. It should be part of a larger EHR strategy.

"Sixty percent to 70% of the data that doctors need in the [EHR] is missing, and images are a big part of that," he says. "With an enterprise imaging system, you're driving data downstream to clinicians who don't have access to all the data they need to make the best decisions for their patients."

Business Impact

Enterprise imaging strategies should also tie into a medical facility's business strategy, according to Ambra Health CEO Morris Panner. Current health care industry trends reflected in enterprise imaging strategies include consumerism and payment models. Patients are increasingly acting like consumers who have a choice in their health care options, trying to make the best decisions for quality and cost, just as they do with any other commodity. High deductibles leave patients paying out of pocket for their medical care. They're questioning decisions regarding their care, as well as the data doctors use to come up with their medical diagnoses. Data tie all that together.

"Enterprise imaging should be a C-level priority, tied to the organization's business plan and core imaging strategy," Panner says.

He says using the cloud enables better collaboration among specialists and is particularly helpful in second-opinion programs.

"The cloud is the key to accumulating data and enabling productivity," Panner says. "Even those installing software on desktops need a cloud strategy to optimize interoperability and collaboration"

New England Baptist Hospital (NEBH) in Boston implemented a cloud-based enterprise imaging solution in 2015 in an effort to reduce the surgery center's multiple PACS. The facility is unique in that more than 95% of its associated physicians are private practice physicians. As a result, NEBH deals with a large number of disparate systems that exist in separate silos.

Rowing in One Direction

Tyler Martin, MHA, executive director of ambulatory network operations at NEBH, leads and implements patient-centered programs and initiatives across radiology, pain management, spine center, occupational medicine, outpatient physical therapy, and sports performance. He spearheaded efforts to adopt an enterprise imaging strategy at the facility.

The goal of implementing an enterprise imaging system at NEBH was to optimize image and data workflow. Planning began at the time the facility was going through a full RIS and PACS upgrade. "We needed a solution for use by physicians who work external to the hospital," Martin says.

The hospital's initial solution involved supplying physicians associated with the hospital with PACS workstations, either on site or off site. This approach was expensive and inefficient, Martin says. In addition, most practices didn't have IT support staff, leaving physicians to take on the tech support role.

The same team—hospital personnel and physician stakeholders—working on the RIS/PACS upgrade also took on the enterprise imaging piece. Those same people were also a part of the request for proposal [RFP] development process and participated in vendor interviews.

"Anyone who would ever touch the system was seen as a champion for the project," Martin says.

Centralized Access

At NEBH, patients are first seen at a physician's office outside the center. Someone else, a primary care physician, has already ordered the imaging before the patient is referred to the orthopedist. After they see the orthopedist, the patient comes to NEBH for surgery or other treatment.

"Without an enterprise imaging network, images would need to be saved onto a CD and delivered by the patient to the specialist, then to the surgery center," Martin says. "Then you have the issue of managing the CD. Does the patient want it back? Does it go back to the primary care physician?"

Now, the patient's image is stored in the enterprise system. Patients can access their own images remotely, as can any of the physicians involved in their care.

"We are working with our partners to be able to transfer images electronically to our doctors or even other hospitals," Martin says. "If a patient needs to go to a rehab facility after surgery, we can push images out to that facility. Patients no longer have to carry their images with them everywhere."

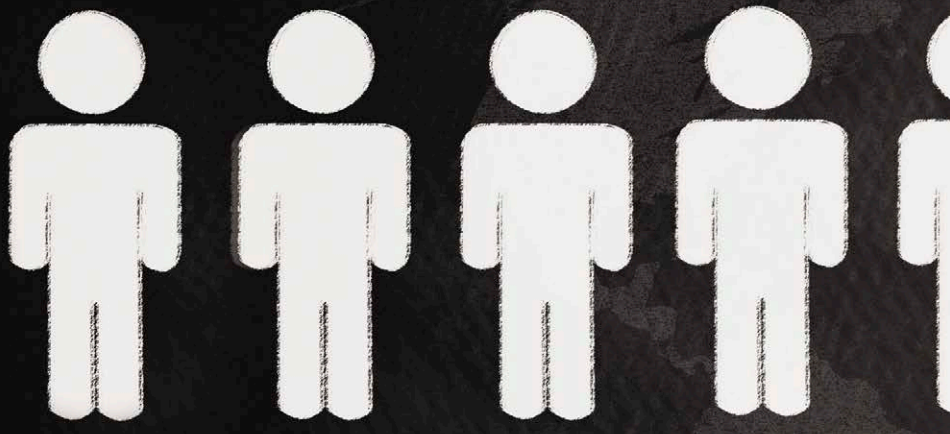
The Sky's the Limit

Martin believes that when working on an RFP for an enterprise imaging system, facility leaders shouldn't limit their list of needs. Consider all possibilities.

"Don't get bogged down in the restraints of your current system," he says. "Use this as an opportunity to shoot for the stars. If it's something that's mission critical [and] that enhances the patient experience, then don't rule it out."

— Kathy Hardy is a freelance writer based in Phoenixville, Pennsylvania. She is a frequent contributor to *Radiology Today*.

MR-guided focused ultrasound is proving to be a safe, effective treatment for tumors in children and young adults.



By **BETH W. ORENSTEIN**

IMPROVED

Teams of physicians are using two modalities that are very well known to radiologists—MRI and ultrasound—to design pediatric tumor interventions that are more precise and less invasive than current methods. Among others, researchers at the Sheikh Zayed Institute for Pediatric Surgical Innovation at Children's National Health System in Washington, D.C., and Nicklaus Children's Hospital in Miami are studying the use of MR-guided focused ultrasound (MRgFUS) for the treatment of relapsed solid tumors, benign bone tumors, and benign brain tumors in children and young adults.

Focused ultrasound is not new. According to the Focused Ultrasound Foundation, one of the first approved applications was to treat uterine fibroids in women; the application was approved by the FDA in 2004. In 2012, the FDA approved the technology for the relief of pain associated with cancer that has spread to the bone. And, in 2015, the FDA approved two focused ultrasound systems for the ablation of prostate tissue.

"You can imagine that high-intensity focused ultrasound [HIFU] would have even greater benefit in the pediatric space because it is delivered without ionizing radiation and surgery," says Peter Kim, MD, CM, PhD, vice president of the Sheikh Zayed Institute at Children's National, who leads its Image-Guided Non-Invasive Therapeutic Energy program. "As physicians, our mission is always to make pediatric care more precise, less invasive, and pain-free."

Researchers at Children's National are looking at MRgFUS, which typically uses a HIFU beam, to treat pediatric osteoid osteomas, benign tumors that usually develop in the long bones of the leg—femurs or tibias—but can occur in any bone. Between 7% and 20% of cases occur in the spine. In most cases, osteoid osteomas are small—less than 2 cm. The tumors are painful, says Karun Sharma, MD, PhD, director of IR at Children's National.

"It's very classic bone pain," he says. "No trauma is associated with it. The pain happens at night, so it wakes them up." Nonsteroidal anti-inflammatory drugs (NSAIDs) can provide some relief, but it is temporary, Sharma says. "This pain can last for years and years, and we don't want to give kids or adolescents strong doses of NSAIDs for that long because of all the side effects."

In the '70s and '80s, surgeons would scrape the tumor from the bone or remove the affected part of the bone. The surgery would often result in collateral damage "and patients often had to be on crutches and bed rest for a long time," Sharma says. In the '90s, radiofrequency ablation (RFA) became a better option. While RFA is less invasive than surgery, it still requires drilling through muscle and soft tissue into bone. "It is a very good treatment and 90% to 95% effective," he says.

Pushing the Envelope

Two years ago, the researchers at Children's National wanted to "push the envelope" and so they began trials to see whether MRgFUS would be an even better option to

locally treat both benign osteoid osteomas and malignant solid tumors. The researchers have treated 12 patients. "We are very pleased with the success of the treatments so far," Sharma says. "We have been able to show that it is a very safe treatment." The next step for the osteoid osteoma study, Sharma says, is to compare MRgFUS head to head with RFA. "We suspect the results will be similar, but there are thousands of cases of RFA recorded and only 30 of MR-HIFU. We have to look at MR-HIFU more closely and in more detail."

The clinical trial in solid tumors, led by AeRang Kim, MD, PhD, a pediatric oncologist at Children's National, also includes desmoid tumors. Desmoid tumors are benign but very locally aggressive soft tissue tumors. Their recurrence rate after surgery is high, and medical therapies have not demonstrated substantial effectiveness, AeRang Kim says.

The patients in the MRgFUS studies don't have tumors that are close to the spine or the brain. "We wouldn't want to risk any thermal or heat injury to the spinal cord," Sharma says. Tumors in the pelvis also would be hard to reach, he adds. One patient with a tumor in the inside of the pelvis had to be excluded from the osteoid osteoma trial because he couldn't be positioned in the machine to make delivering the ultrasound feasible, Sharma says.

The patients receive a CT or MRI scan prior to the procedure so that the physicians can identify the target area that needs to be heated and destroyed. Interventional radiologists who perform ablations understand how to use HIFU to heat the tissue, Sharma says. "But this is a different type of ablation, and you do have to learn how to plan the treatment and avoid any critical structures. It is something that the interventional radiologist can pick up, but there is a learning curve." MR provides real-time guidance to the tumor target, and thermal mapping allows for monitoring. The key is to cause necrosis of the tumor but not affect surrounding tissue, Sharma says.

The preplanning for this procedure is very important, Peter Kim says. "These tumors grow in size and change position, so it is important to plan the procedure accordingly. When you are focusing the energy beam, you want to make sure there aren't any critical structures between the source of the energy and the tissue." The procedure itself takes about an hour, he says.

Tumors of the bone are ideal for HIFU treatment because bone tends to absorb sound and heat very well, Peter Kim notes. "It's an ideal situation to test if it's safe." The only possible complication seen so far—and it's considered minor—is burn to the skin. Without incisions, the risk of infection from the procedure is practically nil, he says.

The researchers at Children's National also are looking at using MRgFUS to deliver a heat-activated chemotherapy. They started a phase I study in 2016, funded by the National Institutes of Health, to determine whether a safe and tolerable dose of Celsion Corporation's ThermoDox, a lyso-thermosensitive liposomal doxorubicin (LTLD), can be administered in combination with MRgFUS to treat refractory or recurrent solid tumors. Under MR guidance, the HIFU waves directly heat the tumor and the surrounding area. LTLD is administered through a vein, and the area around the tumor is heated. Upon heating, liposomes release doxorubicin at the heated tumor site allowing for targeted drug delivery.

"You can imagine that high-intensity focused ultrasound would have even greater benefit in the pediatric space because it is delivered without ionizing radiation and surgery. As physicians, our mission is always to make pediatric care more precise, less invasive, and pain-free."

— Peter Kim, MD, CM, PhD, vice president of the Sheikh Zayed Institute at Children's National Health System

This is the first time that LTLD is being administered in combination with MRgFUS and the first time it is being evaluated in children. The advantage to this method is that it allows for increased local concentration of chemotherapy without increasing systemic side effects. "We may increase the concentration of doxorubicin upwards of 10-fold by delivering therapy this way," says AeRang Kim, the principal investigator of the study. And by targeting the tumor precisely, it causes less damage to surrounding healthy tissue.

Brain Applications

A multidisciplinary team of researchers at Nicklaus Children's Hospital is studying MRgFUS to treat hamartoma tumors in young patients who experience tumor-associated seizures. The first procedure, performed March 7, 2017, on

— IMAGE COURTESY OF CHILDREN'S NATIONAL HEALTH SYSTEM

Karun Sharma, MD, PhD, and two of his patients.

a 21-year-old student, was successful, says Travis Tierney, MD, PhD, the principal investigator. A postprocedure MRI showed that the student's tumor was completely ablated, and she remains seizure-free. If the tumor had been removed with open surgery, the patient would have been hospitalized for several days, required sutures, and been at risk of bleeding and infections, Tierney says. Another option is stereotactic radiation (Gamma Knife or proton beam); however, either method uses ionizing radiation, whereas HIFU does not, Tierney says. He considers HIFU to be a far better option because ionizing radiation could cause new tumors to form along the radiation path.

Also, the brain responds unpredictably to the radiation. "We've seen in a number of cases where radiation causes problems for the child in terms of cognition," Tierney says. "Depending on where their tumor is, they could lose IQ points." Each person's tumor is different. "The shapes are different, and they can be in different spots in the brain. Some are smaller and some are bigger," he says. The first case in which the team used MRgFUS was easy "because it was a small remnant of a tumor left from a previous surgery, and we were able to do it all with just one shot," he adds.

The largest volume that can be treated currently with HIFU is about 8 cm^3, Tierney says. Also, the tumor has to be located in the middle of the brain, away from the skull, because skull bone is very dense, and it will heat. "If the tumor is in the middle of the brain, we can disperse the energy across the skull and avoid bone heating." Most pediatric tumors are probably not going to fall within these parameters, Tierney says, but he expects to find ways of overcoming these obstacles as more research is completed.

Another group of patients who the researchers at Nicklaus are highly interested in treating with MRgFUS are those with subependymal giant cell astrocytoma, a low-grade astrocytic brain tumor that arises within the ventricles of the brain. Nolan Altman, MD, chief of the radiology department at Nicklaus Children's Hospital, says MR-guidance allows doctors to ablate the tumor more precisely with HIFU.

"By using MR, we can do a thermography map to see how much the tissue is being heated in real time," Altman says. "When we do that, we can not only see that noninvolved areas are not being 'burned' but also that we are indeed accurately locating the area we want to ablate. We can see that in a matter of seconds, as the heat goes to the area of concern."

Coming Full Circle

That focused ultrasound is being used to treat brain tumors brings it full circle, Tierney says; in the 1940s and '50s, when focused ultrasound was being developed, the idea was to use it to destroy tumors noninvasively. "It was very much around brain tumors. That's because brain tumors required open surgery, and neurosurgeons didn't like having to remove the bone to get to the tumor, which they sometimes still couldn't reach and had to leave." Before the advent of computers and high-resolution CT scans, however, it was difficult to see where to target the sound waves.

In the 1960s, stereotactic radiation became the standard of care for brain tumors. In the '90s, Tierney worked with Hungarian-born physician and scientist Ferenc Jolesz, MD—who died in December 2014—at Brigham and Women's Hospital in Boston to develop a phased array that would allow the ultrasound to focus on one spot. Jolesz developed a device that was able to deliver focused ultrasound and used it to treat high-grade tumors, but it didn't have enough power, Tierney says. "Researchers at the University of Virginia (UV) realized that you don't need that much power to treat essential tremors, and that's how focused ultrasound has become a standard of care for movement disorders," Tierney says.

Jolesz's and the UV's work led to Insightec's development of the Exablate Neuro ultrasound transducer, which consists of 1,024 beams that generate enough heat to ablate the targeted tissue during treatment. Adults who undergo treatment for their tremors lie on the treatment bed in the MRI scanner fully conscious. Children who are treated with focused ultrasound are sedated so that they stay still. In July 2016, the FDA approved use of the ultrasound device to treat essential tremor in patients who have not responded to medication.

Those who are using MRgFUS to treat tumors in children and young adults are excited about its potential. They expect their research to take a few more years until they can claim it to be a safe and effective nonionizing, nonsurgical treatment method, but their results so far, they agree, look very promising.

— Beth W. Orenstein of Northampton, Pennsylvania, is a freelance medical writer and frequent contributor to *Radiology Today*.

ON THE CASE

By Mathieu Sabbagh, DO; Hadi Bazzi, DO; and Brett Arnkoff, MD

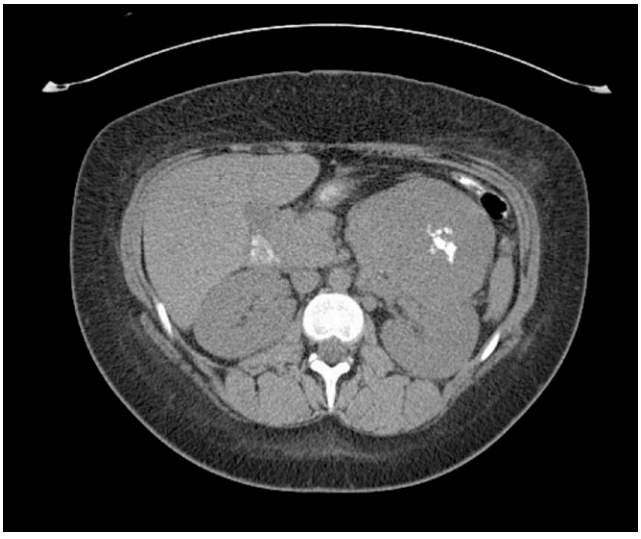


Figure 1: Unenhanced axial CT demonstrates a large soft tissue mass arising from the left adrenal gland with internal calcification.

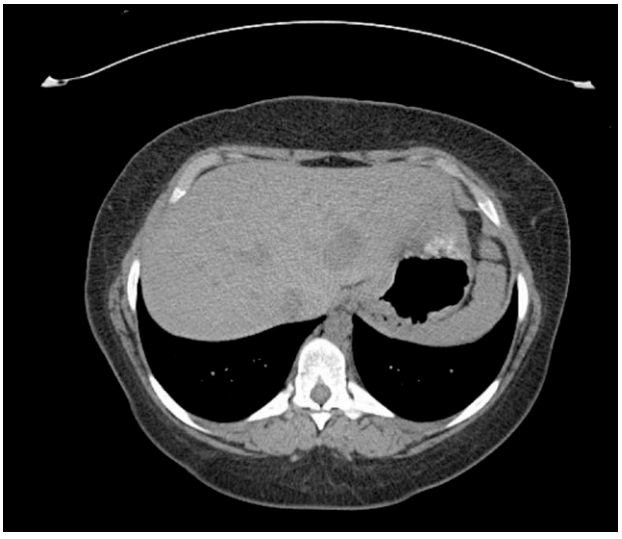


Figure 2: Unenhanced axial CT shows a hypoattenuating well-circumscribed lesion in the left lobe of the liver, segment 2.

History

A 21-year-old woman presented for an outpatient nonenhanced CT of the abdomen and pelvis due to left flank pain. The imaging study was followed by a contrast-enhanced MRI of the abdomen. Laboratory studies, including a comprehensive metabolic panel, complete blood count, and 24-hour urine metanephrines and vanillylmandelic acid, were within normal limits.

Findings

Nonenhanced CT abdomen and pelvis demonstrated a large heterogeneous mass arising from the left adrenal gland measuring up to 9.3 cm in diameter. Coarse intratumoral calcifications were present (Figure 1). At least four liver hypoattenuating lesions were seen in segments 2, 3, 5, and 6. The largest lesion was found in segment 2 of the left lobe of the liver measuring up to 3.5 cm in diameter (Figure 2).

Contrast-enhanced MRI of the abdomen was then performed and illustrated a large, solid heterogeneously enhancing mass originating from the left adrenal gland with only slight T2 hyperintensity (Figures 3 and 4). The enhancement progressed on delayed imaging with central necrosis noted. Several enhancing, T2 hyperintense lesions in the liver were also identified, demonstrating T2 signal isointense to the spleen (Figures 5 and 6).

Diagnosis

Left adrenal cortical carcinoma (ACC) with metastases to the liver.

Discussion

ACC is a rare tumor of the adrenal cortex that affects one to two persons per million per year with a slight predominance in women. ACC accounts for only 0.02% of malignant tumors with approximately 70% of adrenal masses being benign.[1] There are two peaks of incidence: the first and fourth decades of life.[2,3] The classic clinical presentation is a palpable abdominal mass with abdominal or flank pain. Today, ACCs are often found incidentally on imaging studies.[2]

ACC may be related to multiple hereditary syndromes including Beckwith-Wiedemann, Carney complex, familial adenomatous polyposis, Li-Fraumeni, and multiple endocrine neoplasia Type 1.[2]

ACC can secrete a single hormone or a combination of hormones including androgens, aldosterone, cortisol, and estrogen. Patients may present with Cushing syndrome, Conn syndrome, hypertension, or virilization.[1,2] Metastatic disease may be present at the time of presentation. ACC may metastasize to liver, lung, bone, and adjacent lymph nodes. The most common site of metastasis is the liver, and hepatic metastases are vascular with early arterial enhancement on contrast-enhanced studies.[2,3] ACC has a known potential of venous invasion with tumor thrombus extension into the inferior vena cava.[3]

Imaging features of ACC include irregular margins, displacement of adjacent structures, heterogeneous enhancement, classic internal calcifications, venous extension, central necrosis, hemorrhage, and invasion of neighboring tissue.[2] Most ACCs are larger than 4 cm when first discovered.[3]

ACC will demonstrate heterogeneous enhancement and appear T1 isointense or hypointense, although it may be hyperintense on

Figure 3: Axial T2 weighted fat-saturated MR image showing a solid mass arising from the left adrenal gland which is slightly T2 hyperintense.

Figure 4: Axial postcontrast T1 fat-saturated MR image reveals a heterogeneously enhancing mass arising from the left adrenal gland.

T1 weighted images from hemorrhage. T2 weighted images will show heterogeneous hyperintense signal, although less T2 hyperintense than would be expected with a pheochromocytoma.

Differential diagnosis includes adrenal adenoma, pheochromocytoma, and adrenal metastasis. Adenomas are usually smaller than 4 cm and may have MR chemical shift artifact or measure 10 or less Hounsfield Units on nonenhanced CT if lipid rich.[1,2] Pheochromocytomas classically are markedly T2 hyperintense, with most being functional and secreting catecholamines. Patients will present with new onset paroxysmal hypertension.[2,3] Metastatic lesions are often bilateral and will be associated with a known primary tumor.[2]

Treatment for ACC is surgical excision. Chemotherapy with the adrenolytic agent Mitotane may be used for symptomatic management and improved survival for both metastatic and recurrent disease. Radiation therapy is reserved for patients with high risk of recurrence or treatment of bone metastasis.[2]

— Mathieu Sabbagh, DO, is an R2 diagnostic radiology resident at Michigan State University — Garden City Hospital Division.

— Hadi Bazzi, DO, is an R4 diagnostic radiology resident at Michigan State University — Garden City Hospital Division.

— Brett Arnkoff, MD, is a clinical assistant professor at Michigan State University.

For references, view this article on our website at www.RadiologyToday.net.

Figure 5: Axial postcontrast T1 fat saturated MR image illustrating a heterogeneously enhancing lesion in the left hepatic lobe consistent with a metastatic lesion.

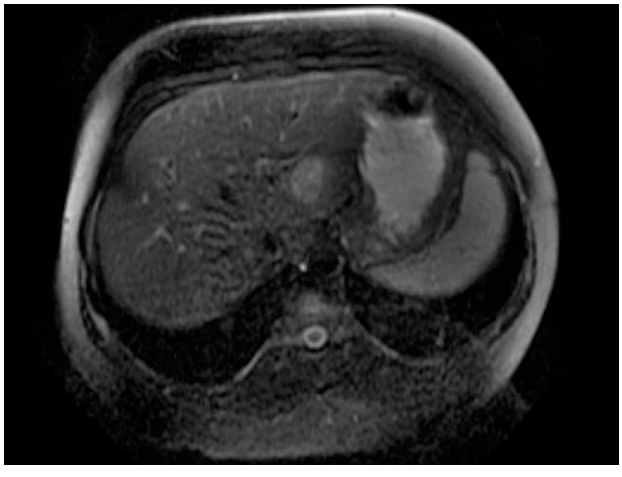


Figure 6: Axial T2 fat saturated MR image shows a T2 hyperintense lesion (isointense to the spleen) in segment 2 of the left hepatic lobe.

Minimizing the Effects of Radiation Injury

New research conducted at the University of Kansas (KU) Medical Center could make treatment for gastrointestinal cancers safer—while also helping to mitigate the dangers of nuclear accidents and terrorist attacks.

The research, led by Subhrajit Saha, PhD, an assistant professor in the department of radiation oncology at KU Medical Center, began more than five years ago when his team embarked on a quest to understand the biology behind radiation-induced gastrointestinal syndrome (RIGS)—a serious risk for people being treated for stomach, pancreatic, colorectal, and other cancers in the abdominal area.

RIGS prevents the body from absorbing nutrients and often causes nausea, vomiting, and diarrhea. RIGS occurs primarily when radiation treatment for these abdominal cancers destroys healthy tissue in the gastrointestinal tract, especially the outer layer of the intestines, known as the epithelium. And when the epithelium is lost, bacteria can spill into the body and cause sepsis, which can kill a patient. Because there is no drug treatment for RIGS, doctors must turn to radiation to treat their patients, which requires them to use extreme caution up to the point of compromising on the necessary treatment. This is of specific concern to cancer patients as more than one-half of patients treated with abdominal radiotherapy are affected by RIGS.

"That's why when the colon is involved, doctors don't want to treat with radiation," Saha says. "And often they can't use aggressive doses of radiation even for other organs in the area because of the sensitivity of the epithelium. They have to be very, very careful."

RIGS also occurs when people are subjected to radiation through a nuclear accident or a nuclear attack.

"This is hugely significant—the government has been investing in research for an effective countermeasure for terrorism involving radiation," Saha says. "The problem is, it's hard to treat someone postradiation because the damage happens so fast and the patient typically dies in seven to 10 days."

Macrophages, the Pac-Men for Cellular Debris, Help Intestinal Stem Cells Regenerate

While Saha was still at the Albert Einstein College of Medicine in New York, his research team began with the knowledge that one reason RIGS is so hard to treat is that the abdominal area of the body has a high turnover of intestinal stem cells (ISCs). Cells like these that divide quickly are especially susceptible to damage from radiation because their DNA receives more exposure.

To figure out how to get around that, the researchers needed to know more about the biology of the epithelium, specifically how ISCs renew and proliferate. They published their first discovery six years ago, after they injected radiation-injured mice with stromal cells, a mixture of different cell types that make up connective tissue, and found that they stimulated ISC regeneration and lessened the damage done by RIGS.

This result showed that ISCs depend on the stromal niche to reproduce new cells, and of the different types of stromal cells, the macrophages were critical. Macrophages are white blood cells that eat up cellular debris, especially infected cells.

"We knew that macrophages are the missionaries of the immune system," Saha says. "But we learned they also assist in organ growth, repair, and regeneration."

The question was how.

Solving the Mystery of ISC Renewal

The first question for Saha, who had by then moved to KU Medical Center, was whether macrophages can help ISCs self-renew and multiply. The researchers had read studies showing that Wnt proteins—a family of proteins that regulate the proliferation of cells, and related signaling—were very important for the ISC renewal and proliferation. Moreover, they have found that macrophages also release these Wnt proteins.

To learn more, the researchers set up a mouse model to halt the release of all 19 varieties of Wnts specifically produced by macrophages. They found that mice without macrophage-derived Wnt were much more sensitive to radiation and had more severe intestinal injury from radiation compared with mice who had not been treated. "This told me that macrophage-derived Wnt is important for intestinal resistance to radiation," Saha says.

For Saha, this discovery made for one of his best days in the lab, but it also was just the first finding. Additional studies showed that damage could be repaired in mice treated with macrophages capable of releasing Wnt proteins. The intestinal epithelium was repaired, and the ISCs were also rescued.

Multiple subsequent studies have since reinforced their findings. They have confirmed that Wnt release by macrophages is essential to the regeneration of ISCs and repair of epithelial tissue. Interestingly, in mice not exposed to radiation, Wnts don't seem critical to keeping the intestines healthy. But where there is a need for regeneration, they become critical.

"We were very much surprised," Saha says. "Macrophages are known for immune system surveillance, but now we know that they can get involved in organ repair."

It's All in the Packaging

Working in collaboration with Andrew Godwin, PhD, deputy director of the KU Cancer Center, and his team, Saha's team also observed that macrophages release the Wnts via extracellular vesicles, tiny sacs of membrane released from the surface of cells. "That was not known," Saha says. "Now we know how Wnts are transported in the system."

Armed with this knowledge, researchers can begin to think about developing therapies using macrophage-derived Wnt to allow doctors to treat gastrointestinal cancers more aggressively and lessen the damage done in the event of a nuclear mishap. Their study was published last year in ***Nature Communications***.

Saha's team is currently working to develop small molecules that can modulate these macrophages to augment their role in regeneration. "We are confident that we can come up with an answer for the mitigation of acute radiation syndrome very soon," he says.

— SOURCE: UNIVERSITY OF KANSAS MEDICAL CENTER

Study Looks at Needles in Shoulder Pain Treatment

According to a new study published online in the journal ***Radiology***, the type of procedure used to treat shoulder calcifications should be tailored to the type of calcification. The results of the study will help interventional radiologists determine whether to use one or two needles for an ultrasound-guided treatment for a common condition called rotator cuff calcific tendinopathy.

Calcific tendinopathy is a condition in which calcium deposits form on the tendons of the rotator cuff, a group of four tendons that stabilizes the shoulder joint. The condition, which occurs in approximately 20% of painful shoulders, causes pain and tenderness ranging from low grade to highly disabling.

"There is still no consensus on how to treat calcific tendinopathy," says researcher Luca Maria Sconfienza, MD, PhD, an associate professor at the University of Milan and chair of the department of radiology at the IRCCS Istituto Ortopedico Galeazzi. "However, ultrasound-guided percutaneous irrigation is widely performed throughout the world and is currently the first-line treatment for the condition, because it is quick, [is] minimally invasive, and has a low complication rate."

The procedure involves injecting a fluid such as saline solution into the tendon to dissolve the calcium deposits and then extracting the calcium-filled solution.

"The main difference among ultrasound percutaneous irrigation procedures is the use of one or two needles," Sconfienza says. "Until now, a direct comparison of one vs two needles has never been performed."

The study included 211 patients (77 men and 134 women between the ages of 24 and 69) who underwent ultrasound percutaneous irrigsation between 2012 and 2014. The patients were randomly assigned to have the one-needle or the two-needle procedure.

Ultrasound exams were performed on each patient to identify the exact location of calcium deposits in the tendons and whether the deposit appeared to be hard or fluid. For patients in the double-needle procedure group, 16-gauge needles were inserted inside the calcification under continuous ultrasound monitoring, and the area was flushed with injections and extractions of saline until the tendon was free of visible calcium. The single-needle procedure utilized an 18-gauge needle for the injection and extraction.

"Procedure times were shorter and the calcium dissolution was easier when using two needles for hard calcifications and one needle for fluid calcifications," Sconfienza says.

"In terms of clinical outcomes after one year of follow-up, there was no significant difference between single- and double-needle ultrasound-guided irrigation," he adds.

At one-year follow-up, no residual or new calcifications or tendon tears at the site of the initial calcium deposits were detected.

— SOURCE: RSNA

Primera Technology, Inc

Primera Introduces New Disc Copier for Medical Images

The new Bravo 4200-Series automates the process of burning and printing quantities of recordable CDs, DVDs, and Blu-ray Discs. Using built-in robotics, discs are transported one at a time into either single or dual optical drives. After data are burned, the discs are transported to a high-speed, high-resolution, full-color disc printer.

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Infab Corporation

Infab Publishes Guide to Radiation Protection Garments

Infab Corporation offers: "How to Select the Proper Radiation Protection Garment," a free downloadable PDF to help medical professionals choose the right garment for their needs. The guide addresses apron styles, the importance of fit, and considerations such as lead equivalency levels and regulations.

The Radiation Protection Garment Buyer's Guide covers the following:

- basic styles of protective garments;
- closure systems and options such as orthopedic support;
- correct fit for protective garments, including measurements and illustrations; and
- areas of concern, such as lead equivalency in certain apron styles.

Infab offers additional educational resources on topics including how to properly clean and store protective garments and the importance of regular lead apron and glove inspection.

For more information, visit www.infabcorp.com/apron-buyers-guide.

Hologic, Inc

FDA Approves Genius 3D Mammography as Superior for Dense Breasts

Hologic, Inc announces that the Genius 3D Mammography exam is now the only mammogram that is FDA approved as superior to standard 2D mammography for routine breast cancer screening of women with dense breasts.

The Genius exam has been commercially available in the United States since 2011, and the newly approved physician labeling is based on clinical studies proving that the exam improves invasive breast cancer detection while reducing unnecessary recalls among women of all breast densities, including those with dense breasts.

Between 40% and 50% of women ages 40 to 74 have dense breasts. Density is only identifiable on a mammogram or other imaging modalities and reflects how much fibrous or glandular tissue is in the breast. Women with dense breasts often require additional imaging, which can result in increased patient anxiety and unnecessary costs. Perhaps most importantly, women with very dense breasts are four to five times more likely to develop breast cancer than women with less dense breasts. To increase awareness of this issue, 31 states require some level of breast density notification after a mammogram, but often this can result in confusion for women receiving the notification letters.

Separately, subgroup data analysis from a previously published retrospective multicenter clinical study (*JAMA* 2014) supporting breast tomosynthesis as the standard of care in women starting at age 40 has recently been made available. This study, "Effect of Age on Breast Cancer Screening Using Tomosynthesis in Combination With Digital Mammography," led by Elizabeth Rafferty, MD, was published online in advance of print in ***Breast Cancer Research and Treatment*** and analyzed the performance of tomosynthesis in specific age groups. The study showed that with the addition of tomosynthesis to digital mammography, detection rates for invasive cancer increased significantly for women ages 40 to 69. At the same time, there was a significant decrease in recall rates for all age groups, with the largest performance gains seen in women age 40 to 49.

The new density labeling is the latest claim for Hologic's Genius exam, which is the only mammogram clinically proven to detect 20% to 65% more invasive breast cancers compared with 2D alone, with an average increase of 41%.

The Genius 3D Mammography exam is only available on Hologic 3D Mammography systems. It consists of a 2D and 3D image set, where the 2D image can be either an acquired 2D image or a 2D image generated from the 3D image set.

For more information, visit www.mygenius3d.com.

KEY MEETINGS

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ASTRO 59TH ANNUAL MEETING
San Diego, California
www.astro.org

NOVEMBER 26 – DECEMBER 1, 2017
RSNA 103RD SCIENTIFIC ASSEMBLY AND ANNUAL MEETING
Chicago, Illinois
www.rsna.org

MARCH 17-22, 2018
SOCIETY OF INTERVENTIONAL RADIOLOGY ANNUAL SCIENTIFIC MEETING
Los Angeles, California
www.sirmeeting.org

APRIL 22-27, 2018
AMERICAN ROENTGEN RAY SOCIETY ANNUAL MEETING
Washington, D.C.
www.arrs.org

SEPTEMBER 6-9, 2017
AMERICAN SOCIETY OF EMERGENCY RADIOLOGY ANNUAL MEETING
Toronto, Ontario, Canada
www.erad.org

SEPTEMBER 7-10, 2017
RADIOLOGY LEADERSHIP INSTITUTE LEADERSHIP SUMMIT
Wellesley, Massachusetts
www.radiologyleaders.org

SEPTEMBER 8-9, 2017
ANNUAL MEETING OF THE PENNSYLVANIA RADIOLOGICAL SOCIETY
Philadelphia, Pennsylvania
www.paradsoc.org

SEPTEMBER 11-15, 2017
AMERICAN INSTITUTE FOR RADIOLOGIC PATHOLOGY ABDOMINAL IMAGING CATEGORICAL COURSE
Silver Spring, Maryland
www.airp.org

SEPTEMBER 13-14, 2017
AMERICAN SOCIETY OF NUCLEAR CARDIOLOGY 2017 NUCLEAR CARDIOLOGY BOARD PREPARATORY COURSE
Kansas City, Missouri
www.asnc.org

SEPTEMBER 14-17, 2017
22ND ANNUAL SCIENTIFIC SESSION OF THE AMERICAN SOCIETY OF NUCLEAR CARDIOLOGY
Kansas City, Missouri
www.asnc.org

SEPTEMBER 16-20, 2017
AMERICAN SOCIETY OF HEAD & NECK RADIOLOGY 51ST ANNUAL MEETING
Las Vegas, Nevada
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OCTOBER 6-8, 2017
SNMMI SOUTHEASTERN CHAPTER ANNUAL MEETING
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OCTOBER 12-15, 2017
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"Worth Repeating...

"X-ray lasers have opened up a new path to protein crystallography because their extremely intense pulses can be used to analyze even extremely tiny crystals that would not produce a sufficiently bright diffraction image using other X-ray sources."

— **Armin Wagner**, from Diamond Light Source, commenting on the method of using X-ray free-electron lasers to reveal the structure of intact virus particles. The method is the first successful attempt to decipher intact viruses on an atomic level, as reported by phys.org

• • • • •

"And by the fourth, fifth, sixth night, the burning just kept traveling, and I would go in and they'd say, well what's wrong with you? And I'm like I, I don't know. I don't feel good. And I'm just, I'm burning. All I can tell you is I'm burning all over. I feel like I have acid everywhere in my tissues, I'm just, I'm on fire."

— **Gena O'Kelley**, Chuck Norris' wife, describing symptoms she suffered after receiving an MRI for rheumatoid arthritis that used gadolinium, as reported by the ***Washington Examiner***

• • • • •

"Doppler ultrasonography could be a valuable diagnostic tool for use by clinical practitioners for the diagnosis of stallions with testicular dysfunction and could be a viable alternative to invasive procedures traditionally used for diagnosis of subfertility disorders."

— **Researchers**, from a range of tertiary institutions in Spain, reporting on the effectiveness of Doppler ultrasonography to diagnose stallions with testicular dysfunction, as reported by horsetalk.co.nz

Tweets From *@RadiologyToday* and Friends

@Mini_Peiris Mini Peiris
Thanks **@RadiologyToday** for taking on important #cloud trend in #medicalimaging. Time to be rid of CDs and faxes in #healthcare.
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In this month's cover story, ***Radiology Today*** examines trends in cloud computing affecting radiologists.
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Many thx to Dave Yeager **@RadiologyToday** for the interview on our #ICA solution. Come see what piqued his interest at #SIIM17 booth #225

@AminoHealth Amino
Interesting finding from our latest data story:
70% of ER doctors' referrals are to radiologists.
https://amino.com/blog/data-on-211-million-referrals-shows-how-doctors-really-work-together/ ...
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AdRad's Dr. Steven Cohen discusses Shear Wave Elastography. From **@RadiologyToday**
http://ow.ly/Dhk330cuRkW

@Ajstractor Aaron Summers
In a new **@RadiologyToday** article, Dr. Woojin Kim discusses how #NLP helps with #radiology reporting -
https://infl.tv/Tt3

@NumedInc Numed, Inc
EXCLUSIVE: Numed's Jack Allen shares the benefits of managed imaging tech solutions with **@RadiologyToday**
http://bit.ly/2sYyNAG
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@mpanner Morris Panner
@RadiologyToday & **@Mini_Peiris** ahead of the curve! Radiologists like their systems; their referrers & patients don't. Cloud is the answer!

@CincyKidsRad Cincy Kids Radiology
Radiologist have to come out of our tunnels and into the light #SIIM17

@SIRspecialists SocInterventionalRad
ICYMI at #SIR17DC, check out the overview via **@RadiologyToday** http://ow.ly/3tJJ30c0aeC

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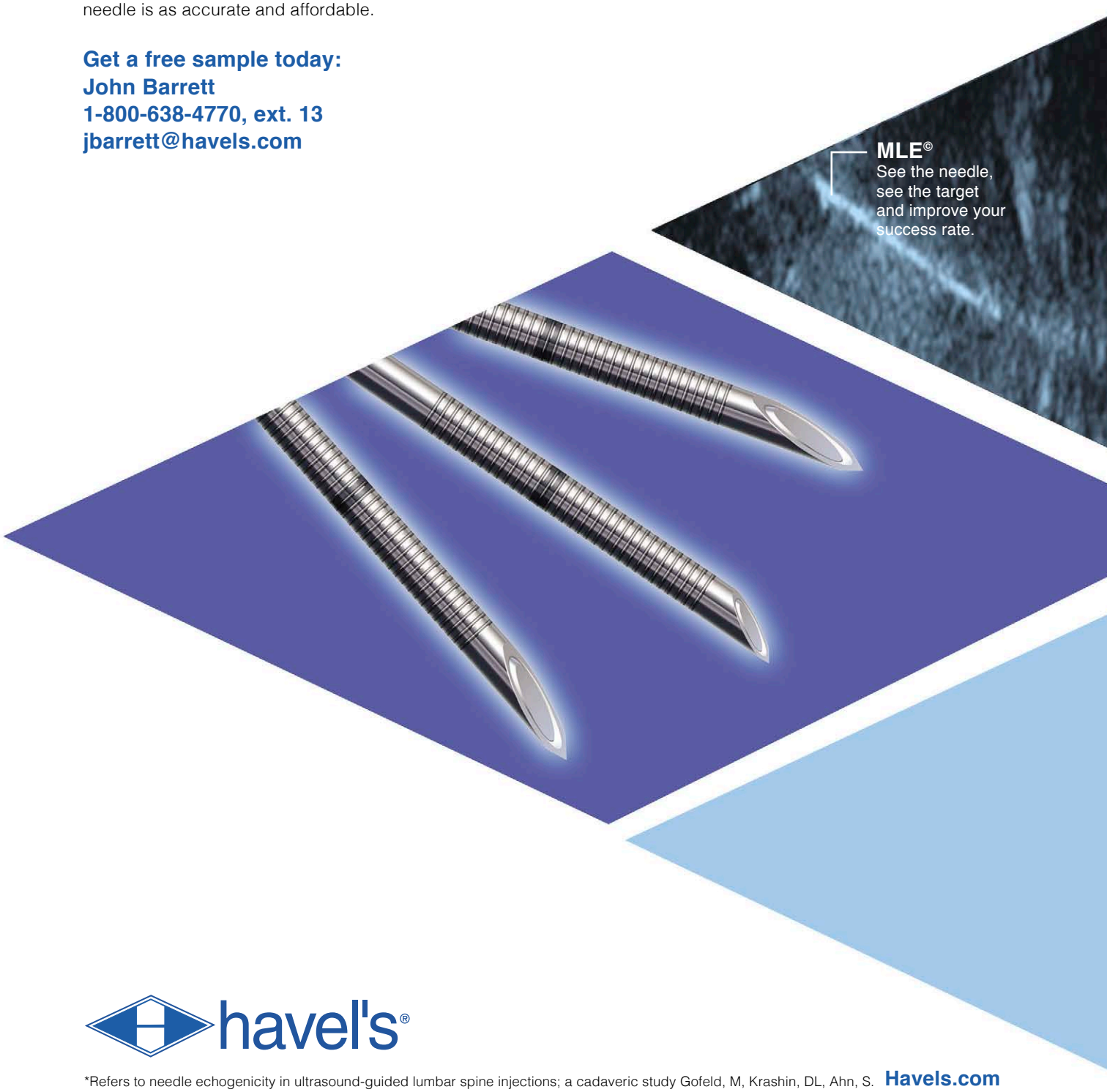

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*Refers to needle echogenicity in ultrasound-guided lumbar spine injections; a cadaveric study Gofeld, M, Krashin, DL, Ahn, S. **Havels.com**

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