



Daily Bulletin

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Gaining Broader Perspectives Beyond Imaging

Radiologists' daily practices send ripple effects across the healthcare landscape, just like a pebble dropped in a pond, according RSNA President Richard L. Baron, MD.

By Shelley Taylor

WE SHOULD CONGRATULATE OURSELVES ON THE hard work and creativity that has pushed our specialty to this level," Dr. Baron told the packed audience in Arie Crown Theater for Sunday's opening session. "Yet we have to keep moving forward," he continued.

In his President's Address, "Beyond Imaging: Ensuring Radiology Impact in Clinical Care and Research," Dr. Baron emphasized the importance of seeking new ways to move the specialty forward—beyond imaging. He focused on four ripple effects that radiologists' daily practices have on healthcare and the patient experience: delivering value in the face of changing reimbursement schemes, working collaboratively as part of the healthcare team, continuing to innovate, and focusing on patients. While calling for a shift in the way radiologists practice, he suggested radiologists can once again become renaissance physicians who truly know clinical medicine.

"This shift does not require revolutionary changes to our practices and culture," he said. "I see it more as a return to basics."

While radiologists have become adept at creating and

processing thousands of images, that skill has come at a cost, he said. "The best radiologists have learned to combine science and art," he said. "But most of us focus only on the image, practicing an extreme of science at the expense of art."

Instead, he suggested spending more time learning from referring physicians and teaching them about new developments in imaging, which will add value and solidify radiologists' position in the medical community.

To bring radiologists back to a time when they were heralded as renaissance physicians, they must return to the basics, Dr. Baron said. Developing stronger clinical knowledge will allow them to provide more meaningful consultation. By better understanding the answers referring physicians and patients need, radiologists can provide



RSNA President Richard L. Baron, MD, delivers the President's Address.

better solutions. Those improved reports would incorporate personal history and advanced medical knowledge to reach more valuable conclusions.

One way to achieve this is by adopting a subspecialty-based practice in order to mirror the practices of referring physicians, providing chest, musculoskeletal and abdominal imaging practices. Additionally, it is important for radiologists to seek face-to-face interactions with referring physicians, a practice that has become rare in the digital age.

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Evolution of Machine Learning Will Strengthen Radiology

By Richard Dargan

THE RAPID ADVANCE OF ARTIFICIAL intelligence (AI) will not render the radiologist obsolete; rather, it will augment the profession, providing radiology with an opportunity to lead the way in precision medicine, said a leading expert during one of yesterday's plenary lectures.

The pace of advances in AI has accelerated in recent years, said Keith J. Dreyer, DO, PhD, vice chairman of Radiology Computer and Information Sciences at Massachusetts General Hospital (MGH) in Boston. In his lecture, "When Machines Think: Radiology's Next Frontier," Dr. Dreyer attributed the recent advances to the development of artificial neural networks that help computers learn in a similar fashion to humans—a process known as deep

learning. This development enabled a revolution in AI, exemplified by the ImageNet Large Scale Visual Recognition Challenge Competition, an annual event where computers once lagged behind humans in visual recognition accuracy. After developers switched to deep learning algorithms in 2013, computers quickly began outperforming humans.

With AI improving at a much faster rate than human intelligence, Dr. Dreyer recalled the words of Ray Kurzweil, a leading expert on AI who famously predicted that technological singularity, or the point when machine intelligence surpasses that of all humans combined, was on the horizon.

CONTINUED ON PAGE 18A



Keith J. Dreyer, DO, PhD

Radiology Offers Lessons to Entire Medical Industry for Digital Transformation

By Paul LaTour

BECAUSE IT EXPERIENCED A DIGITAL transformation early, radiology serves as the "canary in the coal mine" for the rest of the medical industry, according to Robert M. Wachter, MD, who delivered an opening session lecture Sunday in Arie Crown Theater.

"Radiology tends to be first in these areas, so it has many lessons for the rest of us," said Dr. Wachter, during his presentation, "Hope, Hype, and Harm as Medicine Enters the Digital Age: Lessons From (and For) Radiology."

"You (radiologists) really have taught us a tremendous number of lessons. We're all going to live this as technology runs through the rest of our fields," he added.

Dr. Wachter, professor and interim chair

of the Department of Medicine at the University of California, San Francisco, where he also directs the division of hospital medicine, examined this topic in his *New York Times* bestselling book, *The Digital Doctor: Hope, Hype and Harm at the Dawn of Medicine's Computer Age*. He notes in the book that the demise of radiology rounds in hospitals has become an unintended consequence of digitalization of images and PACS.

"When I was a medical student, there was no question the central hub of the hospital was the radiology reading room," said Dr. Wachter, who was ranked the most influential physician-executive in the U.S. by *Modern*

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Robert M. Wachter, MD

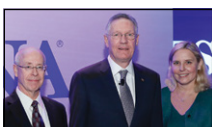
Radiation Safety

Tip of the Day

Just because a device is MRI compatible does not mean it will remain so, if it is altered. For example, a neurostimulator may be MRI conditional, but if the base unit is removed (but leads remain in the patient) that patient is not necessarily safe to scan anymore.

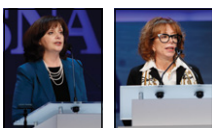
American Association of Physicists in Medicine

INSIDE MONDAY



Outstanding Educator and Researcher

The 2016 awards were presented Sunday. 4A



Personalized Breast Screening

Focused approach may improve outcomes. 17A

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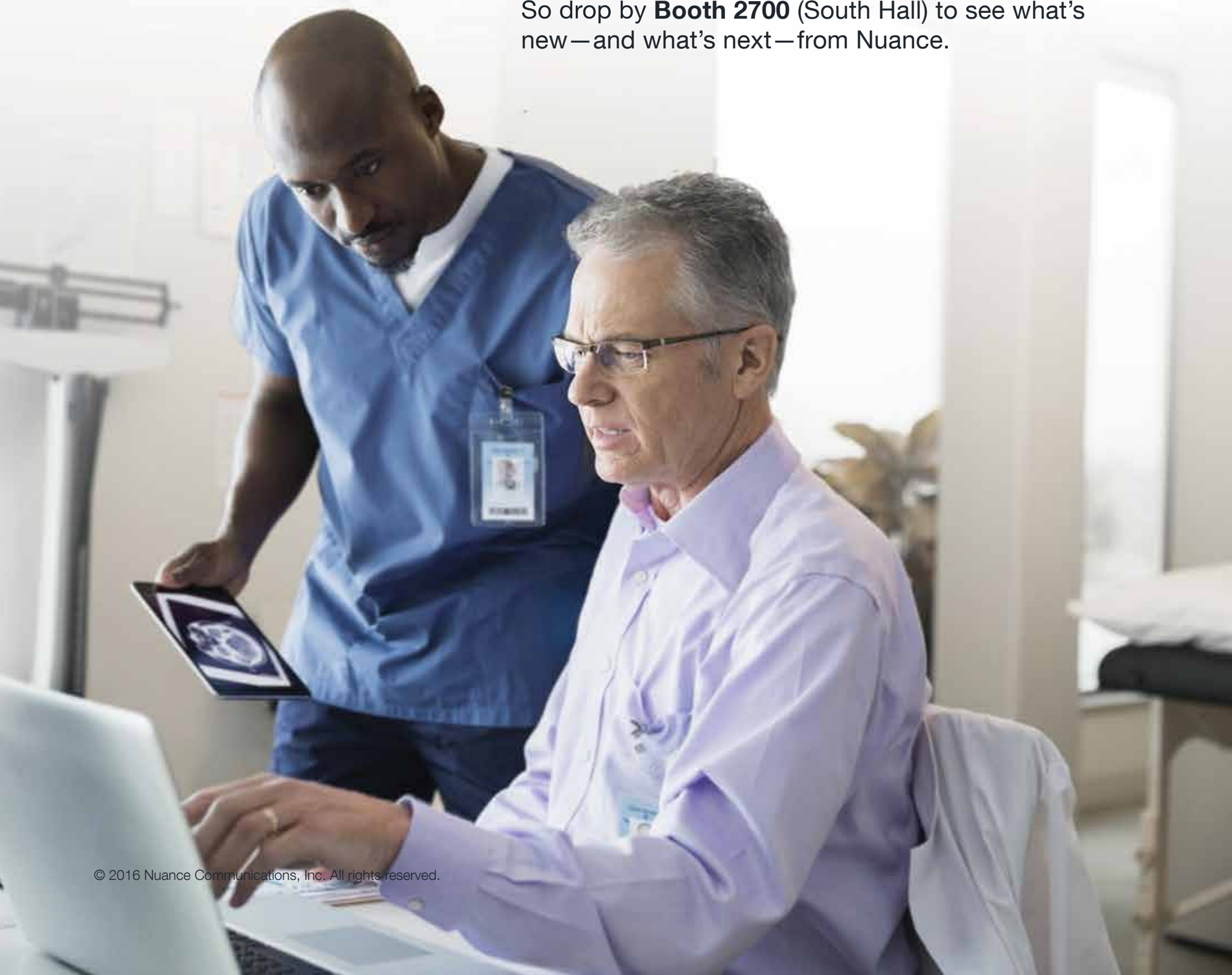


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Monday At a Glance

7:15-8:15

Controversy Session

Controversies in Radiology Education—Have We Landed in the Magic Kingdom or the Wild Wild West? (E451A)

Hot Topic Sessions

Zika Virus: What the Radiologist Needs to Know (E450B)

MSK Quantitative Imaging Biomarkers: MRI and Beyond (E450A)

RSNA Diagnosis Live™: Winter is Coming (E451B)

8:30-10:00

Educational Courses

Molecular Imaging Symposium: Basics of Molecular Imaging (S405AB)

BOOST: Bolstering Oncoradiologic and Oncoradiotherapeutic Skills for Tomorrow

8:30-NOON

Series Courses

10:30-NOON

Scientific Paper Sessions

BOOST: Bolstering Oncoradiologic and Oncoradiotherapeutic Skills for Tomorrow

The Netherlands Presents: Advances in Neuro-degenerative and Neuro-vascular Diseases (E353C)

11:00-1:00

3-D Printing Theater Presentations (Learning Center)

12:15-1:15

Exhibit and Poster Discussions (Learning Center)

1:30-2:45

Plenary Session (Arie Crown Theater) PS20

Presentation of Honorary Memberships

Annual Oration in Diagnostic Radiology Healthcare Transformation: Driving Value through Imaging
Vivian S. Lee, MD, PhD

1:30-6:00

Interventional Oncology Series: Hepatocellular Carcinoma and Cholangiocarcinoma (S406B)

2:30-4:00

Educational Courses

3:00-4:00

Scientific Paper Sessions

3:30-5:00

Molecular Imaging Symposium: Teaching Residents and Their Teachers about Molecular Imaging with Cases: Has the Time Come? (S405AB)

4:30-6:00

Educational Courses

RSNA Diagnosis Live™: Chest and Abdomen (E451B)

Special Interest Sessions (See page 6A for session previews)

4:45-6:00

BOOST: Bolstering Oncoradiologic and Oncoradiotherapeutic Skills for Tomorrow

View the full program and add sessions to My Agenda on the RSNA 2016 App or at Meeting.RSNA.org.



Check out the All-New Discovery Theater

Sunday marked the kick-off of the all-new Discovery Theater, featuring a mix of musical performances, information and education presentations to be held all week during RSNA 2016. Monday events include a Live Painted Mural created by artist Nancy Pochis Bank, and an update on RSNA programs including Image Wisely®, the RSNA Quality Certificate Program, RSNA Research Training Courses, and Navigating RSNA Journals. The theater is located in the Connections Center, Lakeside Center East.

Daily Bulletin

MONDAY

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Further, Together

New Techniques Help Correct Metal Artifacts in CT Images

More and more patients have metal implants that impede the accurate reading of their CT scans, either by blocking the x-rays or by creating artifacts that obscure the image.

By Elizabeth Gardner

SOFTWARE IS MAKING ADVANCES in helping to correct artifact issues caused by the implants, but some correction techniques work better than others, depending on the type of implant and the type of study, according to a research team at the Mayo Clinic in Rochester, Minn.

"Metal artifacts are the most challenging unsolved problem in the 40-year history of CT scans," said Mayo medical physicist Lifeng Yu, PhD.

Artificial joints, amalgam tooth fillings and other metal objects can block the view of the surrounding tissue. The metal itself can also create data inconsistencies from beam hardening, photon starvation, non-linear partial volume effects and beam scattering. These inconsistencies can cause severe streaking and shadow artifacts, making it difficult for radiologists to use the images for diagnosis or to have confidence in their readings.

"When we try to look at structures in the head, a dental amalgam filling can shoot a star artifact that obscures the area," said Mayo medical physicist James Kofler, PhD. "You

could tilt the gantry or move the body to keep the amalgam out of your field of view, but that's not always possible."

Removing the artifacts via software is the next best thing, he said.

In a poster on display all week at RSNA 2016, Mayo researchers made detailed comparisons of two techniques for correcting images that include metal implants: iterative metal artifact reduction (iMAR), and dual-energy virtual monochromatic imaging. The project also combined the two techniques in processing a third set of images. Most

CT manufacturers have introduced some type of metal artifact reduction software that can be used directly from the scanner console.

The team acquired dual-energy CT images of hip, knee, spine and dental implants and also used images taken from patients who had each type of implant. They did post-processing of each set of images using both iMAR and virtual monochromatic imaging.

iMAR identifies the areas that contain metal-contaminated data and either weights those areas less or replaces the data with data from adjacent areas that aren't contaminated. Virtual monochromatic imaging takes advantage of differences in contrast and spectral information between low-energy and high-energy scans, and uses those differences to adjust the weighting factor for areas that have

metal artifacts. The latter method is particularly effective in reducing beam hardening artifacts, though scatter and photon starvation artifacts can still remain.

The team's results showed that iMAR did a better job of eliminating artifacts for hip and knee implants, while for dental implants, iMAR actually introduced new artifacts. In that case, dual-energy virtual monochromatic imaging was more effective. For spine implants, the combined method was most effective. However, in all cases, radiologists must keep the original images next to the corrected ones for comparison.

"While the processed images are a great improvement over the originals, the techniques are still not perfect, and the final outcome is case by case," Dr. Yu said.

Metal artifacts are the most challenging unsolved problem in the 40-year history of CT scans.

Lifeng Yu, PhD



In their research, Mayo Clinic presenters including Michael R. Bruesewitz, RT(R) (above), compared two techniques for correcting images containing metal artifacts. The poster can be viewed all week from 8 a.m. to 5 p.m. in the Physics Community at the Learning Center.

QI Storyboard Poster Walk, 3 to 4 p.m.

JOIN David Larson, MD, and Paul Nagy, PhD, experts in quality improvement in radiology, as they walk through the Quality Improvement (QI) storyboards, highlighting examples of great work and sound methodology. Bring your walking shoes for this interactive session. Those interested in leading and publishing QI projects in the coming months and years will find this session especially valuable.

The session will be held from 3 to 4 p.m. in the Quality Storyboard section of the Learning Center, Lakeside Center East, Level 3.



Learn About ECOG-ACRIN Breast Cancer Trial Recruitment at RSNA 2016

MEDICAL IMAGING providers will have the opportunity to sign up to participate in a new, large-scale breast cancer screening trial funded by the National Cancer Institute. The first such study in nearly 25 years, the Tomosynthesis Mammography Imaging Screening Trial (TMIST), led by the ECOG-ACRIN Cancer Research Group, will begin in mid-2017.

TMIST will enroll 165,000 asymptomatic women in the U.S. and Canada to compare screening results of breast tomosynthesis vs. standard digital mammography. RSNA meeting attendees can learn about how their medical facilities can participate by attending one of two sessions during RSNA 2016. Visit <http://bit.ly/2eXy906> for more information about the trial.

► Monday, Nov. 28, 1:30–2:30 p.m., Room W470A

► Wednesday, Nov. 30, 11:00 a.m.–noon, Room W192BA

2016 Outstanding Researcher & Educator



During the RSNA 2016 Opening Session on Sunday, President Richard L. Baron, MD, (center) honored Clifford R. Jack Jr., MD, (left) the Alexander Family Professor of Alzheimer's Disease Research and clinician investigator at the Mayo Clinic, Rochester, Minn., as the 2016 RSNA Outstanding Researcher. Kristen K. DeStigter, MD, (right) the John P. and Kathryn H. Tampus Green & Gold Professor and Interim Chair of Radiology at the University of Vermont College of Medicine, Burlington, was honored as the 2016 RSNA Outstanding Educator.

Technology

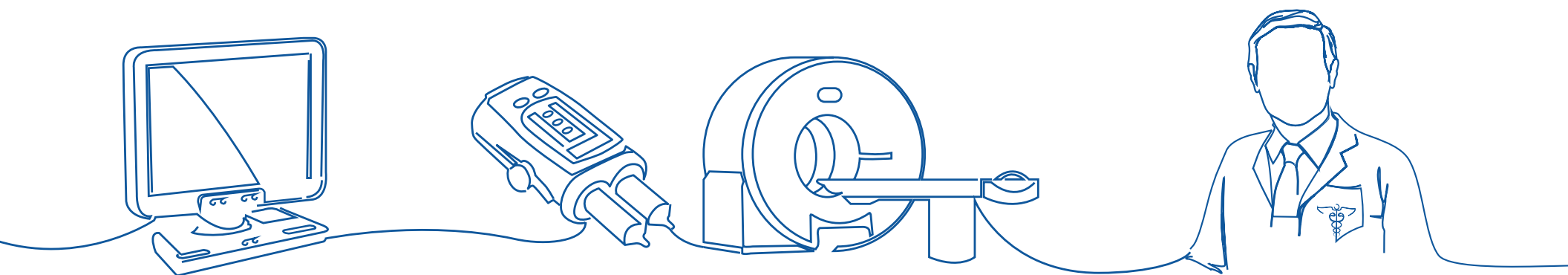
Question of the Day

Q What correction factors do I need to convert CTDIvol to dose?

[Answer on page 13A.]



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† KLAS®. Are all dose monitoring solutions created equal? Early trends in an emerging market. www.klasresearch.com. Published May 2015.

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RSNA 2016 Honorary Members

Honorary Membership is presented for significant achievements in the field of radiology. Today, at the beginning of the Monday Plenary Session, RSNA will award three honorary memberships.

Luis Donoso-Bach, MD, PhD

A celebrated diagnostic radiologist, researcher and inventor, Luis Donoso-Bach, MD, PhD, has earned an international reputation as a leader in building relationships with radiologic societies across the globe and as a pioneer in creating the virtual radiology conference.

Currently, Dr. Donoso-Bach serves as the director of the Diagnostic Imaging Department at the Hospital Clinic of Barcelona and as professor of radiology at the University of Barcelona — positions he has held since 2006.

Dr. Donoso-Bach earned his medical degree in 1981 from the School of Medicine of the Autonomous University of Barcelona and his doctorate degree at the university in 1992. After working as a staff radiologist at Hospital de la Santa Creu i Sant Pau, Barcelona, Dr. Donoso-Bach was appointed chair of the Department of Radiology at the UDIAT Centre Diagnostic, Sabadell, Spain, in 1992, and became executive director in 1998.

He served as vice president of the Spanish Society for Diagnostic Radiology from 1998 to 2002 and as president from 2002 to 2006. Since 2000, he has served the European Society of Radiology (ESR) in various capacities and is the current ESR immediate past president.



Luis Donoso-Bach, MD, PhD

A pioneer in the virtual radiology education concept, Dr. Donoso-Bach worked with Ricardo Garcia-Mónaco, MD, PhD, of Argentina to develop a Spanish-language virtual congress in 2008 that was adopted by the InterAmerican College of Radiology.

Dr. Donoso-Bach received the gold medal of SERAM and honorary fellowship in the American College of Radiology.

Carlo Bartolozzi, MD

A preeminent researcher, educator and innovator, Carlo Bartolozzi, MD, has made invaluable contributions to gastrointestinal and abdominal radiology, and shaped the careers of a generation of radiologists in his native Italy and beyond.

Dr. Bartolozzi earned his medical degree from the University of Padua in 1972 and completed his residency in 1977. He became an associate professor of radiology at the University of Florence in 1980 and radiology professor and chair of the Department of Radiology at the University Hospital of Pisa in 1990 — a position he held until his retirement in 2015.

Also at the University Hospital of Pisa, Dr. Bartolozzi served as director of the Department of Diagnostic and Interventional Radiology and Nuclear Medicine from 2004 to 2015 and as the director of the Department of Oncology, Transplants and Advanced Technologies in Medicine from 1999 to 2007.



Carlo Bartolozzi, MD

Dr. Bartolozzi's research in gastrointestinal and abdominal radiology has advanced innovative techniques such as microbubbles in ultrasound, perfusion imaging in multislice CT, and MR elastography for liver imaging. As chairman of the Department of Radiology at the University of Pisa since 1990, he has taught hundreds of residents and fellows during his lengthy career.

He served as president of the European Society of Magnetic Resonance in Medicine and Biology in 2000 and as president of the European Society of Gastrointestinal and Abdominal Radiology (ESGAR) in 2005.

Dr. Bartolozzi's honors include receiving the ESGAR gold medal in 2009 and the highest recognition of the University of Pisa — the Ordine del Cherubino (the Order of the Cherubim) — in 2011.



Osamu Matsui, MD, PhD

Osamu Matsui, MD, PhD

Osamu Matsui, MD, PhD, is a world-renowned researcher, educator and innovator who has significantly advanced the detection and treatment of liver cancer. He has also forged a unique path in publishing, serving as the first editor-in-chief of the *Japanese Journal of Radiology*.

Dr. Matsui earned his medical degree from Kanazawa University Faculty of Medicine, Japan, in 1972, and his doctorate degree from the university in 1986. He spent his entire career at Kanazawa, beginning

as an assistant professor and holding the positions of associate professor, full professor and chair of the Department of Radiology, Kanazawa University Hospital and Faculty of Medicine.

He served as vice president of Kanazawa University Hospital and dean of Kanazawa University Graduate School of Medical Sciences before officially retiring in 2013. He remains on staff as a professor emeritus at Kanazawa University.

Dr. Matsui's research has focused primarily on diagnostic imaging and interventional radiology, with an emphasis on liver cancer. He developed revolutionary techniques that broke new ground in detecting and treating liver cancer.

As an educator, Dr. Matsui trained and educated more than 200 young radiologists in the Hokuriku region of Japan where radiology was practically nonexistent as a specialty even three decades ago.

Serving from 2006 to 2010 as the first editor-in-chief of the *Japanese Journal of Radiology* (the official journal of the Japan Radiological Society [JRS]), Dr. Matsui oversaw the journal's transition to an English-language publication.

He served as JRS president in 2007, as president of the annual meeting for the Japanese Society of Interventional Radiology in 2007, as president of the Japanese Society of Abdominal Radiology from 2003 to 2013, and as the first president of the Asian Society of Abdominal Radiology.

Among his many honors, Dr. Matsui was awarded gold medals from the Japanese Society of Abdominal Imaging, Asian Society of Abdominal Radiology and Asian Pacific Society of Cardiovascular and Interventional Radiology.

Special Interest Sessions Highlight Current Issues in Radiology

The RSNA Board of Directors has determined these courses to be of particular importance, and increased audience interest is expected. All courses are presented from 4:30 to 6 p.m. today.

SPSI21: Global Medical Radiation Campaigns: Image Gently, Image Wisely and EuroSafe: Is All This Still Necessary?

Room N226

PRESENTERS WILL review the continuing need for educational campaigns and provide insights for organizational success of such campaigns. They will discuss the impact to date of the Image Gently®, Image Wisely® and EuroSafe campaigns and report on the Dose Index Registry.

SPSI22: A New Model of Patient Care: Value over Volume—a RAD Talk

Room E353B

THIS SESSION provides tools to align radiology practices with the value-over-volume approach to patient care. Hear first-hand accounts of a patient and radiologists about the importance of patient-centered care and how to make changes to your practice.

SPSI23: Imaging Cognition 2016: Psychosis

Room E350

PRESENTERS WILL define the clinical features of psychosis and schizophrenia, describe the underlying biological abnormalities and discuss how advanced imaging techniques can assist in the evaluation of patients with psychosis. A panel discussion will address the role of imaging in research and patient care with an emphasis on the first episode of schizophrenia.

SPSI24: Translating Quantitative Imaging from Academia to the Practice of Precision Medicine

Room E351

LEARN THE role of the Quantitative Imaging Biomarkers Alliance (QIBA®) in facilitating the practice of precision medicine and understand the QIBA process and deliverables.

SPSI25: Quality, Clinical Care and Effectiveness in Image-Guided Therapy: Do It Right, First Time, Every Time

Room S404AB

PRESENTERS WILL discuss the role of interventional radiologists in multidisciplinary cancer care teams and as key players in the decision-making process. Quality assurance procedures and the importance of patient-reported outcomes will also be discussed.

SPSI26: How Radiologists Can Improve Mammography Screening in the U.S.—Get Organized

Room S402AB

PRESENTERS WILL discuss how improved systems and partnerships with referring physicians can lead to better adherence with regular breast screening. Processes to ensure accurate breast cancer risk assessment for all patients will also be covered.

SPSI27: Preparing Radiologists to Jump into the “Shark Tank”

Room N228

LEARN ABOUT venture capitalist funding as an alternative to traditional research funding options. Participating researchers will take part in an interactive session modeled after the popular television show “Shark Tank.” Tips for creating a proposal and protecting intellectual property will be covered. Look for full coverage of this session in Wednesday's *Daily Bulletin*.

SPSI28: Special Interest Session: High Impact Clinical Trials

Room S404CD

THREE LATE-BREAKING clinical trials, selected for their significant contributions to radiology research, will be discussed:

- Impact of Repeat Injections on Outcomes Following Epidural Injection of Either Corticosteroid and Lidocaine Versus Lidocaine Alone
- Myometric Data Derived from Routine CT Examinations Predict Adverse Post-Extubation Outcomes in Critically Ill Patients
- A Randomized Trial Comparing Coronary Computed Tomography Angiography and Stress Echocardiography in Low-to-Intermediate Risk Emergency Department Patients with Chest Pain

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R&E Foundation Announces Record Grant Funding in 2016

By Mary Henderson

ON SUNDAY AFTERNOON in the Arie Crown Theater, Burton P. Drayer, MD, gave the Report of the RSNA Research & Education (R&E) Foundation, highlighting the innovative work of funded researchers and the need for continued support of the Foundation's effort to move the specialty of radiology beyond imaging.

"Year after year, R&E grant recipients pursue projects that go beyond radiologic sciences and touch every area of healthcare delivery and discovery," said Dr. Drayer, Chairman of the R&E Foundation. "It is critical that as an entire community, we promote the development of our own researchers who will be positioned to lead collaborative efforts that extend beyond radiology into every area of medicine and most importantly, patient care."

Dr. Drayer reported that *Inspire – Innovate – Invest: The Campaign for Funding Radiology's Future*® is moving steadily toward its goal of \$17.5 million. Launched in 2014, the Campaign will help radiologists secure and maintain a leadership position in the community of innovation.

"Through this Campaign, our Foundation encourages young physician-scientists to think more about the future than the present, to grow and foster cutting-edge research efforts, and to define radiology as the specialty where the investigators are disruptive thinkers," Dr. Drayer said.

Dr. Drayer said Campaign contributions from individuals, private practice groups and corporate colleagues have already translated into record levels of grant funding.

"This year, the Foundation will support an unprecedented 101 research and education grant projects totaling \$4 million, representing a 30 percent funding rate of the grant applications received," he said.

The 2016 recipients hail from 54 different institutions throughout North America and abroad. With R&E Foundation funding, recipients receive the early support and invaluable protected time that is critical to young investigators and educators.

"It is through their awards that these individuals become engaged in research and excited about the prospect of pursuing a career in academic radiology," Dr. Drayer said.

He described the project of Elizabeth Sutton, MD, a 2016 Research Scholar Grant Recipient, who hypothesizes that for a certain subset of women who have had a complete imaging response to neoadjuvant chemotherapy (NAC), pathology from a percutaneous MR-guided biopsy will also accurately diagnose a pathologic complete response, obviating the need for breast surgery.

"This first-in-human clinical trial could potentially cause a major paradigm shift in breast cancer treatment, offering a cost-effective, minimally invasive alternative that preserves the breast," Dr. Drayer told the audience.

He went on to describe the research of Education Scholar Grant recipient Kofoworol Soyebi, MBChB, who is addressing sickle cell disorder, a major health crisis in Nigeria that has devastating complica-

tions including stroke in children under 5 years old.

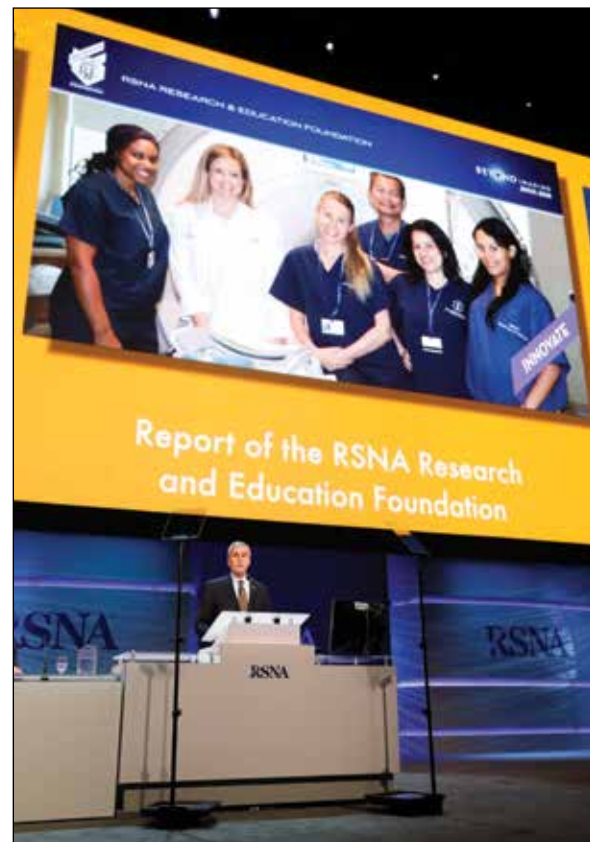
The aim of Dr. Soyebi's project is to increase TCD centers, trainers, sonographers and equipment and to facilitate the integration of TCD screening into routine management of children with SCD.

"These are but a sampling of our incredible projects that go well beyond imaging and directly to the heart of patient care," he said.

Dr. Drayer thanked the Centennial Pathfinders who stepped up early to lay the groundwork for the Campaign, as well as forward-thinking partners in private practice who donate through the Visionaries in Practice giving program.

"This year, we are especially grateful to the members of Strategic Radiology, a consortium of 26 practice groups who have generously committed \$800,000 to fund the RSNA/Strategic Radiology Research Seed Grant," he added.

Dr. Drayer also thanked all of the dedicated corporate donors, or Vanguard companies, for their steadfast support of the R&E mission. Finally, he challenged the audience to join the Campaign to ensure that research in radiologic sciences continues to be conducted by radiologists.



R&E Foundation Chair Burton P. Drayer, MD, addresses the crowd in the Arie Crown Theater.

"The need for your support is great," he said. "As NIH funding dwindles and competition for funding from other private and public sources becomes increasingly more difficult, you can fill this gap by supporting our Foundation, and you can be assured that your donation will be used directly to fund radiology research and education."

Structured Reporting Among Methods for Improving Communication

By Felicia Dechter

COMMUNICATION is vital among all members of a multidisciplinary team working to develop individual treatment plans for cancer patients, according to presenters of a Sunday session.

For example, it's critical that content in radiology reports be communicated clearly to other physicians, said Herbert Alberto Vargas, MD. Yet recent surveys gauging the value of radiology reports found that 20 percent of responding clinicians said the language and style used in radiology reports was unclear, said Dr. Vargas, director of genitourinary radiology at the Memorial Sloan Kettering Cancer Center in New York. Another study determined that referring clinicians may reach different conclusions when reading the same reports, he said.

To that end, structured reporting, which allows for effective communication of imaging findings by standardizing format, terminology and content, is an effective solution, said Dr. Vargas.

"We need uniform ways to communicate radiologic findings, clinical impressions and management recommendations," he said.

Another important issue relevant to standardized reporting is the expression of diagnostic certainty, Dr. Vargas said.

"Radiologists are often tasked with summarizing multiple findings and rendering

an opinion with regard to potential explanations for the radiographic findings," Dr. Vargas said. "There are scenarios in which no differential diagnoses are warranted and the findings are reported in terms of the absolute presence or absence of a pathologic process, for example, 'no fracture.'"

In other cases, findings are not definitive, and radiologists need to indicate their level of certainty for their interpretation of the imaging findings, Dr. Vargas said. In a study of patients with prostate cancer, 38 different terms were used in MRI reports to express the levels of certainty for the presence of extracapsular extension (ECE), prior to the introduction of a five-point "certainty lexicon," he said.

"The lexicon not only simplified the communication of the radiologists' level of suspicion but also allowed more objective quantification of the diagnostic performance of MRI for diagnosing ECE," Dr. Vargas said.

There are many key elements necessary to maximize the clinical utility of diagnostic imaging exams, including a pertinent clinical indication, adequate technical acquisition, accurate interpretation and effective communication of the imaging findings, Dr. Vargas said.

"The literature suggests that structured reporting in radiology leads to clearer and more thorough communication of relevant diagnostic findings than does conventional, free-form reporting," he said.

In a study of body oncologic CT examinations, structured reports were given significantly higher satisfaction ratings by both radiologists and referring physicians compared to "free-form" reports, Dr. Vargas said.

Structured reporting software offers such features as drop-down menus which facilitate data entry and minimize the amount of free-text entries.

"However, the benefits of structured reporting cannot be accepted dogmatically," Dr. Vargas said. "An accurate interpretation reported in 'free-form' style is more clinically useful than a structured report containing erroneous information."

Subspecialty Opinions Demonstrate Benefits to Cancer Patients

While Dr. Vargas discussed how radiologists report using standardized, structured reports, presenter Fergus Coakley, MD, professor and chairman of Diagnostic Radiology at the Oregon Health and Science University in Portland, spoke about who is reporting and the importance of that person being a subspecialist.

Communication is critical in subspecialty opinions given after an initial radiology reading — which is often critical to a patient's care, Dr. Coakley said.

In an analysis of published data on the value of subspecialist reads in journals including *Radiology* and the *Journal of Otolaryngology — Head & Neck Surgery*, Dr. Coakley determined that subspecialist opinions often alter the initial reading of radiological studies in cancer patients.



Herbert Alberto Vargas, MD, and Fergus V. Coakley, MD,

"The bottom line is, if you get a subspecialist opinion, 10 to 20 percent of the time it will result in actionable change," Dr. Coakley said. "And usually — roughly 80 to 90 percent of the time — that change is for the better."

Dr. Coakley cited cases where diagnoses were changed after readings by a subspecialist. In one case, a 51-year-old man diagnosed with pancreatic cancer was referred for the Whipple procedure. But a subsequent read by a subspecialist indicated the patient did not have pancreatic cancer — he had autoimmune pancreatitis that was successfully treated with medication and not surgery, Dr. Coakley said. "He needed steroids rather than a pointless operation," Dr. Coakley said.

In another case, a patient diagnosed with pancreatic cancer underwent four rounds of chemotherapy before a subspecialist reinterpreted the images. "There was no cancer, there had never been a cancer," Dr. Coakley said.

In light of his analysis, Dr. Coakley said that offering formal second opinions for cancer imaging studies is a service that academic radiology departments may want to consider.

The bottom line is, if you get a subspecialist opinion, 10 to 20 percent of the time it will result in actionable change.

Fergus Coakley, MD

High Intensity Focused Ultrasound Helps Control Pain in Cancer Patients

By Richard Dargan and Paul LaTour

MR-guided high intensity focused ultrasound (MRgFUS) is a safe and effective method for managing pain in cancer patients and reducing their dependence on opioid medications, according to research presented Sunday by Alessandro Napoli, MD.

Pain affects up to 80 percent of cancer patients and has a strongly negative impact on quality of life and survival. Opioid pain medications are often prescribed for pain relief, especially in patients with advanced disease, but they have risks, including dependency. Other options like chemotherapy, radiation therapy and ablation carry their own set of risks and side effects.

Dr. Napoli said MRgFUS offers many benefits over those other options.

"This is a completely non-invasive therapy with no risk for bleeding or infection," said Dr. Napoli, a researcher in the Radiology, Oncology and Pathology Department at Sapienza University in Rome, Italy. "In

addition, it's a highly precise technology, thanks to MRI real-time visualization and guidance that increases both the safety and the efficacy profile. Plus it is radiation free so there are no toxicity-related effects."

MRgFUS has emerged in recent years as an innovative and noninvasive alternative pain treatment for cancer patients. In the procedure, a transducer focuses ultrasound beams to induce an increase in temperature in the targeted area, destroying the tissue. Real-time monitoring with ultrasound or MRI increases the procedure's safety and efficacy.

MRgFUS has been studied to relieve pain in pancreatic cancer, bone metastases and recurrent cervical carcinoma. Dr. Napoli's group reported promising results in the management of patients with pancreatic cancer, a condition in which pain is notoriously difficult to control.

"This population of patients often has a poor prognosis and low life expectancy,"

said Susan Dababou, the study's lead author and a medical student at Sapienza. "The cancer-specific therapy is often very debilitating and pain can be a worsening factor of the general condition of these patients."

Studies showed that almost 80 percent of pancreatic cancer patients reported pain relief after focused ultrasound treatment. In one case described by Dr. Napoli, a

74-year-old female with stage III pancreatic cancer experienced significant pain reduction after MRgFUS ablation of a mass in her abdomen. Post-procedural MRI showed that important vascular structures near the treatment area were undamaged. The patient was able to stop daily consumption of opioid medications only two days after the procedure.

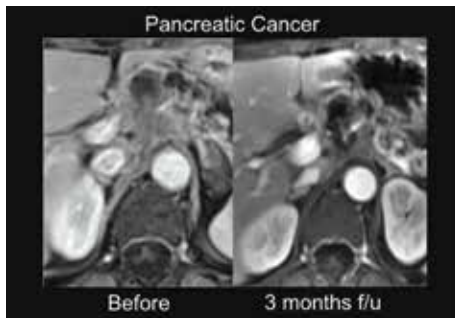
Promising results for MRgFUS have also been seen in patients who experienced cancer spread to their bones. An international multicenter study that included the Sapienza University researchers found pain palliation in more than 70 percent of patients with bone metastases. The technique has also shown promise in patients with recurrent cervical cancer, although more research is needed.

The duration of pain palliation, which is linked to the size of ablation of the tumor mass, can be substantial in the absence of disease recurrence, according to Dababou.

"The patients with pancreatic cancer



Presenters Hans Peter Erasmus (left) and Alessandro Napoli, MD, presented research on pain management in cancer care.



Axial contrast-enhanced MR image before treatment (left) shows the presence of pathological tissue within the pancreatic body determining encasement of the vascular celiac structures. Axial contrast-enhanced MR image three months after treatment (right) with non-perfused area corresponding to the ablated tissue, the surrounding vascular structures are preserved.



Coronal CT image acquired before treatment (left) shows a lytic lesion located in the right iliac bone with evidence of cortical erosion. Bone destruction reaches the acetabulum without articular invasion. Coronal CT image obtained eight months after treatment (right) demonstrates areas of de novo mineralization within the treated area and partial restoration of cortical bone.

treated with focalized ultrasound energy by our group were followed for six months and the pain relief lasted for the whole period," she said. "There is evidence of at least nine months of pain relief in bone metastases treated with MRgFUS."

Recent studies have shown that high-intensity focused ultrasound also has promising effects when coupled with chemotherapy and radiation therapy, improving patients' responses to anti-cancer therapy.

"In comparison with pharmacological treatment, MRgFUS acts on different fronts, ensuring an adequate pain relief, boosting the effect of chemotherapy and radiotherapy, and easing recovery," Dababou said. "The compliance of the patients is favored by the noninvasiveness and non-toxicity of the procedure, and unlike pharmacologic therapy it is a single session treatment with mild or no complications."

Presently, the main limitations of MRgFUS are cost and that not all parts of the body are accessible.

Radiology Should Take the Lead in Improving Cybersecurity

By Richard Dargan

BECAUSE MEDICAL IMAGING DEVICES are increasingly vulnerable to attacks from hackers, radiologists should take a leadership role in ensuring that facilities and institutions are doing as much as possible to counter the threat, according to presenters at a Sunday session.

Threats to medical device security can come from many factors, said Kevin Hemsley, project manager for the Idaho National Laboratory supporting the Department of Homeland Security's Industrial Control Systems Computer Emergency Response Team.

Ideologically motivated "hacktivists" can break into systems in order to make a statement, while criminal elements sell medical data at a premium on the black market. Ransomware attacks, in which hackers take control of a system and demand money, have become increasingly common.

Imaging systems are not invulnerable, Hemsley said. Recently, a company hired to look for vulnerabilities in a hospital's MRI system discovered that the host system's firewall and automatic updates were off and there were 114 open ports.

"The company found out they could get into the imaging processor and controller and they did all of this from the guest WiFi system," Hemsley said.

Radiologists need to be more proactive in taking steps to mitigate threats, said J. Anthony Seibert, PhD, professor and associate chair of informatics at the University of Cali-

"Cybersecurity is more than HIPAA. It equals patient safety."

Kevin Hemsley

fornia Davis Health System in Sacramento.

"We need to overcome our denial," Dr. Seibert said. "Security is an imaging system problem. Even in a secure subnet you can be extremely vulnerable."

Vulnerabilities on devices include hard-coded passwords and no encryption of patient data. A recent study determined that many facilities fail to change the generic usernames and passwords that are supplied with equipment software. The study found that among the most common passwords were "operator," "scan" and "service."

The biggest threats to an organization come from within in the form of disgruntled employees. Administrators should turn off accessibility as soon as employees are dismissed, he said.

"The fact is, security is a shared responsibility," Dr. Seibert said. "It's not just vendors but also users who have ultimate responsibility."

Fighting Back Against Hackers

Radiologists and managers can fight back against hackers in a number of ways, including educating staff on cybersecurity risks. On the technical side, firewalls, virtual private networks and encryption are essential tools. Physical measures include device isolation, access restriction and methods to back up data. Administrators should be sure to docu-

ment security policies, maintain audit trails and enforce policies.

"We need to continue to work on this until we have 100 percent compliance," Dr. Seibert said.

He also recommends using a two factor authentication process, encrypted USB drives and biometric identification for access to imaging systems. Devices should not be directly accessible to the Internet, Hemsley said. Users can use *Shodan.io*, a search engine for Internet-connected devices, to search their IP space to see what devices others can see over the Internet. Hemsley showed results of such searches including imaging reports, prescriptions and other private information.

The best security systems are seamless to users, Dr. Seibert noted. Seamlessness will be achieved in the future through technological advances such as biometric scans to replace passwords and near-field communication devices which require physical proximity to operate a device.

"Security risk management is an ongoing process," he said. "You have to be proactive and maintain patient safety as an overriding objective."

"Cybersecurity is more than HIPAA," Hemsley added. "It equals patient safety."



Anthony Seibert, PhD



Kevin Hemsley

RSNA 2016 Sessions Go Beyond Imaging to Move Radiology Forward



Richard L. Baron

In this new area of radiology and healthcare, radiologists are being asked to go beyond imaging to gain a broader perspective on every facet of the patient experience.

Radiologists must actively collaborate with referring physicians, stay abreast of advancing subspecialty knowledge, be part of the digital revolution and stay at the forefront of clinical imaging research, said 2016 RSNA President Richard L. Baron, MD, in the President's Address Sunday at the Arie Crown Theater.

"Now more than ever the radiology community needs to reflect on our culture and practices and seek new clinical and research approaches. It is time we look beyond imaging to see new ways to move the specialty forward," Dr. Baron said.

This year's RSNA Meeting Program offers a vast array of sessions designed to empower attendees seeking to embrace the future of radiology from every angle. Below is a sampling.

RCC25 (Educational Course)

How to Create a Culture of Continuous Quality Improvement Using Existing and Free Resources

Monday 4:30-6:00 PM

Room: S501ABC

LEARN HOW TO EMPOWER lead performance, interpretation and system improvements and create a culture of continuous quality improvement using existing or available free resources.

SPS122 (Special Interest Session)

Special Interest Session: A New Model of Patient Care: Value over Volume-a RAD Talk

Monday 4:30-6:00 PM

Room: E353B

ALONG WITH DISCUSSING RSNA'S Radiology Cares: The Art of Patient-centered Practice and ACR's Imaging 3.0 campaigns, presenters will discuss how to assess the radiology practice model and realign it to focus on value over volume as well as tactics to put the concepts of patient-centeredness and value vs. volume into practice.

RC317 (Educational Course)

Emerging Technology: PET/MRI – Opportunities and Challenges

Tuesday 8:30-10:00 AM

Room: S504CD

SUBSESSIONS INCLUDE PET/MRI: The Evolving Field of Structure and Function and PET/MRI Physics: The Opportunities and Challenges.

RC354 (Educational Course)

Preparing Your Radiology Practice and IT Department for Big Data

Tuesday 8:30-10:00 AM

Room: S404AB

THE SESSION FOCUSES on big data approaches to radiology and the importance of developing a comprehensive IT architecture and capability beyond the EMR in order to effectively use big data tools.

RC307 (Educational Course)

Predicting Outcomes for Genitourinary Malignancies: Role of Radiomics in Clinical Practice

Tuesday 8:30-10:00 AM | Room: S405AB

PRESENTERS REVIEW the histopathologic and genetic heterogeneity of bladder cancer and how these differences translate importantly to clinical practice. Attendees will learn how tumor features assessed using MR techniques such as DWI and DCE imaging, correlate with clinical and pathogenetic features of bladder cancers such as tumor aggressiveness, stage, histopathologic phenotype, immunohistochemical biomarkers response to chemotherapy and disease specific survival.

SSG07-06 (Educational Course)

Radiology Report Terminology: Interpretive Differences between Patients and Radiologists

Tuesday 11:20-11:30 AM

Room: S402AB

RSNA Student Travel Stipend Award

PRESENTERS DISCUSS research demonstrating that patients' perceptions of terminology within the radiology report are not synonymous with those of radiologists and that these differences could lead to confusion and dissatisfaction.

MSRT41 (Educational Course)

ASRT@RSNA 2016: A Team Approach to Patient-centered Imaging

Wednesday 8:00-9:00 AM

Room: N230B

THE SESSION FOCUSES on the demonstrated value of establishing a multidisciplinary team to enhance patient satisfaction in imaging.

RC527 (Educational Course)

Academic and Community Practice Integration: Challenges and Strategies for Success

Wednesday 8:30-10:00 AM

Room: S104A

THERE IS increasingly blurring distinction between academic and community radiology practices. Presenters discuss the challenges of running successful hybrid academic-community practice and highlight the unique advantages of academic

subspecialty radiology groups in providing quality service for the community.

HP230-SD-WEA5 (Educational Course)

Teaching Radiologists Who Perform Image Guided Interventions Effective Communication Skills through Simulation

Wednesday 12:15-12:45 PM

HP Community, Learning Center Station #5

PRESENTERS THAT DISCUSS workshops that teach radiologists' effective communication skills may increase radiologists' comfort communicating with patients during image guided procedures.

SSM02-03 (Educational Course)

Impact of Second-Opinion Review of Breast Imaging at a Cancer Center: Is It Worthwhile?

Wednesday 3:20-3:30 PM

Room: E451B

RSNA Student Travel Stipend Award

PRESENTERS DISCUSS research showing that second-opinion review of outside breast imaging has a significant impact on surgical management and is a worthwhile utilization of resources and valuable for patient care.

RC627 (Educational Course)

Radiology in a New Payment Model Environment

Thursday 8:30-10:00 AM

Room: S404AB

PRESENTERS WILL DISCUSS the "current state" of Radiology but will also focus on future reimbursement trends that will define our subspecialty for the next 10 years.

SSQ10-01 (Educational Course)

Informatics Keynote Speaker: Using Imaging Informatics to Improve Quality and Safety in the Era of Value-Based Care

Thursday 10:30-10:40 AM

Room: S403A

RC732C (Educational Course)

Mentoring in the Culture of Multigenerational Workforce and Diversity

Thursday 4:30-6:00 PM | RC732C

Room: S502AB

UNDERSTAND HOW mentor-mentee relationship and expectations are changing in the current environment of multigenerational workforce and diversity. Learn what leadership skills are needed to become good mentors. Understand what to do and what not to do when you are looking for a mentor.

VI001-EB-X

Entrepreneurship in Interventional Radiology

All Day

VI Community, Learning Center

THIS EXHIBIT covers the technological advances, miniaturized instruments and high tech imaging which have led to advancements in minimally invasive techniques; reducing risk to patients and improving clinical outcomes. Researchers discuss strategies for choosing a commercialization approach and identifying a market need and funding and financing a startup.

MK258-ED-X (Educational Exhibit)

Musculoskeletal System Imaging-Guided Percutaneous Biopsies: Update and Systematic Comprehensive Review

All Day

MK Community, Learning Center

PRESENTERS DISCUSS the multidisciplinary approach to musculoskeletal system imaging-guided percutaneous biopsies, whereby the radiologist works closely with the clinicians/pathologist to maximize the possibility of definitive diagnosis while minimizing potential complications.

NR22-1-ED-X (Educational Exhibit)

Looking through the Surgical Lens: A Radiologist's Guide to Understanding Surgical Landmarks and Advances in Head and Cancer Therapy

All Day

NR Community, Learning Center

THIS EXHIBIT covers important surgical landmarks that are crucial for planning head and neck cancer surgery so that these can be incorporated into radiology reports. Advances in oncologic surgery including robotics and the role imaging plays in determining surgical options are included.

RSNA 2016 Sessions Explore the Potential of Machine Learning

Learning Center Exhibits

Monday – Friday, 8 a.m.-5 p.m.

AI and Machine Learning in Radiology Demonstration: The Eyes of Watson

With advances in machine learning and artificial intelligence, a new role is emerging for machines as intelligent assistants to radiologists in their clinical workflows. Computers can pre-analyze large amounts of imaging and text in electronic health records using deep learning to identify patterns and perform clinical inference using a priori clinical knowledge to assemble relevant information for diagnosis by radiologists.

But what systematic clinical thought processes are these machines using? Are they similar enough to those of radiologists to be trusted as assistants? At the Eyes of Watson demonstration, participants can select a case from various subspecialties, attempt to make a diagnosis, and then see Watson's process for the same case. Attendees can watch the inner workings of Watson as it attempts the case and then help evaluate its approach. Learn how machines can assist radiologists, reducing the time to diagnose and increasing efficiency in workflows.

Deep Learning: What the Radiologist Needs to Know

Deep learning (DL) is rooted in machine learning and artificial neural networks, concepts which focus on teaching computers to learn to solve problems. This session will focus on the application of DL to radiology and its potential to add significant value to the radiologist's interpretation of complex images.

IN003-EB-X | IN Community, Learning Center

Mind in the Machine: A Radiology Primer on Machine Learning

Presenters will define machine learning (ML), review applications of ML, offer an overview of fundamental steps in common ML algorithms and discuss future directions.

IN014-EC-X | IN Community, Learning Center

Artificial Neural Networks: A Machine Learning Algorithm for Image Analysis in Radiology

Presenters will discuss neural networks — machine learning (ML) algorithms that use computational architectures inspired by the organization of the mammalian visual cortex — and give an overview of an artificial neural network (single-layer vs. convolutional neural networks).

IN101-ED-X | IN Community, Learning Center

Deep Learning with Convolutional Neural Networks for Radiologic Image Classification

The presenter will review recent research developments in deep learning, particularly with respect to convolutional neural networks applied to image classification.

IN117-ED-X | IN Community, Learning Center

Daily Bulletin Coverage of Machine Learning

Read Tuesday's *Daily Bulletin* for coverage of the session, "Use of Deep Learning in Breast Cancer Risk Assessment: Evaluation of Convolutional Neural Networks on a Large Clinical Dataset of FFDMs."

Read Thursday's *Daily Bulletin* for coverage of the Controversy Session, "Elementary, My Dear Watson: Will Machines Replace Radiologists?"

Monday, Nov. 28

Deep Learning: A Primer for Radiologists

Presenters will review the key concepts of deep convolutional neural networks, illustrate applications of deep learning (DL) techniques for lesion detection, classification and monitoring, and discuss the potential benefits of computer assisted diagnosis with DL techniques.

12:45-1:15 p.m., | IN111-ED-MOB7 | IN Community Learning Center, Station #7

Machine-Learning-Based Delineation Approach for Gross Tumor Volume Region of Three Types of Lung Tumors using Planning CT and PET/CT Datasets

Presenters will discuss research on the effectiveness of a computer-assisted delineation system for gross tumor volume region of three types of lung tumors with a machine learning classifier based on the planning CT/PET datasets.

12:45-1:15 PM | PH010-EC-MOB | PH Community, Learning Center

Tuesday, Nov. 29

Deep Learning: An Example of Big Data Applications

This session provides a technical overview of machine learning (ML) and deep learning (DL), illustrate applications of ML and DL in radiology, and examines challenges in deploying ML and DL in radiologist workflow and productivity demands.

8:30-10:00 AM | RC354C | Room: S404AB

Wednesday, Nov. 30

Improving Reading of T2 MRIs through Deep Learning

Presenters discuss a possible direction for automating the process of finding new relevant imaging biomarkers for disease using a relatively uncommon disease in a heterogeneous patient group. Researchers trained a neural network to identify both the standard TNM staging as well as the 12-month outcome variable.

12:45-1:15 PM | IN247-SD-WEB2 | IN Community, Learning Center, Station #2

Ensemble Deep Learning for the Improvement of the Performance of Computer-aided Detection of Polyps in CT Colonography

Presenters discuss research evaluating an ensemble deep learning (EDL) in the improvement of the detection performance of computer-aided detection (CADE) of polyps in CT colonography.

10:40-10:50 AM C SSK17-02 | Room: S404AB

Deep Learning & Machine Intelligence in Radiology

- An Introduction to Deep Learning & Machine Intelligence: What the Radiologist Needs to Know
- Applying Deep Learning to Image Diagnosis
- Applying Deep Learning to Radiology Workflow Quality and Efficiency

4:30-6:00 PM | RCC45 | Room: S501ABC



Visitors to the Eyes of Watson demonstration can watch Watson at work.



Radiologists evaluate Watson's approach to a case.

Thursday, Dec. 1

Hot Topic Session: The Promise of Machine Learning (and Pattern Recognition) in Radiology

7:15-8:15 AM | SPSH50 | Room: E350

Quantitative Radiomics, Big Data, and Deep Learning in Precision Medicine

The presenter will discuss advances in computer power and machine learning algorithms that are allowing for computer-extracted features, both from clinically-driven computer-extraction systems (such as those from computer-aided diagnosis) and deep learning methods, to yield "radiomics" — the high throughput conversion of image sets into a multi-dimensional feature space.

1:30-2:45 PM | PS50C | Room: E450A

Gaining Broader Perspectives Beyond Imaging

CONTINUED FROM COVER

The result, he said, is a decentralized team and less collegial work environment.

Dr. Baron applauded departments that have flipped that model, explaining that the University of Colorado, the University of Chicago and Johns Hopkins have all moved radiology reading rooms closer to the consulting clinicians, and the results have been impressive.

While praising the rapid pace of innovation radiology has set, Dr. Baron reminded the audience that continued meaningful research is critical to continued growth.

"Innovation will drive the future, and the future belongs to those who lead impactful research," he said.

That means radiology research that reaches beyond the radiology journals and community to contribute to the



Richard L. Baron, MD

general medical and science community. Radiology has not been adept at this, according to Dr. Baron, and "(we) need to dramatically increase our research focus in this area."

Finally, Dr. Baron turned the focus to patients.

"All of these changes create ripples in the pool of healthcare delivery, but the furthest reaching impact is that on our patients," Dr. Baron said, emphasizing that all of this should be considered through the lens of an improved patient experience.

"The radiology community should make virtually all practice decisions with a focus on what is optimal for the patient rather than focusing on what is convenient, more efficient, or more lucrative," he said.

That starts with the radiology report, according to Dr. Baron. He noted resources such as the RSNA report template library that provide a framework for organizing the findings and ensuring a complete evaluation. And that reorganization around subspecialty practices will enable radiologists to keep up with the "explosion of medical knowledge" and provide optimal answers.

"Every report should be approached and delivered exactly as you and I would want for our family members," he said.

Studies have shown, he said, that when radiologists keep the patient in mind—keeping a photo nearby, for example their accuracy improves.

Reminding the audience of that pebble creating ripples in a pond, Dr. Baron said, "With these changes in place, we will position ourselves and the specialty of radiology as valued resources and indispensable partners in patient care."

System Inefficiencies Lead to Duplicate CT Studies

By Mike Bassett

Acute trauma patients who receive imaging before being referred to a trauma center are likely to receive duplicate CT studies, leading to added radiation dose for patients and increased costs to the healthcare system, according to a study presented Sunday.

The study, presented by Ricarda Hinzpeter, MD, from the University Hospital Zurich in Zurich, Switzerland, retrospectively looked at all adult trauma patients transferred from other hospitals to a level-1 trauma center at University Hospital Zurich in 2014.

"CT is the modality of choice in the early imaging work-up of severely-injured patients," said Dr. Hinzpeter, who added that severely-injured patients are often transferred from regional hospitals to level-1 trauma centers and are re-scanned.

Dr. Hinzpeter and her colleagues analyzed repeated CT scans and categorized them according to the reasons for duplication, including inadequate CT image data transfer, poor image quality, repetition of head CT after head injury together with completion to whole-body CT (WBCT), and follow-up of injury known from previous CT.

They also calculated the cumulative radiation dose and costs associated with



Ricarda M. Hinzpeter, MD

potentially preventable duplicative CT exams, which they defined as scans that were repeated because of inadequate image data transfer or poor image quality.

In this study 68 out of 298 patients whose conditions were not manageable in the referring hospital were transferred to the trauma center because of either severe head injury (n=45) or major body trauma (n=23). Seventeen other patients were transferred because they were being repatriated from a foreign country (n=14) or because there was no ICU capacity (n=3).

Of these 85 transferred patients, 74 (87.1 percent) had repeated CT scans. The reasons included:

- Inadequate CT image data transfer (n=29; 39.2 percent)
- Repetition of head CT with completion to WBCT (n=24; 32.4 percent)
- Follow-up of known injury (n=21; 28.4 percent).

None of the repeated CT studies were performed because of poor image quality.

Dr. Hinzpeter and her colleagues determined that the cumulative dose-length product of all of the repeated CT scans was 1,383 mSv or 18.7 mSv per patient, while patients who underwent potentially

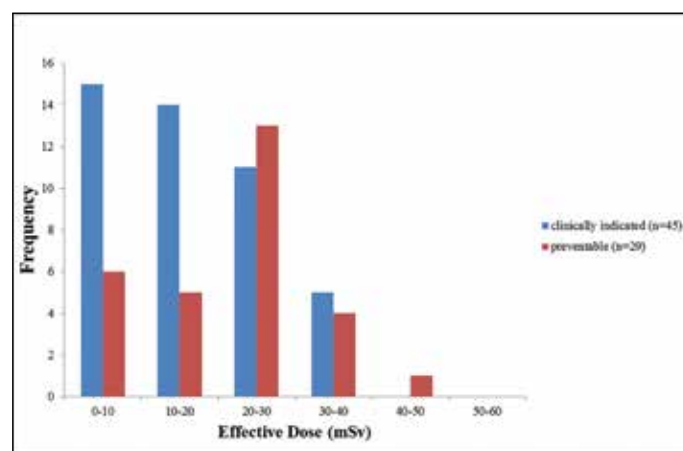
preventable repeat CT scans (those due to inadequate CT data transfer) received an overall additional effective radiation dose of 631 mSv, or 21.8 mSv per patient.

The additional costs associated with all of the repeated CT exams was \$70,433, while the additional costs of potentially preventable CT exams was \$38,961.

"A considerable number of transferred trauma patients undergo potentially preventable repeated CTs, adding radiation dose to the patients, and costs to the healthcare system," Dr. Hinzpeter concluded, adding that the main culprit was inadequate CT image data transfer.

"Future efforts should be made for improving and accelerating image data transfer, allowing for timely and complete availability of CT image data, even in the setting of acute trauma," she said.

Hatem Alkadhi, MD, of the University Hospital Zurich, who co-authored the study, pointed out that CT image data transfer of trauma patients to his hospital is performed either by manual transfer of CDs or via the internet. The problem is that in the case of acute trauma radiologists and clinicians want CT images made available as quickly as possible, even though the use of CDs is known to be hampered by incompatibilities with different computer and software systems.



On a percentage basis, patients who underwent clinically indicated repeat CTs received lower effective radiation doses than patients who underwent potentially preventable CTs.

And while the web-based transfer of images is feasible for patients who are being transferred in a non-trauma setting, it doesn't appear to be fast enough for some emergency situations.

So what's the solution? According to Dr. Alkadhi various initiatives for sharing radiologic images that are becoming available can easily solve the issue.

He noted that the use of a DICOM-email protocol has been proposed as a potential solution for fast and secure connections between hospitals causing minimal problems with existing firewall policies. And he added that another solution is streaming, which allows physicians at the trauma center to electronically access the images obtained in the regional hospital's emergency department, allowing trauma surgeons to review and evaluate CT images well ahead of patient arrival at the trauma center.

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Non-invasive Techniques May Improve Outcomes for More Heart Patients

By Mike Bassett

TRANSCATHETER AORTIC valve replacement (TAVR) continues to see dramatic growth in Europe and North America, and multidetector computed tomography (MDCT) is playing an increasingly important role in improving the clinical outcomes of patients undergoing the procedure, according to presenters at a Sunday session.

While open aortic valve replacement continues to be the gold standard for treating patients with severe aortic stenosis, “the rapid evolution of balloon-expandable TAVR—both procedural developments and technical enhancements—indicates it is at least as good, if not better, than the best surgical outcomes in comparable patient groups,” said Dominik Fleischmann, MD, a professor of radiology at the Stanford University Medical Center, and session moderator.

And while TAVR has traditionally been a treatment for severe symptomatic aortic stenosis for patients who are at high risk of mortality or complications from traditional open-heart surgery, Dr. Fleischmann pointed out that studies have been carried out demonstrating the value of TAVR for intermediate risk patients.

“And we can predict that even lower-risk patients will be doing TAVR very soon,” he said. “The salient point is that if you ask patients, they really want TAVR.”

With that in mind, said Jonathon Leipsic, MD, vice chairman of radiology and associate professor of radiology and cardiology at the University of British Columbia, it is apparent that “TAVR is really pushing the boundaries.”

Dr. Leipsic described how the use of

MDCT has helped improve the clinical outcomes of patients undergoing TAVR.

“While cardiac CT initially played a secondary role in screening patients prior to TAVR, for the last seven or eight years it has really advanced the field through the integration and validation of cardiac CT,” Dr. Leipsic said. “Now, it plays an essential role in the pre-procedural planning and guidance of TAVR.”

According to Dr. Leipsic, cardiac CT is now the first-line test for device sizing, and the non-invasive gold standard for the discrimination of risk of for annular rupture or coronary occlusion.

“All of this has happened through active research by the CT community, looking first at which measures of CT are reproducible, how to obtain them, and



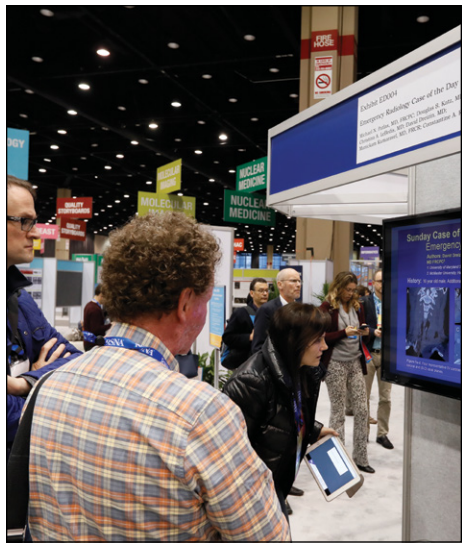
Dominik Fleischmann, Jonathon Leipsic, M.D.

then looking at how to integrate into pre-procedural planning,” said Dr. Leipsic.

Dr. Leipsic outlined a number of reasons why pre-procedural MDCT is essential for TAVR, such as preventing vascular injury, obtaining more precise pre-procedural measurements, and preventing annular injury.

“The original reason why we used CT is vascular injury,” Dr. Leipsic said,

CONTINUED ON 14A



Student Travel Awards Displayed in the Learning Center

RRNA TRAVEL AWARDS for young investigators support candidates invited to present high-quality science. The \$500 award helps defray the costs of attending the RSNA annual meeting. To be eligible, abstract presenters or poster exhibitors must be pre-doctoral students or have been awarded their doctoral degrees no more than three years prior to submission.

A list of the 400 presenters who received 2016 Travel Awards can be viewed in the Learning Center, Lake-side Center East, Level 3. Full eligibility requirements for the award will be available with the 2017 Call for Abstracts in mid-January.

Technology Answer

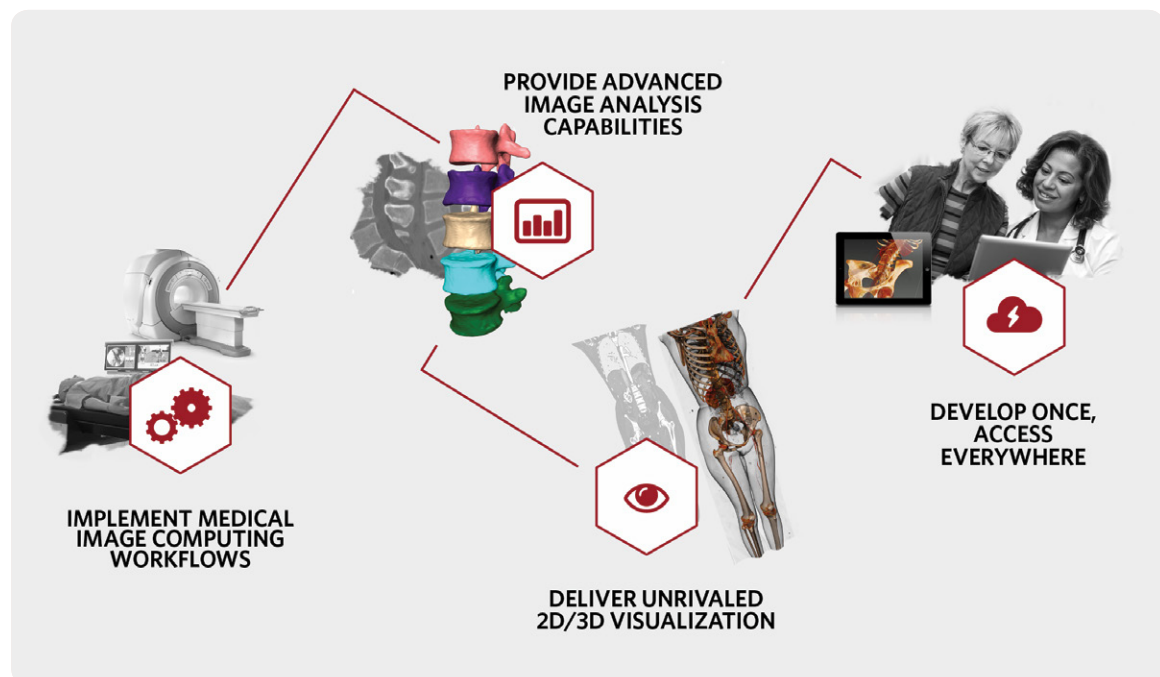
[Question on page 4A.]

At a minimum, you will need patient size and scan dimensions to approximate patient dose. Perfusion and time series scans need to be accounted for thoughtfully when the gantry is stationary.

Q&A courtesy of AAPM.

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RSNA 2016 Press Releases

Several press releases will be distributed to the media highlighting research presented at RSNA 2016. RSNA's media outreach helps the public gain a greater understanding of radiology and its role in personal healthcare. The following research developments were released to the media in advance of the annual meeting:

Musical Training Creates New Brain Connections in Children (PD235-SD-WEA1)

Taking music lessons increases brain fiber connections in children and may be useful in treating autism and Attention Deficit Hyperactivity Disorder (ADHD), according to a study from the Hospital Infantil de México Federico Gómez in Mexico City. The researchers studied 23 healthy children between the ages of five and six years old. All of the children were right handed and had no history of sensory, perception or neurological disorders. None of the children had been trained in any artistic discipline in the past. The study participants underwent pre- and post-musical-training evaluation with diffusion tensor imaging of the brain. After nine months of musical training, results showed brain fiber growth and new connections in areas of the brain associated with autism spectrum disorders and ADHD.

Obesity in Adolescence May Cause Permanent Bone Loss (PD219-SD-MOB5)

Teenagers who are obese may be doing irreparable damage to their bones, according to a new study from Harvard Medical School. Researchers recruited 23 obese adolescents with a mean age of 17 years and a mean body mass index of 44 kg/m². An analysis of bone mineral density, bone microarchitecture and body composition revealed that having a high amount of visceral fat coupled with a low amount of

muscle mass puts adolescents at risk for weakened bone structure.

Researchers Generate 3-D Virtual Reality Models of Unborn Babies (PD230-SD-WEB1)

Parents may soon be able to watch their unborn babies grow in realistic 3-D immersive visualizations, thanks to new technology that transforms MRI and ultrasound (US) data into a 3-D virtual reality model of a fetus. The virtual reality fetal 3-D models are remarkably similar to the postnatal appearance of the newborn baby. They recreate the entire internal structure of the fetus, including a detailed view of the respiratory tract, which can aid doctors in assessing abnormalities. A special headset places the user in an immersive environment, complete with heartbeat sounds derived from the US of the fetus. Users can study the 3-D fetal anatomy simply by moving their head.

Diabetes Proves Deadly for Smokers (CH241-SD-SUB1)

While it is well known that smoking causes lung cancer, heavy smokers with diabetes are also at increased risk of death from causes other than lung cancer. Researchers examined the risk for all-cause mortality among people with and without diabetes within the National Lung Screening Trial. They conducted an analysis of the relative risk for overall mortality, lung cancer mortality, and non-lung

cancer mortality associated with diabetes, adjusting for age, gender, body mass index (BMI), and pack-years of smoking. Participants with diabetes tended to be older, reported more pack-years of smoking, and had a higher BMI than those without diabetes. The results showed that diabetes doubled the risk for all-cause mortality and non-lung cancer mortality among heavy smokers.

New Studies Provide More Insight into Zika Effects (NR394-SD-WEB2; PD200-SD-SUA1; PD232-SD-WEA3)

Three new studies report on the effects of the Zika virus outbreak in Brazil. The first study identified a pattern of CT brain findings in babies exposed to Zika, including decreased brain volume, simplified gyral pattern, calcifications, ventricular dilatation and prominent occipital bone.

Another study analyzed the imaging results of three target groups affected by Zika: adults who developed acute neurological syndrome, newborns with vertical infection with neurological disorders, and pregnant women with rash outbreaks suggestive of Zika. Many of the adults had symptoms of Guillain-Barré syndrome, and a few showed inflammation of the brain and spinal cord or brain stem and spinal cord lesions. In the newborns, MRI showed orbital injuries and anatomical changes in brain tissue.

In a third study, ultrasound and fetal MRI were performed on pregnant patients

with Zika virus infection at different gestational ages. More than half the babies had microcephaly, brain calcifications and loss of brain tissue volume, along with other structural changes.

TODAY'S PRESS RELEASES

- **Head Impacts Lead to Brain Changes in High School Football Players (SSE20-02)**
- **Large Study Finds No Evidence for Age-Based Mammography Cut-Off (RC215-15)**
- **Study Finds Cause of Visual Impairment in Astronauts (SSC11-04)**

TUESDAY'S PRESS RELEASES

- **Depression in Soldiers Linked to Brain Disruption from Injury (SSJ19-03)**
- **New Report Warns of Chest Injuries in Children after ATV Accidents (RC313-06)**
- **Alcohol Consumption Shows No Effect on Coronary Arteries (SSG02-06)**

WEDNESDAY'S PRESS RELEASE

- **Aerobic Exercise Preserves Brain Volume and Improves Cognitive Function (SSK14-06)**

FRIDAY'S PRESS RELEASE

- **Short-term Sleep Deprivation Affects Heart Function (SST02-03)**

All RSNA 2016 press releases are in the newsroom at RSNA.org/Press16, available on the day of the presentations.

CONTINUED FROM 13A

Non-invasive Techniques May Improve Outcomes for More Heart Patients

pointing out that patients who experience vascular injury are at an increased risk not only of morbidity, but of mortality. Research has shown that the use of CT helps prevent this, he said.

When it comes to the use of MDCT for annular sizing and valve selection, "we in the CT community can take a lot of pride in improving sizing," said Dr. Leipsic. "In the early days of TAVR people were using 2-D [echocardiography] and you can imagine that the annulus is almost a uniformly non-circular structure. So how are you going to give a two-dimensional measurement of a 20 by 28 millimeter structure?"

"This is where CT has really asserted itself as the primary tool for sizing," he said.

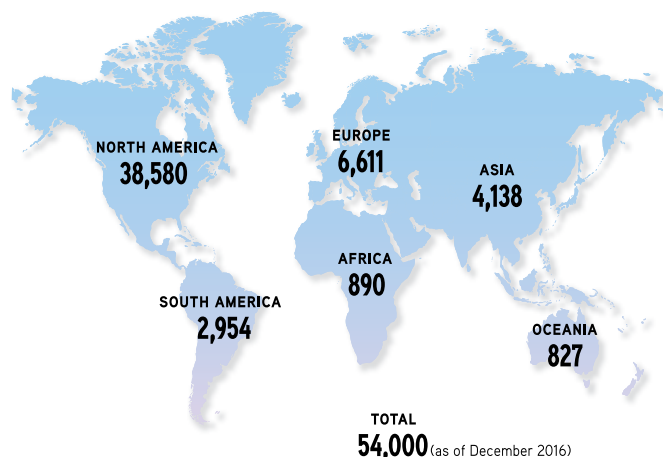
Dr. Leipsic referred to the results of a multi-center trial he participated in that showed that CT integra-

tion allowed for a significant reduction in paravalvular regurgitation.

These kinds of results, "show the improvements in paravalvular regurgitation, very much related to — no doubt — iteration of the devices, and improvements in technique, but also to more appropriate sizing," he said. "Putting in the device that actually matches the patient's anatomy."

"Unlike surgical aortic valve replacement where they actually look at and physically assess the size of the annulus, here we rely on imaging," Dr. Leipsic said. "So the very granular information provided by CT allows us to be more accurate in our device sizing, which allows us to reduce the risk of leakage around the valve and improve clinical outcomes in both the short term and long term."

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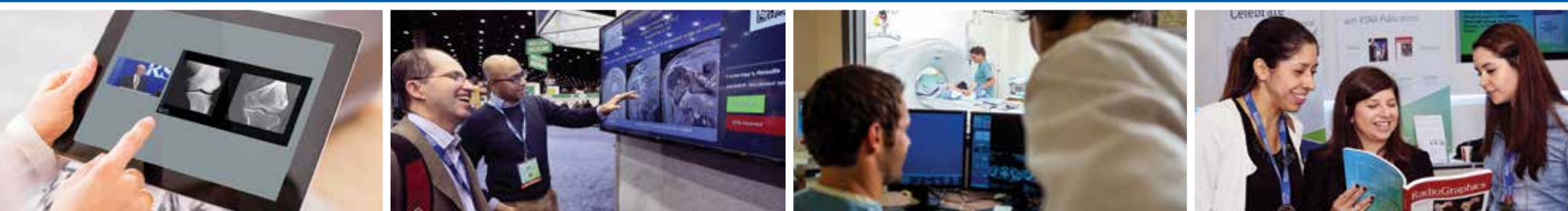
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Open-source Software May Help Reduce the Cost of 3-D Printing

Three-D printing takes 3-D visualization to another level by transforming digital images from CT and MRI scans into physical models that clinicians can hold in their hands.

By Elizabeth Gardner

BUT MAKING SURE THE 3-D “print-out” is a perfect representation often has challenges, according to presenter of a Sunday session.

Vendors of commercial 3-D printers for medical applications also sell FDA-approved software that has been rigorously tested to make sure the printer renders the information from the images accurately. But it typically costs thousands of dollars to license that software, so despite the sharp drop in price for the printers themselves, the models can still be costly.

“Medical 3-D printing can get very expensive very quickly,” said James Shin, MD, a biodesign and informatics fellow in radiology at Weill Cornell Medical College in New York.

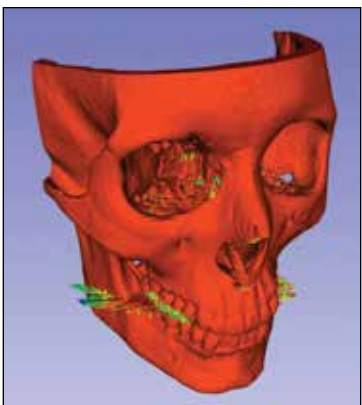
Although free open-source software can greatly reduce the cost of making a medical

model, it has to be validated against commercial software. “It’s not sexy research, but if we’re not sure the software is accurate, it’s not going to contribute the way it should,” Dr. Shin said.

Dr. Shin presented research that compared Mimics, a commercial software package from the Belgian company Materialise, with 3-D Slicer, a free software program created under multiple grants by a consortium of researchers and programmers. (The 3-D slicer is also being demonstrated this week in the Quantitative Imaging Reading Room, Lakeside Center.)

The research compared a model of facial bones with a model of a cardiac lumen. The facial bone model was based on a single non-contrast 64-slice

CT scan of the face, while the cardiac lumen model was based on a single 320-slice contrast-enhanced cardiac CT scan.



A 3-D model of a facial bones from Dr. Shin’s study.



In his research, James Shin, MD, compared commercial software with open-source software in 3-D printing.

The study found that for facial bones and the cardiac lumen, the two programs created physical 3-D models of comparable accuracy and quality. The cardiac models were virtually identical, Dr. Shin said, and the model of facial bones showed only minor discrepancies.

Both types of software interpret DICOM images and do a certain amount of “guess-work” to fill in gaps in the data, but with the density and detail available from most imaging studies today, gaps are minimal. Moreover, commercial software packages often use the same algorithms available in open-source software.

One potential danger in image processing is choosing to “oversmooth” the images — removing artifacts while accidentally taking away some of the small detail that makes a 3-D model accurate and useful.

“At some point you hit the sweet spot where the image is smooth but still accurate,” Dr. Shin said.

But it’s possible to take the process too far, he added.

Because there is not yet a formal recognized training for using images to print 3-D medical models, this decision may fall to a radiologist, an engineer, or even a graphic designer, depending on the process used to create the model.

“If you don’t have a grasp of it as an integrated vertical process, you leave yourself open to errors,” Dr. Shin said.

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Annual Oration in Diagnostic Radiology Presented Today

Healthcare Transformation: Driving Value Through Imaging

IN THE EVOLUTION from fee-for-service healthcare to value-driven population health, healthcare systems must learn to embrace patient-centered, value-focused practices, and the leaders of these systems must be committed to building these cultures, according to **Vivian S. Lee, MD, PhD, MBA**, who will present today’s Annual Oration in Diagnostic Radiology, “Healthcare Transformation: Driving Value through Imaging.”

As a centralized core of experts informing care pathways and practices, radiology must play a key role in both understanding and defining value for providers and their patients, said Dr. Lee, a professor of radiology, senior vice president for health sciences, dean of the school of medicine and CEO of University of Utah Health Care.

At the University of Utah and elsewhere, engaged radiologists are tapping



Vivian S. Lee, MD, PhD, MBA

into their health systems’ culture of value to evolve the way providers engage with imaging specialists to improve patient expectations, and create real and measurable cost efficiencies. The transformation of healthcare requires engaged radiologists to produce more cost effective, quality outcomes.

Dr. Lee serves on the Council of Councils of the National Institutes of Health and the Administrative Board of the Council of Deans for the Association of American Medical Colleges. Dr. Lee is a past president of the International Society for Magnetic Resonance in Medicine.

Dr. Lee served on the RSNA Refresher Course Committee as cardiac chair and cardiovascular chair. She received the *Radiology* Editor’s Recognition Award for reviewing with distinction in 2003, 2005 and 2007.

► 1:30 p.m., Arie Crown Theatre

Correction:

We regret that an incorrect image appeared on page 6B of the Sunday *Technical Exhibits Focus*. The correct image is to the right.

Samsung Electronics, BOOTH 4735 | Mobile Digital Radiography System

Samsung Electronics’ newly launched GM85, a premium mobile digital radiography system, provides advanced mobility, maximized user convenience and a high image quality. Its ultra-compact design allows easy access around tight spaces and the adaptive soft driving control, front bumper sensor and collapsible column offer safe navigation and an ultimate driving experience. The system also features a multi-touch screen panel, image display screen on the tube head unit (THU), and extensive long tube reach for easier operation.



Resident Performance Benefits from 24/7 Attending Coverage

Radiology residency programs that have shifted to a learning model that includes 24/7 in-house radiology attending coverage are seeing positive results in terms of resident performance, efficiency and patient care, new research shows.

By Felicia Dechter

AS WITH ALL ACADEMIC MEDICAL CENTERS, our radiology residency program has experienced the transition towards more direct supervision with an on-site radiology attending presence,” said **Siavash Behbahani, MD, MS**, a third-year radiology resident at Winthrop-University Hospital in Mineola, N.Y., during a Sunday session. “While multiple economic and legal forces have fueled this movement, it challenges traditional learning models for radiology residents.”

In assessing the impact of 24/7 in-house radiology attending coverage on radiology resident performance at Winthrop, Dr. Behbahani and principal project investigator, A. Orlando Ortiz, MD, MBA, chairman of the Radiology Residency Program at Winthrop, retrospectively reviewed radiology resident reports on emergent diagnostic radiology procedures conducted between November 2015 and March 2016.

In all, 29,636 studies were preliminarily interpreted by 17 radiology residents on call under 24/7 supervision by an in-house radiology attending who was available for questions during the shift.

The analysis demonstrated that the resident-faculty rate of missed findings for radiographs was 0.8 percent compared to a higher rate reported in the literature of 1.4 percent without 24/7 direct attending supervision, Dr. Behbahani said.

Results also demonstrated a decrease in the rate of resident-faculty discrepancy for cross-sectional studies (CT — 0.5 percent vs. 2.4 percent, ultrasound — 0.1 percent

vs. 0.6 percent, and MR — 1.1 percent vs. 3.7 percent). The first number relates to residents under 24/7 direct attending supervision, while the second — the versus number — relates to independent resident calls in his study, Dr. Behbahani said.

As the year of resident training increased, missed findings decreased, he said.

“At the critical level of resident education, this 24/7 in-house attending approach reinforces communication as a key driver in enhancing the call experience as a true learning platform.”

Siavash Behbahani, MD, MS

“We also observed that the rates of minor and major discrepancies substantially decreased with increasing resident year of training,” Dr. Behbahani said. “Finally, the turn-around time for generating radiology resident preliminary reports decreased as compared to turn-around times previously reported in the literature.”

Ultimately, results demonstrated that radiology resident on-call performance — with respect to diagnostic radiology interpretations — improves with the presence of 24/7 in-house radiology attending coverage. And in-house radiology attending coverage and supervision ultimately improves patient care, emergency room management/dis-

charge time and appropriateness of management, researchers said.

Communication Key to Reducing Miss Rates

Missed radiologic findings are not uncommon in general, Dr. Behbahani said. A plethora of studies — including research on single radiologist interpretations — have shown miss rates as high as 19 percent, he said.

“There is also literature which suggests that the studies that are preliminarily interpreted by radiology residents

and subsequently reviewed and interpreted by an attending radiologist have shown lower rates of missed findings compared to that of an attending interpretation alone,” Dr. Behbahani said.

Keeping the rate of missed findings as low as possible benefits radiology on a number of fronts — from economics to patient care to the quality of resident education, Dr. Behbahani said.

“At the critical level of resident education, this 24/7 in-house attending approach reinforces communication as a key driver in enhancing the call experience as a true learning platform,” he said.

Along with adopting the 24/7 attending supervision model, Dr. Behbahani suggests that institutions embrace strategies that optimize the interpretation experience and environment. This approach could range from using standardized imaging protocols and search patterns to adopting reading stations that offer optimal lighting, proper ergonomic conditions and controlled interruptions.

“The intrinsic value of this coverage model is founded on the concept of multidirectional proactive communication,” Dr. Behbahani said.



Siavash Behbahani, MD, MS

Personalized Breast Cancer Screening May Improve Outcomes, Reduce Exposure

By Mary Henderson

Keynote presentations by **Rachel F. Brem, MD**, director of Breast Imaging and Interventional Center at George Washington University, and Maxine S. Jochelson, MD, director of Radiology, Breast and Imaging Center, Memorial Sloan Kettering Cancer Center bookended seven presentations on multimodality screening during a Sunday morning science session on breast imaging.

“Ninety percent of breast cancer patients are cured of the disease based on five-year survival rates,” Dr. Brem said in her keynote kicking off the session. “Both treatment and screening have impacted the reduction in mortality rates.”

She said going forward we must now look at the intensity of the cure offered to breast cancer patients and evolve to a more personalized, risk-based approach to screening in order to “deliver better, safer and less costly care.”

Women with dense breasts, a personal history of breast cancer, or with a suspicious lesion diagnosed as atypia all require specific approaches to screening and surveillance, she added.

For intermediate-risk women, or those with a lifetime risk of breast cancer that is 12 to 20 percent higher than the average woman, Dr. Brem advocated for annual screening after age 40 with both mammography and ultrasound.

“Mammography can find upwards of 95 percent of cancers in women with fatty breasts. However, a third of cancers in



Rachel F. Brem, MD

women with dense breast tissue are hidden,” she said. “It’s a perfect storm. Women with dense breast tissue have a two- to six-fold higher risk of breast cancer but cancers are harder to detect in dense tissue.”

In a clinical trial of 15,000 women, screening with both mammography and ultrasound detected 26 percent more clinically important breast cancers.

“It’s not one size fits all for breast cancer screening,” Dr. Brem said. “We must look at our expanding armamentarium of technologies to maintain and improve upon our 30 percent reduction in breast cancer mortality.”

Dr. Jochelson ended the session with her keynote on screening high-risk patients

and whether women who carry the BRCA1 gene mutation benefit from screening mammography.

“Ninety percent of breast cancer patients are cured of the disease based on five-year survival rates”

Rachel F. Brem, MD

“ACR guidelines for women with a 20 percent or higher risk of breast cancer suggest an MRI every year, which was a terrific starting point,” she said. “Now we’ve learned more and are able to fine-tune that.”

She reviewed the results of five prospective studies of MRI and high-risk women addressing the similarities between BRCA1 and BRCA2 carriers, whether MRI screening improves mortality reduction, how often to screen, and whether or not to include mammography.

“BRCA1 and BRCA2 are two different diseases that should be screened dif-

ferently,” she said. “BRCA2 affects young patients and is not as easily detected at BRCA1.”

In a study of high-risk women screened every six months alternating between MRI and mammography, 12 of 13 cancers in patients with the BRCA1 gene mutation were detected on MRI but none were identified on screening mammography.

“Mammography was of no value to women with BRCA1,” she said. “For these patients, cutting back on mammography would not affect cancer detection and would reduce radiation exposure to the patient.”

Based on the findings, Dr. Jochelson said that eliminating screening mammography in BRCA1 carriers should be strongly considered, particularly in women under 40. She suggested screening BRCA1 carriers yearly with MRI from age 25 to 40 and then every six months alternating between MRI and mammography beginning at age 40.

“Screening every six months with MRI may be better,” she said, but acknowledged that insurers are unlikely to reimburse for two MRI exams per year.

As an alternative, she suggested contrast-enhanced digital mammography (CEDM) as a replacement for routine screening mammography. A science session on contrast mammography and CT breast imaging (SSJ01) will be held Tuesday from 3 to 4 p.m. in the Arie Crown Theater.

Evolution of Machine Learning Will Strengthen Radiology

CONTINUED FROM COVER

"This point of singularity could happen in about 2029, just as Kurzweil predicted," Dr. Dreyer said.

But even as he detailed the rapid evolution of machine learning (ML), Dr. Dreyer offered reassurance for radiologists fearing obsolescence. He recalled how, when IBM's chess-playing computer Big Blue beat world champion Garry Kasparov in 1997, Kasparov noted that humans had made the machine that defeated him. After the defeat, Kasparov incorporated the computer's analytical, unemotional approach into his game—an approach he named after the centaur, a creature from Greek mythology with the head, arms and torso of a man and the body and legs of a horse. Dr. Dreyer likened Kasparov's inspiration to the future of radiology, where humans work closely with AI-powered machines to optimize patient care.

"Radiologists will be the centaur diagnosticians, allowing machines to make us smarter, help us do more and give us more value," he said.

Clinical Data Science Critical to Radiology's Evolution

The impact of computer learning will be most apparent at the crossroads of radiology and the emerging field of clinical data science, which encompasses the collection, transformation and analysis of clinical data. Earlier this year, Dr. Dreyer helped open the new MGH Clinical Data Science Center —

part of a new approach to diagnosing and treating disease that uses cognitive computational algorithms such as ML and artificial neural networks to, in effect, call upon the shared expertise of hundreds of radiologists when reviewing a patient scan.

"There is a tremendous amount of applications for AI in radiology," he said. "The radiology field itself is going to be the foundation of precision healthcare."

For instance, once computers are trained to analyze solid lung nodules, images could

be sent to a secure cloud and evaluated according to Lung Imaging Reporting and Data System (Lung-RADS) guidelines. With more than 9 million people eligi-

ble for lung cancer screening in the United States alone, pulmonary nodules represent an enormous potential application for AI — and that represents only a small fraction of radiological findings.

"Soon we will be able to create a precision radiology report for all body parts and all examinations," Dr. Dreyer said.

Dr. Dreyer advised radiologists to ask for AI that not only automates but also augments what they do. Vendors, he said, should provide AI that improves reality, making a single procedure deliver even more value.

"We should use AI to expand our diagnostic and clinical roles," he said, enhancing the radiologists' role as the patients' trusted advisor.

We should use AI to expand our diagnostic and clinical roles.

Keith J. Dreyer, DO, PhD

Radiology Offers Lessons to Entire Medical Industry for Digital Transformation

CONTINUED FROM COVER

Healthcare magazine in 2015.

"Within a year or two, PACS eliminated the radiology rounds. Nobody said they should end, nobody speculated that they would. It just happened because physicians no longer needed to look at film," he added.

Dr. Wachter took away several lessons from that experience: digitization of the "thing" (in this case radiology reports) creates the opportunity for infinite distribution; social relationships and communication patterns that previously depended on gathering around the old technology will wither; and power relationships mediated by who controls the new technology will be renegotiated.

Dr. Wachter said he sees this pattern happening at his institution, estimating internists now spend half their time on computers. This results in physicians spending less time in hospital wards.

"There are no more doctors in the wards because they are no longer tethered there by paper charts, and therefore we left," he said. The downside of this is that doctors become less visible, which can limit interaction with patients, families and nurses.

He said two things went wrong. First, technology was treated as technical change rather than adaptive change. Adaptive change requires users themselves to change.

Second, the industry is still in the early stages of adapting to healthcare information technology, which he broke into four stages.

So far, only the first stage, digitalization of the medical record, has been reached. The remaining three stages are still to come: creating ubiquitous connectivity from the various digitalized parts from individual institutions, gleaned meaningful insights from the data, and, finally, converting those insights into action that improves value.

"The fourth part is the hardest — it involves changing the workflow, the training, the skills," Dr. Wachter said.

He added that because digital reports eliminated radiology's monopoly on that information, the specialty is at risk of commoditization or replacement by cheaper alternatives. He said radiologists need to demonstrate their value to

practicing physicians and patients.

"It's not just that you get the reading correct, it's that that reading leads to better, safer, cheaper care for patients," he said. "That will be your savior."

But while the risk of digital replacement is real, Dr. Wachter said he doesn't see that happening anytime soon. Instead he said hybrid models where technology augments the work of people will be the norm for the foreseeable future.

"Within a year or two, PACS eliminated the radiology rounds. Nobody said they should end, nobody speculated that they would. It just happened because physicians no longer needed to look at film".

Robert M. Wachter, MD

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