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Daily Bulletin

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Physician Workforce Must Reflect the Diversity of Patients

By Nick Klenske

In the summer of 2020, the ongoing COVID-19 pandemic and multiple incidents of police brutality against African Americans converged to shift the national narrative on racial justice. Included in this conversation was a new look at how health care disparities based on race and ethnicity affect population health.

"Although Black or African American and American Indian or Alaskan native populations have the poorest overall health status among all U.S. population groups, Black people experience the worst cancer outcomes of all races and ethnicities," said Iris Gibbs, MD, associate dean of MD Admissions and professor of Radiation Oncology at Stanford Medicine.

Speaking at a Wednesday plenary session, Dr. Gibbs noted that these disparities in health care can, in part, be traced to the disparities found within the physician workforce. For instance, according to a study co-authored by Dr. Gibbs and published in the *International Journal of Radiation Oncology,* despite a diverse pipeline of residents, Black physicians remain disproportionately underrepresented in certain medical specialties, particularly radiation oncology (RadOnc).

"Although the student pipeline to the Black RadOnc residency applicant pool is representative of the U.S. resident applicant pool, the number of Black RadOnc residents selected for training is not representative of the Black overall resident pool," Dr. Gibbs explained.

Furthermore, even though the number of RadOncs doubled between 1974 and 2016 (from 374 to 720), the number of Black RadOnc residents dropped from 31 to 23 during that same time (across 91 ACGME programs).

A similarly bleak picture is seen on the faculty side of the equation, where Black RadOnc faculty representation is less than half of their representation in the U.S. faculty pool. "The most depressing trend is that the rate of decrease for Black faculty has been steady, at a rate of 0.16% annually, from a peak of 3.1% in 2006 to 1.5% in 2016," Dr. Gibbs said.

Change is Possible

According to Dr. Gibbs, these disparities in physician workforce have a direct, negative impact on patient care. For example, Black academic faculty are more likely to conduct research on health disparities than their white counterparts. Likewise, minority physicians are more likely to practice in underserved communities and treat uninsured patients than white physicians.

Gibbs

"Our absence or underrepresentation in the RadOnc specialty means that much of this work isn't getting done — and minority patients are the ones who suffer for it," Dr. Gibbs said.

Yet Dr. Gibbs is adamant that change is possible — and that it needs to start in radiology. "Start by educating yourself about the historical context of current health disparities and challenge yourself to recognize your own contributions to inequities in patient care," she said.

She also recommended that radiologists advocate for inclusive and equitable health care policies that improve health access for marginalized communities. "We need to interrupt bias by speaking up within our own spheres of influence and volunteer our time and talent toward building a diverse pipeline of trainees," she added.

Embracing a Vision of Health Equity

Not since the Civil Rights era has there been such a notable and vociferous call to address the structures of racism — structures that continue to fuel inequities and effectively exclude minority physicians and deny patients appropriate care.

"Improving physician workforce diversity to be more reflective of the changing diversity of patient populations is an important step toward eliminating health disparities — and this has to start with us," Dr. Gibbs concluded.

Haffty is RSNA President

Haffty

Bruce G. Haffty, MD, is RSNA president for 2022. Dr. Haffty is associate vice chancellor, Cancer Programs, at Rutgers Biomedical and Health Sciences. He also serves as professor and chairman in the Department of Radiation Oncology at Rutgers Robert Wood Johnson Medical School, Rutgers Cancer Institute of New Jersey and Rutgers New Jersey Medical School.

At Rutgers' Robert Wood Johnson Medical School, New Jersey Medical School and Cancer Institute of New Jersey, Dr. Haffty spearheaded the expansion of the radiation oncology program and developed residency programs in radiation oncology and medical physics—the only such programs in the state of New Jersey.

As president, Dr. Haffty will focus on expanding RSNA's profile in the broader medical community and will work to promote the value of the radiological sciences to patients and partners in health care delivery.

An internationally sought-after speaker, Dr. Haffty has given many scientific research presentations nationally and internationally and has been an invited lecturer or visiting professor at nearly 180 institutions and meetings worldwide. He has authored or co-authored 50 books, book chapters and theses, more than 400 peer-reviewed articles and numerous editorials, commentaries and letters. He is a leader in national clinical trials and is currently co-investigator on

CONTINUED ON PAGE 2A

Mauro Reappointed to RSNA Board

Mauro

Matthew A. Mauro, MD, was reappointed as chair of the RSNA Board of Directors. Dr. Mauro is president of University of North Carolina (UNC) Faculty Physicians and senior physician executive of UNC Health Care System Revenue Cycle. Dr. Mauro is the James H. Scatliff Distinguished Professor of Radiology, as well as a professor of surgery and interim chair of the Department of Surgery, at the UNC at Chapel Hill School of Medicine. He has been a faculty member at UNC since 1982.

As RSNA chair, Dr. Mauro will continue to provide leadership in pursuing key initiatives including implementing governance changes, increasing the Society's diversity and supporting RSNA's mission by fostering advances in the radiologic sciences.

Dr. Mauro received his medical degree from Cornell University Medical College in 1977. He completed his residency training in 1980 at the UNC School of Medicine and was chief resident during his last year. Between 1980 and 1982, Dr. Mauro completed fellowships in diagnostic and vascular radiology at UNC and abdominal and interventional radiology at the Mallinckrodt Institute of Radiology at the Washington University School of Medicine in St. Louis.

A prolific researcher, Dr. Mauro has published over 150 journal articles and numerous book chapters. He has co-authored five books. His

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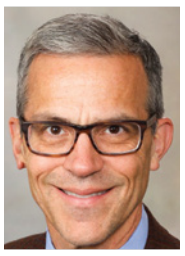
Thursday At a Glance

RSNA/AAPM Symposium

11 a.m.-12 p.m. | Arie Crown Theater

Chen

McCollough



Fletcher

Guang-Hong Chen, PhD
Cynthia McCollough, PhD
Joel G. Fletcher, MD
Together We Can Make a Difference
In this session, Dr. Chen, Dr. McCollough and Dr. Fletcher will discuss the importance of imaging technology innovation to today's radiology practice and providing optimum patient care.

View the full program and add sessions to My Agenda at *Meeting.RSNA.org.*

Please note rooms will be cleared for 30 minutes between sessions for cleaning.

8 – 9 a.m.
Science and Education Sessions

9:30 – 10:30 a.m.
Science and Education Sessions

11 a.m. – 12 p.m.
Science and Education Sessions

12:15 – 1:15 p.m.
Poster Discussions
Learning Center

1:30 – 2:30 p.m.
Science and Education Sessions

3 – 4 p.m.
Science and Education Sessions

Thursday's Physics Quiz

American Association of Physicists in Medicine

Q A 40keV virtual mono-energetic abdominal CT gives higher iodine HU values than a 100keV image. What is the main trade-off for this improved iodine HU?

A. Higher Patient Doset
B. More Image Noise
C. Lower Iodine Contrast

[Answer on page 5A]

Daily Bulletin

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Haffty is RSNA President

several national clinical trials through the NRG Oncology and Alliance for Clinical Trials in Oncology cooperative groups.

Dr. Haffty's research on new methods of delivering radiation therapy for breast cancer has focused on molecular and genetic factors as they relate to radiation resistance and outcomes in patients. His *Lancet*-published research on BRCA1 and BRCA2 gene mutations in conservatively managed breast cancer documented high rates of second primary ipsilateral breast cancers (cancers affecting the same treated breast) and has impacted clinical practice. Dr. Haffty's research has created unique factors associated with outcomes, paving the way for molecular targeted therapies in combination with radiation.

In addition to editing the comprehensive *Handbook of Radiation Oncology*, Dr. Haffty has served on numerous editorial boards, such as *The Cancer Journal*, *International Journal Radiation Oncology - Biology - Physics, Clinical Cancer Research, Journal of Clinical Oncology, Cancer Therapeutics, Women's Oncology Review, Radiation Oncology Investigations* and *Oncology Reports*. He also serves as a frequent reviewer for *The Journal of the National Cancer Institute, Cancer, Lancet* and others. Dr. Haffty currently serves as deputy editor of *Journal of Clinical Oncology*. He served on the *RSNA News* editorial board from 2009 to 2015.

Dr. Haffty has volunteered with RSNA in several roles, including as third vice president from 2013 to 2014 and as co-chair of the Bolstering Oncoradiologic and Oncoradiotherapeutic Skills for Tomorrow (BOOST) Program. At RSNA 2009, he delivered the Annual Oration in Radiation Oncology, "Genetic Factors in the Diagnostic Imaging and Radiotherapeutic Management of Breast Cancer." Dr. Haffty was named RSNA Outstanding Educator in 2013. He has served on the RSNA Board of Directors since 2014.

In addition to having a busy clinical practice, Dr. Haffty has served in many other leadership positions. He served as the founding president of the Association of Directors of Radiation Oncology Programs (ADROP) in 2000, providing tools and resources to advance the quality of residency training and education in radiation oncology. He served as ADROP president from 2000 to 2003.

He has been on numerous national committees related to research and education in breast cancer and radiation oncology. He served as president of the American Board of Radiology, American Society for Radiation Oncology and the American Radium Society.

Dr. Haffty completed his medical school and residency training at Yale University School of Medicine in 1988 and spent the next 18 years specializing in breast, head and neck cancers in Yale's Department of Therapeutic Radiology. He served on the faculty at Yale from 1988 through 2005. Dr. Haffty was promoted to professor of therapeutic radiology in 2000, served as residency program director from 1992 through 2004, and vice chairman and clinical director from 2002 to 2005.

CONTINUED FROM PAGE 1A

Mauro Reappointed to RSNA Board

textbook, *Image-Guided Interventions*, serves as a standard reference in the field. Dr. Mauro has given dozens of scientific research presentations nationally and internationally and has been an invited lecturer or visiting professor at over 200 institutions and meetings worldwide. He has served as principal or co-investigator on numerous funded grants, including several grants focused on diagnostic atherosclerosis imaging and treatment of complex pathology of the descending thoracic aorta.

A dedicated RSNA volunteer, Dr. Mauro served on the Scientific Program Committee beginning in 2005, and as chair from 2009 to 2013. He served on the Public Information Advisors Network from 2002 to 2011. Dr. Mauro is a regular faculty member for annual meeting educational courses and was the associate editor of Radiology from 2002 to 2007. He has served on the R&E Foundation Public Relations Committee and the Corporate Giving Subcommittee, and as an R&E Foundation grant reviewer. Dr. Mauro joined the RSNA Board of Directors in 2015, serving as liaison for education.

Dr. Mauro has worked extensively with the Society of Interventional Radiology (SIR), where he was on the Board of Directors from 1996 to 2000, serving as president during his last year. With SIR, he served on the Executive Council from 1994 to 2000 and again from 2002 to 2006, the Scientific Program Committee from 2000 to 2002, the Steering Committee World Conference on Interventional Oncology in 2005, and many other positions and committees between 1992 and 2006.

Dr. Mauro has served on several editorial boards, including *Clinical Imaging, Applied Radiology, American Journal of Roentgenology,* and *Seminars in Interventional Radiology*, among others. He has been a manuscript reviewer for several journals, including *RadioGraphics*, *Journal of Interventional Radiology, Cardiovascular and Interventional Radiology, Journal of Vascular Surgery* and *Pediatrics*.

Dr. Mauro has been a book reviewer for *Gastrointestinal Radiology, Journal of Vascular and Interventional Radiology, Investigative Radiology* and *Academic Radiology*.

Since 2020, Dr. Mauro has been the RSNA Representative to the Academy for Radiology & Biomedical Imaging Research Executive Committee, and he has served with many societies and organizations. He was past president of the Southeastern Angiographic Society, where he served on the Board of Directors from 2012 to 2018. Dr. Mauro has served on the American Heart Association's Scientific Sessions Program Committee, as well as the Executive Committee, and served on the Board of Chancellors of the American College of Radiology from 2003 to 2009. At the American Board of Radiology (ABR), Dr. Mauro served on the Board of Governors from 2015 to 2018 and on the Executive Committee from 2013 to 2015. He was trustee from 2006 to 2015.

He was awarded the gold medal by SIR in 2014. The ABR has presented Dr. Mauro with both the Distinguished Service Award and the Lifetime Service Award.

Medical Imaging Crucial to EVALI Diagnosis

By Nick Klenske

The use of e-cigarettes, also known as vaping, has risen over the past decade. In 2019, an illness linked to vaping was discovered following an outbreak of unexplained respiratory illnesses in Wisconsin. According to a Chest Journal *study, vaping induced lung injury, which came to be known as e-cigarette or vaping-induced lung injury (EVALI), hospitalized 2,807 and killed 68 people between March 2019 and February 2020.*

"Although e-cigarettes were initially introduced as a safer alternative to traditional cigarettes, the recent discovery that vaping can cause acute lung injury (ALI) has shown that it also has potential health risks," said Constantine Raptis, MD, a radiologist at the Washington University School of Medicine, who co-authored the study.

According to Dr. Raptis, who spoke at a Wednesday Hot Topics in Emergency Radiology session, patients with EVALI typically have a nonspecific clinical presentation characterized by a combination of respiratory, gastrointestinal and constitutional symptoms. However, before an EVALI diagnosis can be made, one must also show that the patient has a history of recent vaping within 90 days, other etiologies must be excluded, and opacities must be found on chest imaging.

"This makes EVALI a diagnosis of exclusion — and one that radiologists must play an important part in," Dr. Raptis said. "Imaging is important as radiologists have to be able to detect lung injury in its earliest stages."

> ***"Because both EVALI and COVID-19 can manifest with similar clinical and imaging findings, an accurate diagnosis is essential, especially considering the differences in treatment and infection prevention and control."***
>
> **Constantine Raptis, MD**

Raptis

Unfortunately, this is easier said than done.

"EVALI's symptoms can be very similar to many other respiratory diseases — including COVID-19," Dr. Raptis added. "Because both EVALI and COVID-19 can manifest with similar clinical and imaging findings, an accurate diagnosis is essential, especially considering the differences in treatment and infection prevention and control."

The CT Imaging Appearances of EVALI Patients

To help radiologists make the distinction between EVALI, COVID-19 and other forms of ALI, Dr. Raptis highlighted some of the *Chest Journal* study's key findings. The retrospective study described the CT imaging appearances of 160 subjects diagnosed with EVALI — the largest cohort collected to date.

According to the study, most patients with EVALI have CT imaging findings along a spectrum ranging from organizing pneumonia (OP) to diffuse alveolar damage (DAD), both of which can mimic causes of ALI. "This is why I believe vaping exposure should be included in the clinical history of all patients with CT findings of ALI without another known cause — particularly if they are young and otherwise healthy," Dr. Raptis said.

Dr. Raptis went on to say that some patients in the EVALI cohort demonstrated CT findings less commonly seen in etiologies of ALI, including superimposed upper lobe predominant centrilobular nodules (CNs) and peribronchovascular (PBV) sparing. Whenever a radiologist sees these findings in conjunction with the more typical manifestations of ALI, EVALI should be considered as a potential cause.

"Radiologists will continuously encounter acute/subacute lung injury from different triggers, including vaping," Dr. Raptis concluded. "By being able to recognize the CT findings of lung injury, we will be properly equipped to understand 'hot new diseases' like EVALI and recognize their clinical importance."

Access the presentation, "Hot Topics in Emergency Radiology," (W2-CMS02) on demand at *Meeting.RSNA.org*.

Automated Assignment Tool May Make Radiologists' Workloads More Equitable

By Jennie McKee

Using an auto-assignment tool for non-stat MR and CTs can even out workloads in radiology departments and improve turnaround times (TATs) for stat studies. The study, conducted at Texas Children's Hospital, aimed to address concerns among the members of the neuroradiology department regarding workload distribution.

Sher

"Issues ranged from the feeling that some radiologists were reading more than their fair share and impacting the productivity of others, to some radiologists not contributing enough, to others preferentially reading less time-consuming studies," said Andrew Sher, MD, assistant professor of radiology and chief of radiology informatics and nuclear radiology at Texas Children's Hospital in Houston.

These problems, noted Dr. Sher, can lead to burnout and potential turnover. To avoid these issues, he and his colleagues created an intervention to balance the neuroradiologists' contributions more fairly.

Implementing a Partially Automated Workflow

The researchers used software to automate the assignment of non-stat MR and CTs to individual radiologists from 7 a.m. to 5 p.m., Monday through Friday, at three-minute intervals.

"Stat studies remained unassigned, with the intent that higher capacity readers could preferentially interpret them in a timely manner," Dr. Sher explained.

Dr. Sher and his colleagues compared data from the radiology analytics platform, scheduling software and peer learning database at their institution from January through March 2020 (pre-intervention) and January through March 2021 (after implementing the new workflow on Dec. 1, 2020). They used Levene's and Fisher's exact tests to analyze the following metrics:

- Mean of assigned studies interpreted per radiologist
- Average work relative value units (wRVUs) per radiologist
- Variability of wRVUs among radiologists
- TATs for stat and non-stat exams
- Frequency of errors

Evaluating TATs and Workload Distribution

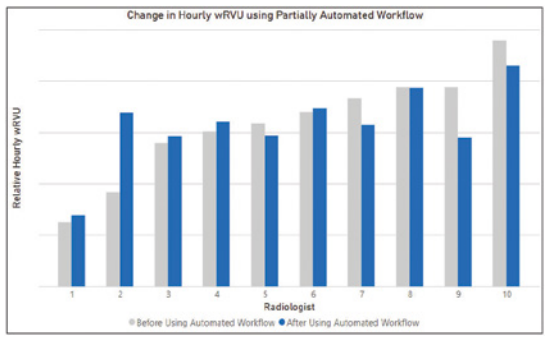
During the pre-intervention period, there were 3,430 exams, including 650 stat exams and 2,780 non-stat exams. In the post-intervention period, there were 3,536 exams, including 629 stat exams and 2,907 non-stat exams.

The mean TAT for non-stat exams stayed essentially the same, going from 142 minutes in the pre-intervention period to 144 minutes after the workflow was introduced; however, the mean TAT for stat exams decreased from 83 minutes to 59 minutes after the workflow was implemented.

According to Dr. Sher, a mean of 91% of the assigned studies were read by the assigned radiologist. The partially automated workflow led to a more even distribution of hourly productivity, with the range of the average hourly wRVU/radiologist decreasing by 17.8% wRVU, and standard deviation decreasing by 26.2%.

Dr. Sher's advice for other institutions is to customize auto-assignment software based on input from the radiologists who will be using it, and not to force radiologists to read studies they aren't comfortable reading.

"We had a few speedbumps at the beginning, but we worked through them," Dr. Sher said, noting the tool has had multiple iterations and refinements, and "has become an essential part of the daily workflow."



After using the partially automated workflow, the hourly wRVU improved for the four radiologists who had the lowest hourly productivity prior to the automation, which was met by a likely compensatory decrease in the four highest. Overall, there was a trend towards more even distribution of hourly productivity using the partially automated workflow.

Access the presentation, "Partially Automating The Workflow To Decrease Cherry Picking In An Academic Radiology Department," (SSIN06-6) on demand at *Meeting.RSNA.org*.

The Forgotten Middle—Strategies to Engage Mid-Career Radiologists

By Mary Henderson

Unlike the junior and senior phases of a radiologist's career, the middle years are often overlooked from a programming and support standpoint. An education course on Wednesday was designed and sponsored by RSNA's Professionalism Committee to provide suggestions for engaging and supporting the mid-career radiologist.


Brown

"There's a lot of support and energy directed at the beginning and the end of our careers and without trying, we've neglected the middle," said course moderator Brandon Brown, chair of the RSNA Professionalism Committee. "We've heard from a growing number of mid-career radiologists that they feel forgotten."

In the decades spent in the mid-career phase — defined as five years past training and more than five years from planned retirement — radiologists may experience stagnation, lack of fulfillment at work and increased expectations for productivity.


Hanneman

"We spend a substantial part of our career in these middle years, when there is a greater potential for burnout but fewer resources available," said incoming chair of the RSNA Professionalism Committee, Kate Hanneman, MD, MPH, associate professor at the University of Toronto.

Dr. Hanneman said leadership can assist mid-career professionals by providing flexibility, supporting professional development and identifying paths to promotion. Radiologists can help themselves by working on creating a career plan, finding a mentor and engaging in networking.

"Now more than ever, it's easy to become siloed," Dr. Hanneman said.

Dr. Brown addressed strategies for retaining the mid-career radiologist.

"The mid-career is so challenging because you are no longer a rising star and you're not yet a revered senior radiologist," said Dr. Brown, vice chair of the Department of Radiology at the Indiana University School of Medicine. "It's no man's land in the middle when the thrill of work has faded and work becomes ordinary, routine and less fulfilling."

As departments and practices grow in size it's easier for people to get lost and suffer from a lack of attention, he said. Disappointment syndrome may also set in.

"There's so much energy and promise attached to your career in the beginning, so many mentors pulling for you," Dr. Brown said. "Eight to 10 years in, you start to hear people worrying about squandered potential and unmet expectations."

Support Needed for the Middle Years

To engage the mid-career radiologist, Dr. Brown suggested overhauling recognition programs by recognizing and encouraging the non-transactional part of our work, including acknowledging the physician exceling as a consultant, giving compassionate care, providing excellent sponsorship and being an on-the-job educator.

On a one-to-one basis, Dr. Brown said our task is to remind our colleagues of their worth and contribution to the health of patients and the work at hand.


Wagner

"With the loss of rituals like gathering around the patient chart or discussing cases in the radiology suite, we need to intentionally and purposely seek out opportunities to give each other recognition and perspective," he said.

Brent H. Wagner, MD, MBA, discussed the challenges facing private practices, including staff shortages and constantly increasing case volumes.

"What I find most challenging is the increased rate in urgent cases to be read," said Dr. Wagner, executive director of the American Board of Radiology. "We can no longer keep up with the scanners."

Because it's increasingly difficult to be proficient in all areas of radiology, he said radiologists should seek out an area for clinical sub-specialization they enjoy.

"Accept the evolving priorities of the practice of radiology and seek fairness, not equity," he said.


Catazano

Tara M. Catazano, MD, addressed the unique challenges of mid-career faculty, which for many includes raising young families and caring for aging parents. She said it's challenging to create programming to support mid-career radiologists because there are so many different career paths available.

"What mid-career radiologists have in common is many of us feel stuck, we're not sure where we're going or what to do next," said Dr. Catazano, professor of radiology, University of Massachusetts Medical School.

The remedy, she said, is to embark on a journey of self-discovery and to seek out people who can help you get where you want to go.

"It's important to get to know yourself, to sample different things and to write down your ideas and discuss them with friends or colleagues," Dr. Catazano said. "Mid-career radiologists need to engage in self-reflection to understand what they love to do and what their next steps should be."

She recommended programming support geared to the different needs within the mid-career group, including mentorships and sponsorships.


Canon

Cheri L. Canon, MD, professor and chair at the University of Alabama Department of Radiology, presented the faculty viewpoint, emphasizing that academic radiologists who feel 'forgotten in the middle' should avail themselves of multiple people for different types of support.

"Mentors are like sherpas, sponsors encourage and tell us we can achieve, and coaches help us identify our deficits," said Dr. Canon, who is also president of the Society for Chairs of Academic Radiology Departments.

From an organizational standpoint, she said departments should consider placing radiologists in leadership roles earlier and helping women and minorities break through the glass ceiling through sponsorships.

"We need to create more development opportunities for mid-career professionals with robust faculty development programs," Dr. Canon said.

Access the presentation, "Engaging the Mid-Career Radiologist: Challenges, Retention and Opportunities," (W4-RCP19) on demand at *Meeting.RSNA.org*.

Personalized Chest CT Protocols Substantially Reduce Radiation Dose

By Cindy Zinkovich

With personalized chest CT protocols, radiation dose for certain clinical indications can be reduced without reducing interpretability, according to research conducted at University Hospital Erlangen in Germany.

"We found that personalized chest CT protocols lead to significant dose reduction," said presenter Markus Kopp, MD, consultant, University Hospital Erlangen. "This study provides a suggestion for optimized CT protocol for detecting pneumonia, especially with the COVID-19 pandemic, and for nodules."

The researchers first evaluated 10 tin filter-based low-dose CT protocols in a preclinical setting, on a human cadaver without known lung disease. Four protocols were optimized for high-resolution structures, pulmonary nodules, infectious disease and one minimum dose protocol with less but still sufficient quality to detect lesions, were selected for clinical application.

Radiation dose and image quality for the four protocols—high-resolution CT (HR-CT), pulmonary nodule CT (PN-CT), infectious disease CT (ID-CT) and minimum dose CT (MIN-CT)—were prospectively evaluated using a volume scanner (32 x 0.7 mm z-coverage, 0.8 seconds rotation time, tin pre-filtration).

The volume CT dose index (CTDI) in the clinical setting were 5.4 milligray (mGy) for HR-CT, 1.2 mGy for PN-CT, and 0.6 mGy for ID-CT ($P < 0.001$). The 0.2 mGy difference between ID-CT and MIN-CT wasn't significant ($P = 0.262$). For the upper reference protocol, the dose settings of a preexisting high-resolution CT were used. The radiation dose for MIN-CT was comparable to a chest radiograph in two planes.

In the clinical setting, the researchers applied the corresponding CT protocol to 88 patients based on the primary clinical indication, including 38 HR-CT, 21 PN-CT, 20 ID-CT, and nine MIN-CT. Radiation dose, and subjective and objective image quality were compared.

"Which CT protocol was selected for which patient was based on the primary clinical indication and made by the radiologist in charge," Dr. Kopp said. "For example, a patient with suspected infectious disease would receive the infectious disease protocol. However, because a patient may have multiple conditions—a patient with suspected pulmonary fibrosis, for example, may also have infectious disease, or vice versa—most of the CT images were evaluated for several lung lesions and patterns."

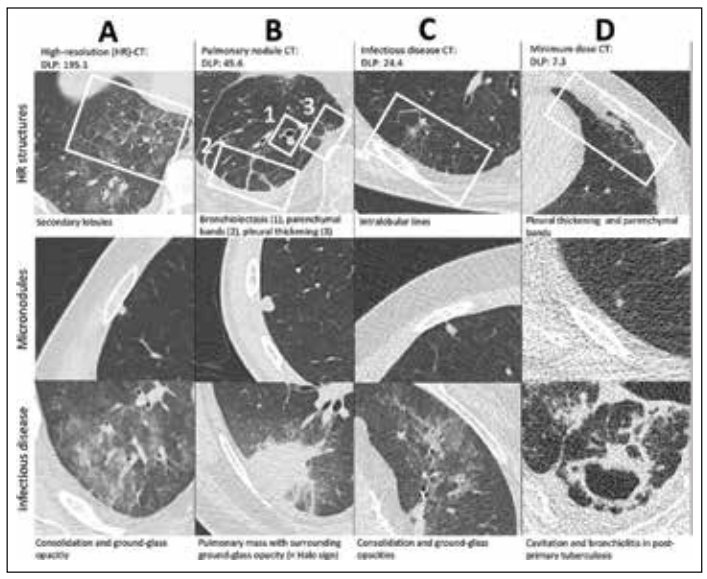
The reduction in radiation dose in the clinical setting ranged from 50% between the PN-CT and ID-CT protocols, to a maximum reduction of 96% between the HR-CT and MIN-CT protocols. The reduction was 78% between HR-CT and PN-CT, and 67% between ID-CT and MIN-CT.

"This is a really substantial and also significant dose reduction between high-resolution CT and pulmonary nodule CT, and pulmonary nodule CT and infectious disease CT," Dr. Kopp said.

Image Quality Informs Dose Recommendations

Optimal image quality was defined as a Likert scale rating of 4 (good delineation) or 5 (perfect delineation). A Likert score of 3 was still diagnostic but limited.

"In all 20 examinations with ID-CT, image quality was sufficient to accurately characterize the infectious disease patterns," Dr. Kopp said. "In our opinion, there is no reason we should provide more radiation dose than necessary."



Patients who receive a HR-CT with the question for pulmonary fibrosis may also have infectious disease or vice versa. Therefore, most of the CT images were evaluated for several lung lesions and patterns.

Appropriate, personalized radiation dose while maintaining image clarity is important for patient safety and to prevent repeat imaging.

Some pulmonary nodules detected via ID-CT scored an unacceptable 3 or 3.5 on the Likert scale for ID-CT.

"We don't want to miss any relevant findings," Dr. Kopp said. "Our study shows that radiologists should use slightly higher dose levels for dedicated examination of pulmonary nodules."

With MIN-CT, detection of pulmonary nodules and infectious diseases was still possible, but the characterization of the lung lesions became more difficult.

Access the presentation, "Personalized Chest CT: Optimal Examination Protocols for the Detection of Fibrosis, Nodules and Pneumonia," (SSCH06) on demand at *Meeting.RSNA.org*.

R&E Foundation Board of Trustees Welcomes New Officers and Members

Satoshi Minoshima, MD, PhD, is the Chair-Elect of the R&E Foundation Board of Trustees (BOT).

Minoshima, MD

Dr. Minoshima is professor and chair in the Department of Radiology and Imaging Sciences at the University of Utah, Salt Lake City, where he specializes in nuclear medicine and molecular imaging.

Stamatia V. Destounis, MD, was appointed BOT secretary, and Reginald F. Munden, MD, was reappointed treasurer and to a second term.

The BOT also welcomed new members, Phan T. Huynh, MD, Matthew A. Mauro, MD, and Pamela Woodard, MD.

Vijay M. Rao, MD, is the BOT Chair. Other BOT members include Lori L. Barr, MD, Michael J. Harsh, Marta E. Heilbrun, MD, Bonnie N. Joe, MD, PhD, and Umar Mahmood, MD.

The mission of the R&E Foundation is to "invest in the future of radiology by developing investigators and supporting lifelong innovative research and education. Since its inception in 1984, the Foundation has awarded $70 million in grant funding to over 1,600 researchers and educators.

Thursday's Answer

[Question on page 2A.]

A B. The lower energy mono-energetic images rely more heavily on the lower energy acquisition of the dual energy CT. This energy is more attenuated by the body and is noisier – making the virtual image noisier as well.

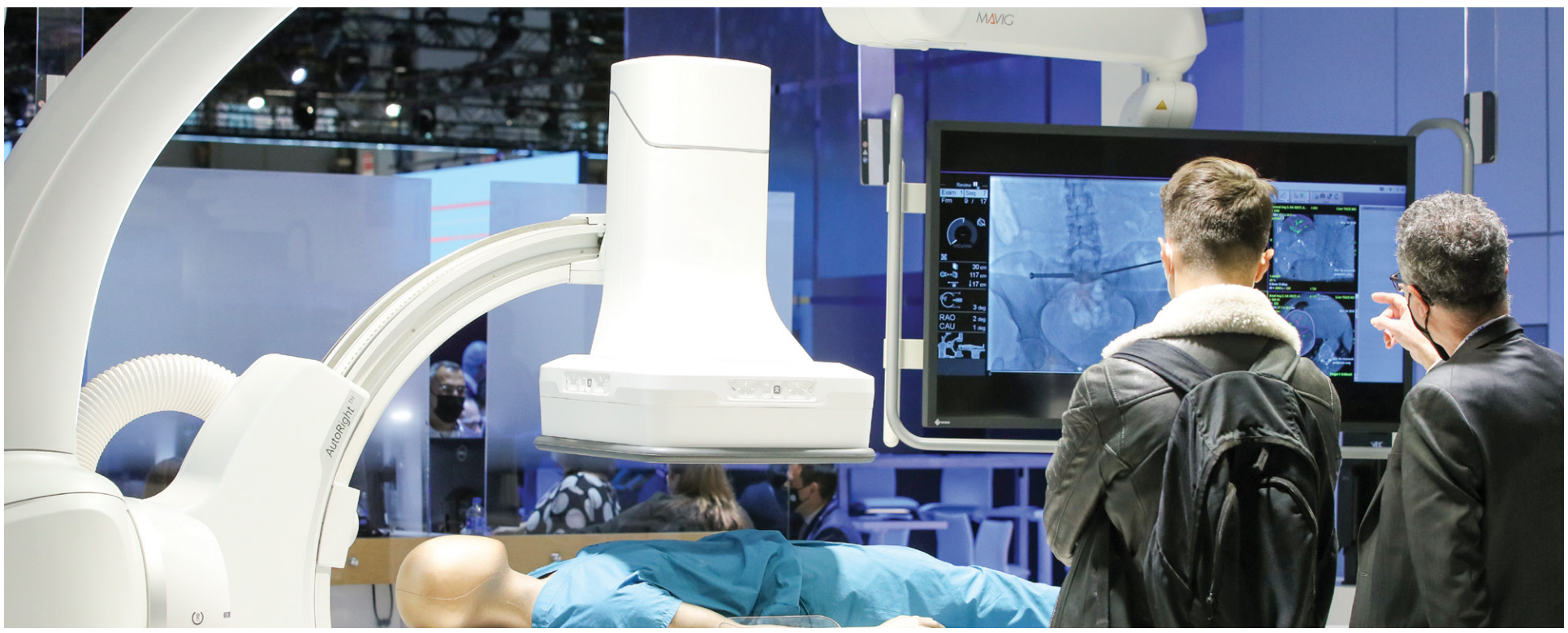
Attendees relaxed throughout the week in the Discovery Theater and enjoyed a variety of live entertainment, including the Frank Russell Band.

The Technical Exhibits offer attendees the opportunity to experience product demos of the latest innovations, including virtual reality solutions.

Excited to be meeting in person again, attendees celebrated the message "Unity is Strength" by contributing to a 3D mosaic comprised of selfies taken by radiology professionals visiting from around the world.

RSNA leadership and staff were thrilled to welcome nearly 20,000 attendees back to Chicago for RSNA 2021. The halls of McCormick Place rang with excited voices as colleagues reconnected.

RSNA Board of Directors member Sanjeev Bhalla, MD (*right*), stopped by the Residents Reception to meet the next generation of radiologists. Trainees attending RSNA 2021 enjoyed the opportunity to relax and mingle with colleagues and radiology leaders on Tuesday evening.



Exhibitors and attendees alike were happy to interact and learn throughout the Technical Exhibits Halls.

Show off your RSNA pride—Stop by the Connections Center before heading home to pick up the newest RSNA swag.

The RSNA R&E Foundation awarded 85 new and continuing multi-year grants to researchers and educators at 40 different institutions across North America in 2021. Visit the Foundation booth in the Connections Center to learn about their innovative projects.

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RSNA SPOTLIGHT COURSE

Radiomics May Guide Pre-Operative Evaluation of Pancreatic Cancer

By Richard Dargan

A pre-operative model that extracts features from medical images significantly improves predictions of survival for patients with pancreatic cancer compared with currently used clinical methods, according to research presented on Wednesday.

Patients with pancreatic cancer face poor odds, with a five-year survival rate of less than 10% internationally. Predicting patient survival at the beginning of treatment — a concept known as prognostication — has been investigated as a way to improve outcomes for patients.

"This information can help decide what treatment is most appropriate for the patient; in particular, the question as to whether patients should have neoadjuvant chemotherapy prior to surgery," said presenter and study author Gerard Healy, BM BCh, from Toronto General Hospital.

For the new study, Dr. Healy and colleagues used radiomics, the extraction of features from medical images, to develop a prognostic model for pancreatic cancer based on pre-operative CT. Radiomics has shown potential value for prognostication, but previous studies have lacked external validation.

The researchers studied the radiomics model in 352 pancreatic cancer patients who underwent pre-operative contrast-enhanced CT without neoadjuvant therapy at five North American hospitals. The patients subsequently underwent surgery at the University Health Network in Toronto.

The researchers then externally validated the radiomics model on 215 patients who underwent surgery at St. Vincent's University Hospital in Dublin following pre-operative CTs performed at 34 hospitals.

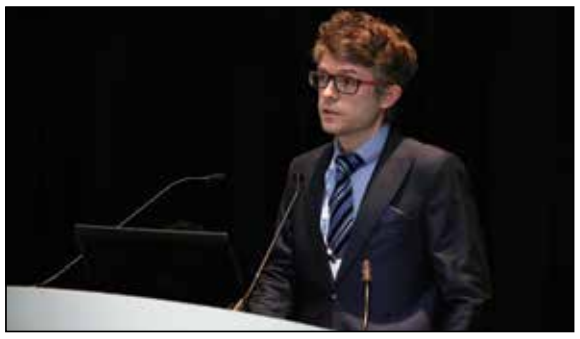
"We are the first group in pancreas radiomics to conduct such a robust external validation of our model," Dr. Healy said.

The radiomics score significantly improved prognostication for patients compared to using clinical information alone. In the external validation group, the radiomics score was the dominant predictor of overall and disease-free survival. No other clinical features were significantly associated with overall and disease-free survival. Radiomics performed similarly to pathological information, which is only available post-operatively.

"Our results found that the model performed better than the clinical prognostic variables currently available in clinical practice," Dr. Healy said.

AI Methods May Be More Effective

The model could help guide pre-operative therapy decisions, but more improvement is needed before it reaches that level. Dr. Healy noted that prior studies in this field by other groups have had positive results, but they used smaller study populations and included minimal to no external validation.



Healy

"Since we are the first group to perform such robust external validation, our conclusion is that radiomics is not currently ready for clinical implementation in pancreatic cancer prognostication," Dr. Healy said. "We therefore conclude that the results of those prior studies were overly optimistic."

When asked at the session if any particular tumor feature on CT stood out for predictive value, Dr. Healy pointed to tumor attenuation.

"Low attenuation tumors do worse," he said.

Dr. Healy believes that the future of prognostication in pancreatic cancer lies in more advanced artificial intelligence methods like deep learning. His lab is shifting its focus to that through continuing collaboration between the St. Vincent's University Hospital in Dublin and the lab of radiologist Masoom Haider, MD, at the University of Toronto.

Dr. Healy's two-year clinical-research fellowship at the University of Toronto was made possible through a scholarship from the Faculty of Radiologists, Royal College of Surgeons in Ireland.

Access the presentation, "Pre-operative Radiomics Model For Prognostication In Resectable Pancreatic Adenocarcinoma: Multi-institutional Development And External Validation," (SSGI11) on demand at *Meeting.RSNA.org*.

DECT Can Help Radiologists Detect Previously-Missed Gallstones

By Melissa Silverberg

An emerging CT technology can make the detection and treatment of gallstones easier according to a new paper on the accuracy of dual energy CT (DECT) for detection of gallstones, said Shambo Guha Roy, MBBS, radiology resident at Mercy Catholic Medical Center, Darby, PA

"While working on a night shift as a resident it is not uncommon to encounter a patient with upper abdominal pain who will get a CT first followed by upper abdominal ultrasound and overwhelmingly the ultrasound would not add more to the CT," Dr. Roy said.

Often a patient may be experiencing gallstones that are not yet calcified and may not be detected on a normal CT. Getting the additional ultrasound can be time consuming, add costs, and may not impact patient's care.

DECT is an emerging imaging technique that is growing in use. The advanced reconstruction algorithm of DECT in the form of virtual non contrast (VNC) and virtual monochromatic (VMC) images improve the ability to detect non-calcified gallstones, which have been harder to detect using CT alone, Dr. Roy said.

While some studies have shown the effectiveness of DECT in detecting gallstones, Dr. Roy said there had not yet been a study that included a control group to test for real-world sensitivity and specificity.

> *"We can avoid the unnecessary ultrasound in the emergency department by instead using DECT if gallstones are suspected. It will reduce patient wait time and health care costs if more radiologists are trained on how to pick up gallstones on dual energy CT."*
>
> **Shambo Guha Roy, MBBS**

DECT Demonstrates Higher Sensitivity

The study looked at all patients between January 2018 through December 2020 who underwent both DECT of the abdomen and right upper quadrant ultrasound within six months of each other. The presence or absence of gallstones on ultrasound was used as standard. The CTs were reviewed by four attending radiologists, who were blinded to the ultrasound results. The CT results were taken as either positive or negative for gallstones when at least three readers were in agreement.

Of 209 DECT that were reviewed, 106 had gallstones and 103 did not. In 197 of 209 DECTs studied there was 3:1 agreement between the readers. The DECT was reported as positive in 95 out of 106 patients with ultrasound-proven gallstones. Furthermore, 98 out of 103 patients without gallstone on ultrasound were reported as negative on DECT.

Roy

The study found that DECT had a sensitivity of 92% for gallstone detection, which is higher than the previously reported sensitivities in the 70's using standard CT.

Dr. Roy said detecting those stones earlier, saving patients additional tests and making use of emerging technology can help both radiologists and patients

"We can avoid the unnecessary ultrasound in the emergency department by instead using DECT if gallstones are suspected," he said. "It will reduce patient wait time and health care costs if more radiologists are trained on how to pick up gallstones on dual energy CT."

Access the presentation, "Gallstones Detection On Dual Energy Computerized Tomography (DECT)- Is It Ready For Real-world Use? A Retrospective Observational Study," (SSGI12-3) on demand at *Meeting.RSNA.org*.

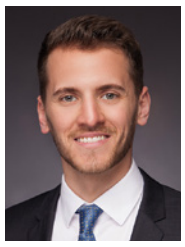
Thursday's Physics Tip

American Association of Physicists in Medicine

The equation for Hounsfield Unit can be interpreted as 10 x the percent difference in attenuation between water and the tissue. Thus, a tissue with an HU of 20 would be roughly 2% more attenuating than water.

CT Uncovers Bone Disease in Tyrannosaurus Rex Jaw

The method could have significant applications in paleontology as a less-destructive alternative to fossil assessment methods



Hamm

Researchers in Germany identified bone disease in the fossilized jaw of a Tyrannosaurus rex using a CT-based, nondestructive imaging approach, according to a Wednesday presentation.

A familiar subject of today's popular culture, the T. rex was a massive, carnivorous dinosaur that roamed what is now the western United States millions of years ago. In 2010, a commercial paleontologist working in Carter County, Montana, discovered one of the most complete T. rex skeletons ever found.

The fossilized skeleton dates back approximately 68 million years to the Late Cretaceous period. It was sold to an investment banker, who dubbed it "Tristan Otto" before loaning it out to the Museum für Naturkunde Berlin in Germany. It is one of only two original T. rex skeletons in Europe.

Charlie Hamm, MD, a radiologist at Charité University Hospital in Berlin, and his colleagues recently had an opportunity to investigate a portion of the Tristan Otto's lower left jaw.

While previous fossil studies have mostly relied on invasive sampling and analysis, Dr. Hamm and colleagues used a noninvasive approach with a clinical CT scanner and dual-energy computed tomography (DECT).

The "Tristan Otto" Tyrannosaurus rex skull that was examined by researchers

"We hypothesized that DECT could potentially allow for quantitative noninvasive element-based material decomposition and thereby help paleontologists in characterizing unique fossils," Dr. Hamm said.

The CT technique enabled the researchers to overcome the difficulties of scanning a large portion of Tristan Otto's lower jaw called the left dentary. The piece's high density was particularly challenging, as CT imaging quality is known to suffer from artifacts, when looking at very dense objects.

"We needed to adjust the CT scanner's tube current and voltage in order to minimize artifacts and improve image quality," Dr. Hamm said.

On visual inspection and CT imaging, the left dentary showed thickening and a mass on its surface that extended to the root of one of the teeth. DECT detected a significant accumulation of the element fluorine in the mass, a finding associated with areas of decreased bone density. The mass and fluorine accumulation supported the diagnosis of tumefactive osteomyelitis, an infection of the bone.

Method Shows Promise in Other Applications

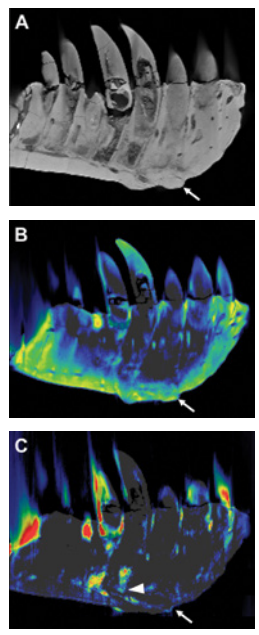
"While this is a proof-of-concept study, noninvasive DECT imaging that provides structural and molecular information on unique fossil objects has the potential to address an unmet need in paleontology, avoiding defragmentation or destruction," Dr. Hamm said.

"The DECT approach has promise in other paleontological applications, such as age determination and differentiation of actual bone from replicas," added Oliver Hampe, PhD, senior scientist and vertebrate paleontologist from the Museum für Naturkunde Berlin. "The experimental design, including the use of a clinical CT scanner, will allow for broad applications."

Dr. Hamm and his colleagues also collaborated with paleontologists from Chicago's Field Museum and colleagues from the Richard and Loan Hill Department of Biomedical Engineering at the University of Illinois at Chicago to perform a CT analysis of the world-famous T. rex "Sue" that is housed in the museum.

"With every project, our collaborative network grew and evolved into a truly multidisciplinary group of experts in geology, mineralogy, paleontology and radiology, emphasizing the potential and relevance of the results to different scientific fields," Dr. Hamm said.

Access the presentation, "Quantitative Dual-Energy CT Reveals Fluorine As A Noninvasive Biomarker For Osteomyelitis In A Tyrannosaurus Rex," (SSMK08-6) on demand at *Meeting.RSNA.org*.



CT reconstructions of the tooth-bearing part of the left dentary. (A) Reconstruction of the conventional CT images in lateral view showing well-preserved anatomical structures such as the replacement teeth. The arrow indicates the focal exophytic mass—the abnormal growth that sticks out from the surface of the tissue—on the ventral surface at the level of the 3rd to 5th tooth roots. (B) The DECT-based calcium material map shows a homogeneous mineral distribution, while (C) the fluorine material map shows significant mineral accumulation in the center of the exophytic mass and adjacent tooth roots (arrowhead).

Deep Learning Method May Assist in Fight Against Type 2 Diabetes

By Lynn Antonopoulos

Artificial intelligence (AI) may be used to help radiologists opportunistically detect and predict Type 2 diabetes in patients undergoing imaging for other medical conditions.

Hima Tallam, a first-year MD/PhD student at Rutgers New Jersey Medical School, presented findings from a retrospective study that used fully automated deep learning to investigate CT biomarkers in patients who previously underwent colorectal cancer screening using CT colonography.

Tallam

"In the field of medical image analysis, there is a need for improvement in automated pancreas analysis and its application to clinical problems. This study was a step toward the wider use of automated methods to address clinical challenges," said Tallam who performed the work as part of her National Institutes of Health (NIH) postbaccalaureate research fellowship in the lab of Ronald Summers, MD, PhD, at the NIH Clinical Center's Department of Radiology and Imaging Sciences.

In a collaboration with Perry Pickhardt, MD, at the University of Wisconsin Hospital and Clinics, Tallam and her colleagues used scans from 8,992 patients including 572 who had Type 2 diabetes and 1,880 who were experiencing problems with unstable blood sugar.

They used a fully automated, deep learning method to segment the pancreas and yield measurements for various pancreatic biomarkers. Some extra-pancreatic biomarkers like visceral fat and atherosclerotic plaque were also included. Then they separated subjects into groups based on the time between Type 2 diabetes diagnosis and the date the CT scans were taken.

The researchers performed univariable and multivariable analyses of the measurements. According to Tallam, they included several CT-derived and clinical factors, such as the patients' sex, age, body mass index (BMI) and BMI over 30 and determined the best set of Type 2 diabetes predictors using multinomial logistic regressions.

Deep Learning Indicated Higher Intra-Organ Fat

The results showed that patients with Type 2 diabetes had, on average, lower pancreas, muscle and liver CT attenuation values indicating higher amounts of intra-organ fat when compared to non-diabetics.

The best predictors of Type 2 diabetes included standard deviation of pancreas CT attenuation, fractal dimension of the pancreas, visceral fat volume, severity of abdominal aortic plaque and BMI higher than 30.

"Previous work has shown that patients with diabetes tend to accumulate more visceral and intrapancreatic fat than non-diabetics, but no significant work has been done using automated methods on a dataset of this magnitude," Tallam said.

Though she acknowledged the limitations of the retrospective use of the data set as well as the difficulty of performing the pancreas segmentation, she noted that the deep learning model had an average Dice similarity coefficient of 0.69 on selected test cases which, she said, is considered state-of-the-art performance for pancreas segmentation on non-contrast CT.

The team was encouraged by the model's performance as the final multivariate model showed pairwise areas under the curve (AUCs) ranging from 0.79 to 0.92 between diabetics and non-diabetics.

"We were excited to see that the multivariable model with only CT-derived and a few clinical factors achieved high AUCs without serum markers such as glucose and hemoglobin," Tallam said.

"Ultimately we hope that the CT biomarkers investigated in this work might inform opportunistic diagnosis of early stages of Type 2 diabetes," she said. "And allow patients to make lifestyle changes to alter the course of this chronic disease."

Access the presentation, "Fully-automated CT Biomarkers for Type 2 Diabetes Using Deep Learning," (SSGI11-3) on demand at *Meeting.RSNA.org*.

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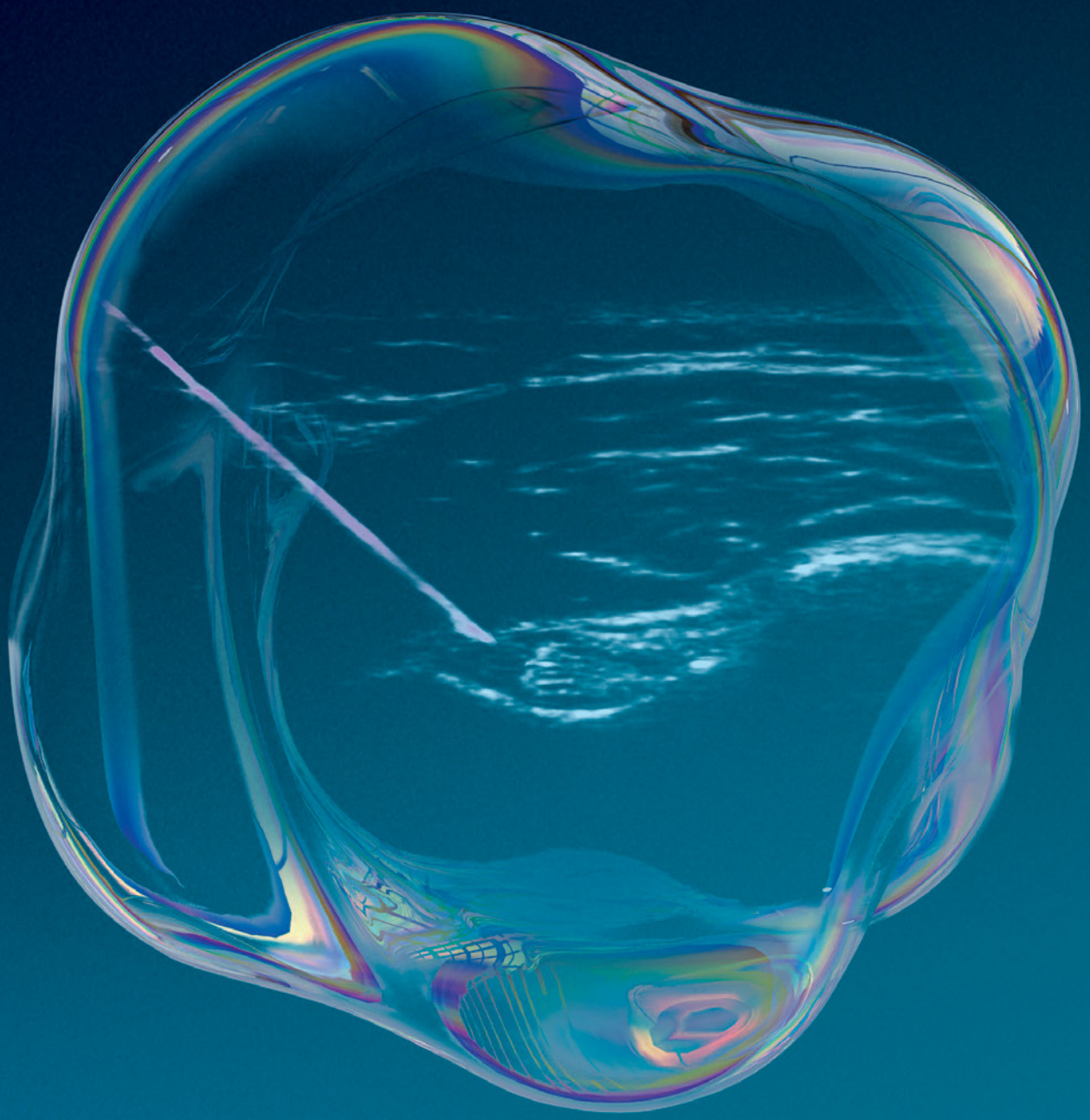

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