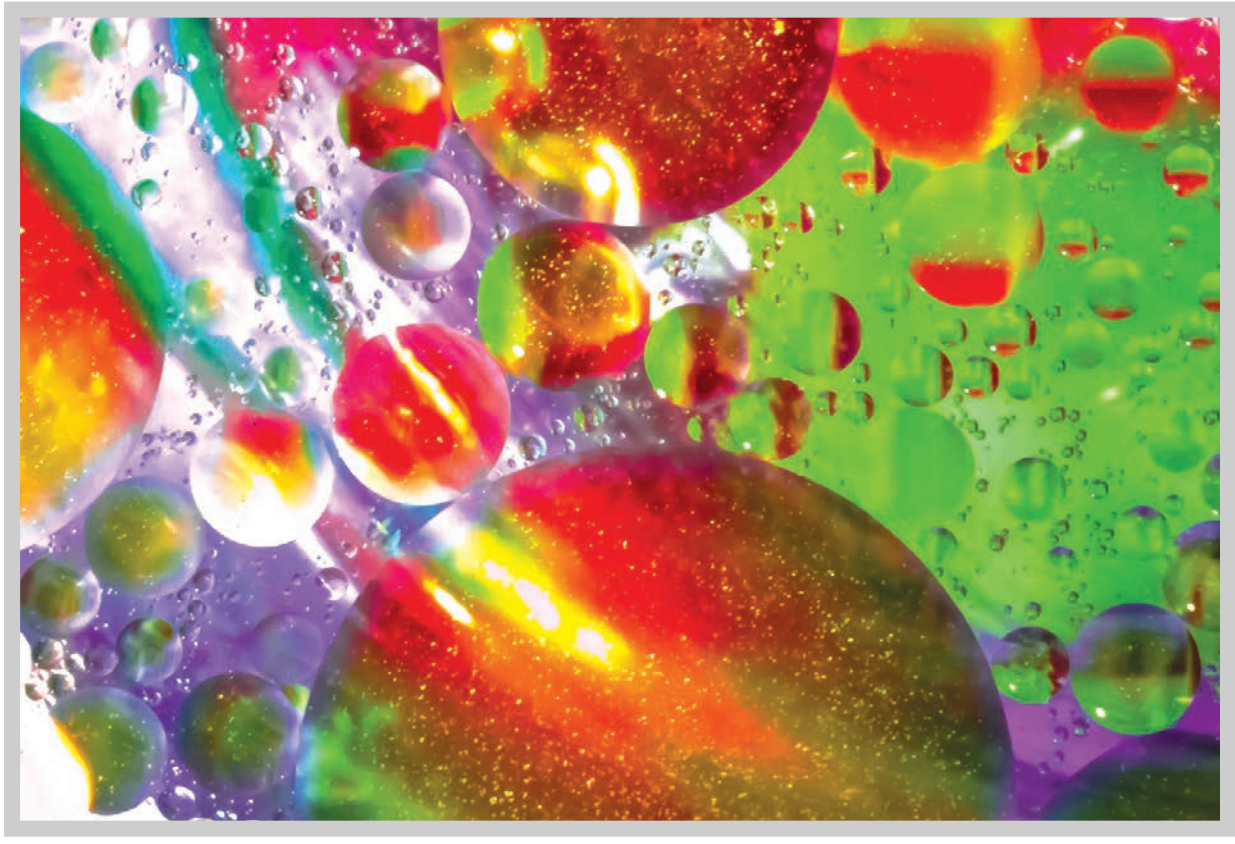
RSNA News™

**February 2018** Volume 28, Issue 2



## Art and Radiology Intersect in RSNA 2017 Image Contest

**ALSO INSIDE:**



**RSNA 2018 Abstract Submission Open**
**See Page 24**

**FEBRUARY 2018** • VOLUME 28, ISSUE 2

## FEATURES





**RSNA MISSION**
The RSNA promotes excellence in patient care and healthcare delivery through education, research and technologic innovation.

Follow us for exclusive news, annual meeting offers and more!

**Vinay Prabhu, MD, *right*, receives his 2017 Roentgen Resident/Fellow Research Award from Nancy Fefferman, MD.**

# Roentgen Nominations Open

Nomination Deadline
**April 2**

Nominations are now being accepted for the RSNA Roentgen Resident/Fellow Research Award, recognizing residents and fellows who have made significant contributions to their departments' research efforts as evidenced by presentations and publications of scientific papers, receipt of research grants or other contributions.

Nominations are limited to one resident or fellow per program in radiology, radiation oncology or nuclear medicine per year. The program director or department chair selects the nominee for each program.

The RSNA Research & Education (R&E) Foundation provides an award plaque for the department to display and a personalized award to present to the selected resident or fellow. The deadline for nominations is April 2. Learn about the nomination process and see a list of past recipients at *RSNA.org/Roentgen_Research_Award.aspx*.



**Hess**

## Hess Named Radiology Chair at UCSF

**Christopher Hess, MD, PhD**, was recently appointed chair of the Department of Radiology and Biomedical Engineering at the University of California, San Francisco (UCSF).

A respected imaging expert in neurodegenerative disorders, epilepsy and vascular disease, Dr. Hess previously served as a professor of radiology and neurology and chief of neuroradiology at UCSF.

Dr. Hess is the RSNA Refresher Course Committee track chair for neuroradiology and a deputy editor of *Radiology*. He is a member of RSNA's Health Services Policy & Research Subcommittee and the Public Information Advisors Network. He also holds leadership roles with the International Society for Magnetic Resonance in Medicine and the American Society for Neuroradiology and is on the editorial board of the *American Journal of Neuroradiology*.

Former RSNA President Ronald L. Arenson, MD, retired from the UCSF position in the fall of 2017.

## Numbers in the News

**50**

Percentage of radiologists estimated to be suffering from burnout. Read more about solutions for battling stress and burnout on Page 8.

**600**

Approximate number of courses in the new RSNA Online Learning Center. Read more on Page 25.

## RSNA Molecular Imaging Roundtable

Thirteen representatives from various subspecialty societies and the National Cancer Institute (NCI) met at the Molecular Imaging (MI) Roundtable, held in November during RSNA 2017. The group discussed the increasing role of MI within the Precision Medicine Initiative and the swift advances in contrast agents, radiotracers and instrumentation that are driving MI technology forward. The group is particularly interested in identifying pathways to mainstream MI into clinical practice and introducing cutting-edge MI into residency/fellowship education and to the next generation of radiologists. Several of the participants are collaborating on an online education portal to provide MI content useful to both clinicians and researchers.

Of special note was the Cancer Imaging Program (CIP/NCI) Investigational New Drug (IND) Directory, a centralized resource to facilitate the sharing of imaging agent IND information. The CIP IND Directory (*http://bit.ly/2jquQlT*) includes both unpublished and published INDs. Readers are invited to submit INDs to this directory by using the online form, or contacting *CIPINDDirectory@mail.nih.gov*.

## Pettigrew Named CEO of New EnHealth Program at Texas A&M

**Pettigrew**

Founding director of the National Institute of Biomedical Imaging and Bioengineering (NIBIB), **Roderic I. Pettigrew, PhD, MD**, has joined Texas A&M, in College Station, TX, to lead Engineering Health (EnHealth), the nation's first comprehensive educational program to fully integrate engineering into all health-related disciplines.

An innovative leader in biomedical imaging and bioengineering, Dr. Pettigrew is CEO of EnHealth and Executive Dean for EnMed, the university's engineering medicine track in partnership with Houston Methodist Hospital. Along with the appointment, Dr. Pettigrew is also the endowed Robert A. Welch Chair in Chemistry at Texas A&M.

Dr. Pettigrew delivered an Opening Plenary lecture and was awarded an RSNA Gold Medal in 2017, and he presented the RSNA 75th Anniversary Diamond Jubilee New Horizons Lecture. He is an elected member of the U.S. National Academy of Medicine and the National Academy of Engineering, and an elected foreign fellow of the National Academy of Science, India.

## Apply Now for RSNA Editorial Fellowships

Applications are being accepted for the RSNA William R. Eyler Editorial Fellowship and the RSNA William W. Olmsted Editorial Fellowship for Trainees.

Both fellowships offer the opportunity to work with *Radiology* Editor David A. Bleumke, MD, PhD, in Madison, WI, and *RadioGraphics* Editor Jeffrey S. Klein, MD, in Burlington, VT. The Eyler fellowship lasts three weeks and the Olmsted fellowship lasts one week.

Each fellow will also visit the Publications Department at RSNA Headquarters in Oak Brook, IL. The Eyler Fellow will work with the *RadioGraphics* editorial team at RSNA 2018.

Apply by May 1 to be considered for the William R. Eyler Editorial Fellowship and April 1 for the William W. Olmsted Editorial Fellowship for Trainees.

To learn more and to apply, visit *RSNA.org/RSNA_Editorial_Fellowships.aspx*.

Radiology | RadioGraphics

## In Memoriam

**William W. Orrison Jr., MD**

**A pioneer of research in magnetoencephalography, William W. Orrison Jr., MD, died on Oct. 19, 2017, at age 68. He was retired from the University of Utah School of Medicine, Salt Lake City, where he served as professor and chairman of radiology.**

**Dr. Orrison's years in medical school at the University of Kansas School of Medicine, Kansas City, were interrupted by his service in the U.S. Air Force. After graduating and completing his double residency in neurology and radiology at the University of Wisconsin, Madison, Dr. Orrison completed fellowships in neuroradiology at Ulleval Hospital, Oslo, Norway, and the University of Wisconsin. He was chief of neuroradiology and later chair of radiology at Keesler Air Force Base, Biloxi, MS, attaining the rank of major. Following his time in the service, Dr. Orrison entered academic medicine at the University of New Mexico, Albuquerque, where he led the medical school's efforts in uroradiology, special procedures, non-invasive diagnosis and MRI.**

**Dr. Orrison authored the well-respected textbook *Neuroimaging*, and wrote four additional textbooks on medical imaging. He was a frequent author and contributor to numerous textbooks and papers and held 11 patents.**

**He served as a member of the RSNA Membership Committee and as a *Radiology* manuscript reviewer.**

# RSNA Board of Directors Report

The RSNA Board of Directors met at RSNA 2017 to assess the Society's many activities over the past year and plan for the future.

### RSNA 2017: Exploring. Inventing. Transforming.


Borgstede

More than 50,000 attendees at RSNA 2017 explored the remarkable innovations transforming radiology. The Connections Center and Discovery Theater continued to be popular spots to relax, network and learn. The Discovery Theater stage offered myriad entertainment and presentations including a lively head-to-head RSNA Diagnosis Live™ game between four residency programs, with the University of Cincinnati taking the trophy.

In addition to the wide range of educational courses and scientific sessions offered at the meeting, attendees participated in standing-room-only hands-on machine learning (ML) sessions and enjoyed the new Fast 5 Session, with five speakers presenting compelling ideas in five minutes. The Machine Learning and Start-up Showcases in the Technical Exhibit halls were also crowd-pleasing additions to the annual meeting.

Popularity of the Virtual Meeting continued with 134 live-streamed and on-demand courses; 23 of the courses were designated for CME credit via on-demand access following the live sessions.

### Planning Underway for RSNA 2018

The Board is already looking forward to the 104th annual meeting. RSNA President Vijay M. Rao, MD, has selected the theme "Tomorrow's Radiology Today" to highlight the extraordinary advances being made every day in our field. The RSNA 2018 plenary speakers are in place and the Image Interpretation Session has been expanded to cover more subspecialties. The Fast 5 Session debuted at RSNA 2017 was so popular that it will be held again in 2018. RSNA and the Asian Oceanian Society of Radiology will present a joint symposium at the Asian Oceanian Congress of Radiology 2018 and RSNA 2018 on multimodality head and neck imaging.

### Educational Programming

The Board approved a proposal to establish an Education Council subcommittee to oversee the entire annual meeting educational program and strive toward program optimization. This subcommittee will be responsible to review current course offerings and all proposals for new ones, develop guidelines for retiring courses and/or educational course tracks, determine appropriate amount of redundancy in course topics, and develop or solicit innovative delivery formats that can be used by all.

The Board also approved the Education Committee's proposal for an invitational workshop in 2018 to discuss an overall vision for RSNA educational programs. This "think tank" will focus on educational trends and environmental shifts in education to fulfill the Society's goals to develop educational content to meet the continuing professional development needs of members in a customized manner, respond to member preferences for and attitudes toward digital delivery of RSNA content, and support innovations in the delivery of education and science content.

### New Journals

The Society will begin publishing three new subspecialty journals in 2019. The journals will be published solely online and will cover cancer imaging, to be launched in January 2019, followed by the launch of ML/artificial intelligence (AI) and cardiothoracic imaging journals.

The subspecialty journals will accept new submissions in 2018 and will provide a forum for transferred submissions within the family of *Radiology* journals. Each journal will contain a mix of original research and topical reviews. RSNA members will receive access to all of these journals as a benefit of membership.

### Collaborating to Highlight Radiology's Value

RSNA will collaborate with the European Society of Radiology, American College of Radiology and Canadian Association of Radiologists to develop a white paper on the value of radiology with a goal to publish in a high-impact general medical journal such as the *New England Journal of Medicine (NEJM)* or *The Lancet*. The objective is to make the case to the larger medical community and policymakers that value-based healthcare (VBH) concepts must position diagnosis as the first and most important patient outcome, and to establish value-based radiology as a necessary concept within the VBH framework.

### RSNA Cosponsors NIBIB Workshop on AI

The Board will cosponsor an NIBIB invitational consensus workshop on AI in medical imaging with Curtis P. Langlotz, MD, PhD, Board liaison for information technology and annual meeting, as the RSNA representative. It is expected to be a two-day meeting in August or September 2018.

### RSNA on ML at ECR 2018

Dr. Langlotz will also represent RSNA as an invited speaker on ML at ECR 2018.

**James P. Borgstede, MD**
*Chairman*
*RSNA Board of Directors*

February 2018 • Volume 28, Issue 2
Published monthly by the Radiological Society of North America, Inc.
820 Jorie Blvd., Oak Brook, IL 60523-2251. Printed in the USA.

Postmaster: Send address corrections or changes to: *RSNA News*, 820 Jorie Blvd., Oak Brook, IL 60523-2251

Non-member subscription rate is $20 per year; $10 of active members' dues is allocated to a subscription of *RSNA News*.



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# LOOK AHEAD

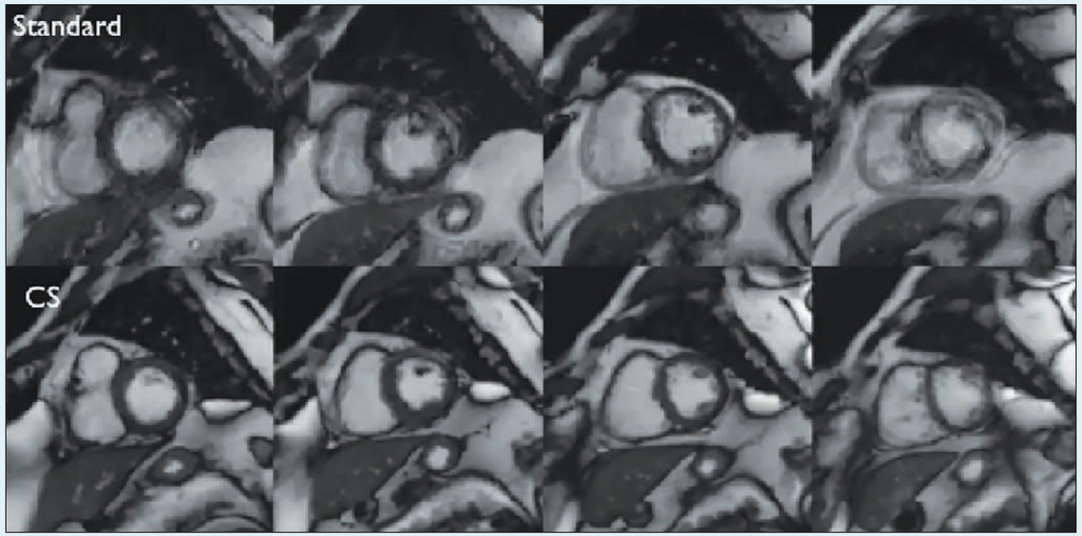
## *The Future of Cardiac MRI*

BY JAMES CARR, MD

> *"As CMR becomes simpler, quicker and easier to use, it will become more widely adapted in routine clinical practice"*
>
> JAMES CARR, MD

It has now been over a decade and a half since cardiac MRI (CMR) made its advent onto the medical diagnostic scene with much promise and fanfare about finally achieving the elusive goal of becoming the comprehensive cardiac exam. Certainly early on it looked like CMR would be able to provide functional and structural information together with direct noninvasive visualization of the coronary arteries with coronary MR angiography (MRA) in a single study. As with most things in medicine, the world did not sit still as another modality, CT angiography, quickly replaced the more complex, time-consuming coronary MRA acquisition. Despite this minor setback, CMR continued to progress with leaps and bounds and has now become a routine test for evaluating cardiac disease, particularly for common indications such as ischemic heart disease and heart failure. So, where does this maturing diagnostic modality go from here? There are many advances on the horizon, which will make CMR a more clinically accepted tool, while at the same time helping us better understand the mechanisms that cause cardiac disease in a noninvasive manner.

**JAMES CARR, MD,** is director of cardiovascular imaging and vice chair for research in the Department of Radiology at Northwestern University Feinberg School of Medicine. Dr. Carr is the Knight Family Professor of Cardiac Imaging and professor of radiology, internal medicine and biomedical engineering. He is an immediate past president of the Society for Magnetic Resonance Angiography and is a member of the executive board of the Society for Cardiovascular MR. He is also on the program committees of RSNA and the International Society of Magnetic Resonance in Medicine, as well as co-chair of the RSNA Vice Chairs of Research Group.




***Top row*: Segmented cine MRI in a patient with atrial fibrillation has marked motion artifact due to arrhythmia. Each slice is a seven-second breath hold. *Bottom row*: Compressed sensing real-time cine MRI in the same patient has no motion artifact despite arrhythmia. The entire heart is covered free breathing in 24 seconds.**

### MRI Acceleration Strategies Will Help Simplify, Shorten Routine CMR Exam

The current CMR exam is considered by most to be absolutely not "routine," due to its complexity and time-consuming acquisition. The standard protocol consists of cine MRI in multiple cardiac orientations followed by delayed enhanced imaging after an injection of gadolinium contrast. Each image is acquired as a single slice during breath holding, making for a long exam, which is best suited for cooperative patients. Additionally, ECG gating is required to overcome the effects of cardiac motion, therefore ECG leads have to be attached at the beginning of the study (which prolongs the patient preparation time) and it is preferable that patients be in sinus rhythm in order to avoid significant degradation caused by motion artifact. Adding to that, CMR is not easy, requiring knowledge about cardiac anatomy and cardiac planes as well as familiarity with complex pulse sequences. Several strategies will become available over the coming years that will help simplify the current CMR protocol and speed it up significantly.

First, compressed sensing, which has been applied in other modalities such as CT, can speed up the MRI acquisition four- to five-fold. With CMR, this may allow the entire heart to be imaged in a single breath hold, or alternatively may facilitate rapid, free-breathing real-time cine MRI of the heart with comparable image quality to the routine "slower" segmented approach (Figure 1). Second, self-gating strategies for respiratory and cardiac gating, where motion is recorded in line during the MRI acquisition, will permit so called "leadless" cardiac imaging during free breathing, thereby markedly simplifying and shortening the entire CMR protocol. Third, automated computer algorithms are currently being integrated into the user interface software, where cardiac imaging planes are set up automatically, thereby simplifying the exam for the technologist. Finally, post-processing tools will become fully automated in line and will use deep learning strategies to improve analysis over time. Before long we will attain the holy grail for the routine CMR exam, leadless rapid 3-D cine and delayed enhanced imaging with automated slice reconstruction and inline calculation of cardiac functional parameters, all in less than 15 minutes.

### MRI Reveals More About Microstructural Properties of the Heart

The routine CMR protocol of cine and delayed enhanced imaging provides about 80 percent of what we need and want to know about cardiac disease. Once we can shorten this to less than 15 minutes, we can spend more time focusing on what is going on at the microscopic level using mapping techniques. As we know, MR images are created from differences in T1 and T2 relaxation times between different tissues providing qualitative depictions of anatomy.

With recently developed mapping techniques, T1 and T2 can be measured quantitatively in different tissues and can be used to more accurately characterize pathology and normal tissue structures. T2 mapping to detect abnormally high T2 values, which are used as a surrogate for edema, can be used to image inflammatory conditions such as myocarditis and transplant rejection. With T1 mapping, abnormally high T1 values are seen with myocardial fibrosis and short T1 values are seen in iron deposition.

A relatively novel parameter called the extracellular volume fraction (ECV) is calculated from T1 values pre- and post-contrast and the patient's hematocrit. ECV values are very sensitive to myocardial fibrosis and are high in any condition that causes myocardial fibrosis, such as hypertrophic cardiomyopathy and in infiltrative disorders such as cardiac amyloidosis. Using these techniques, CMR is rapidly becoming a quantitative imaging tool, in which imaging biomarkers are routinely calculated and becoming part of the imaging report. Acceleration techniques will also shorten these acquisitions, perhaps with 3-D imaging, and automated algorithms will calculate values in line. It is only a matter of time before deep learning strategies will integrate MRI-derived imaging biomarkers with clinical parameters to predict outcomes and potential response to therapies.

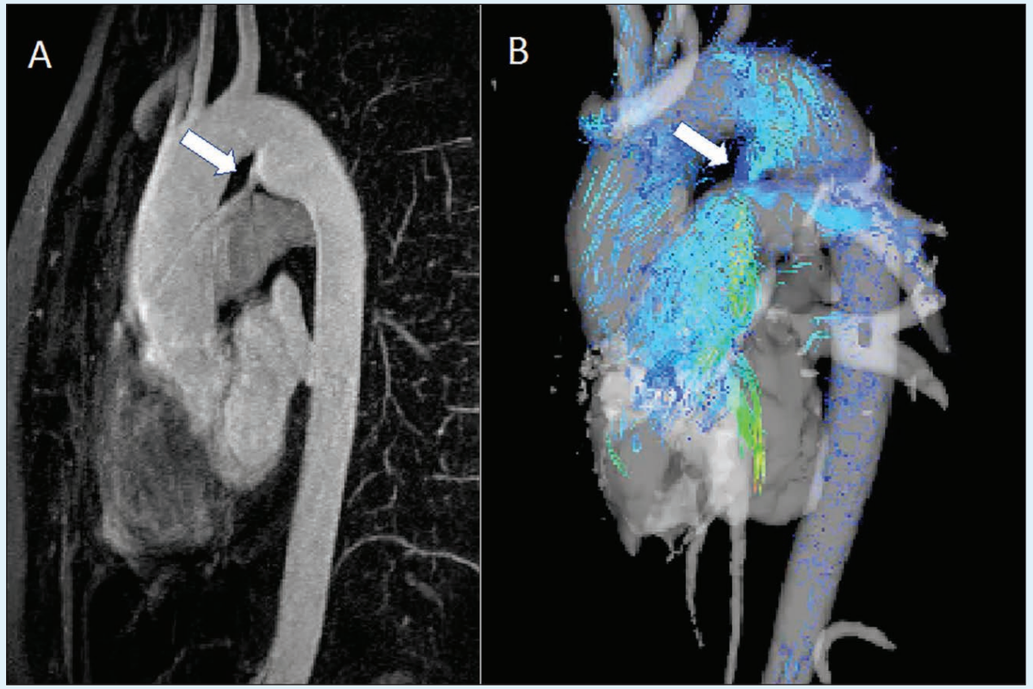
### 3-D Hemodynamic Flow Imaging Demonstrates the Heart and Vessels in Exquisite Detail

Phase contrast MRI (PC-MRI) is the basic technique for measuring velocity in the heart and vascular system and flow can be calculated from that data. 2-D PC-MRI is limited in that it is only able to encode velocity in one direction. For instance, if the jet is off axis to the imaging place, the velocity will be underestimated because only a vector of the true velocity is being measured. Additionally, conventional PC-MRI is a 2-D acquisition and is therefore dependent on accurate placement of the imaging slice at the region of interest.

With 4-D flow MRI, the velocity is encoded in the x, y and z directions during the same acquisition, permitting full representation of velocity fields in multiple directions and allowing visualization of vortical and turbulent flow. Additionally, the data is acquired spatially in three dimensions allowing larger anatomic regions to be imaged. This technique has proven to be useful clinically in regions and pathologies where the cardiovascular anatomy is complex, such as congenital heart disease (Figure 2) or thoracic aortic aneurysms. Novel imaging biomarkers, such as wall shear stress and energy loss, can be derived from 4-D flow MRI data and may help us better understand mechanisms of certain diseases such as aneurysm formation associated with bicuspid aortic valve disease. A disadvantage of 4-D flow MRI is the long acquisition time, sometimes over 12 to 15 minutes, which is highly disruptive to an already complex and lengthy CMR protocol. Acceleration strategies based on parallel imaging and compressed sensing may be particularly beneficial to 4-D flow MRI and have already been shown to reduce acquisition times in the aorta to less than two minutes. Similarly, post processing is onerous and complicated, however, newer easy-to-use tools have become more widely available and promise to make this technique more applicable and practical in the clinical setting.

### Future Expectations

As CMR becomes simpler, quicker and easier to use, it will become more widely adapted in routine clinical practice. CMR has the advantage of identifying disease to the microstructural level, which gives it a distinct advantage over other modalities such as echocardiography. Newer hybrid systems, such as PET-MR, will facilitate the combination of structure-function imaging with MRI and molecular imaging with PET, opening the gates to true diagnostic precision medicine.




**Patent ductus arteriosus. A. MRA of thoracic aorta shows a patent ductus arteriosus (PDA) between descending thoracic aorta and main plumonary trunk. B. 4-D flow MRI also shows PDA with flow from aorta to pulmonary circuation. The shunt can be calculated directly from 4-D flow MRI.**

*Editor's Note*: This is the final article in a series examining the impact of stress and burnout on radiologists.

# PATIENT INTERACTION
## May Help Mitigate Radiology Burnout

BY FELICIA DECHTER

Burnout is a hot-button issue for doctors across the entire medical spectrum — including in radiology. In fact, one 2017 study estimates that 50 percent of radiologists are suffering from burnout, which manifests in a variety of ways.

*"Ultimately, if we are able to keep the patient at the center of our activities, we can mitigate against burnout."*

CHERI CANON, MD

But because the causes of burnout are often multi-layered and continue to shift with the changing health-care environment, reversing and/or preventing radiology burnout does not happen overnight. Solutions can be as complex as the root causes, experts say.

Nevertheless, the most effective strategies tend to begin at the same place: the beginning.

"We must remember why we decided to enter the field of medicine in the first place," said Cheri Canon, MD, a professor and the Witten-Stanley Endowed Chair of Radiology at the University of Alabama at Birmingham School of Medicine, who presented a session on burnout solutions at RSNA 2017. "Ultimately, if we are able to keep the patient at the center of our activities, we can mitigate against burnout,"

Recent research from the Mayo Clinic found that spending one day a week doing truly meaningful work, such as with patients, may help prevent burnout, Dr. Canon said. "I often say that we should remember that behind every pixel in our PACS is a patient, and our clinical decisions will have far-reaching implications for them," she said.

Patient interaction is also key to a 2017 study, "A Picture of Burnout: Case Studies and Solutions Toward Improving Radiologists," which recommends that radiologists, who often work in isolation, strive to increase their visibility in patient care.

The study, published in the journal *Current Problems in Diagnostic Radiology*, estimates that radiology has a 50 percent burnout rate and ranks the specialty 10th out of 25 surveyed in terms of burnout.

Lead author Nicole Restauri, MD, an assistant professor of radiology at the University of Colorado School Of Medicine, Aurora, created fictional cases focusing on common sources of burnout, including isolation. In one case, a small-town radiologist moves to an academic setting where he interacts with colleagues far less frequently than at his previous workplace. Soon he is feeling stressed and isolated.

Canon

Restauri

"Increasing isolation played a significant role in developing symptoms of emotional exhaustion and depersonalization," according to Dr. Restauri, who named lack of autonomy and control over the work environment, the absence of meaningful work and the changing healthcare landscape as other sources of radiology burnout.

Along with increasing patient interaction, the authors also recommend that radiologists engage more with their colleagues as part of a multidisciplinary team, which increases feelings of value and connectivity. And radiologists should cut back on less rewarding, non-physician-related tasks such as paperwork when possible.

### A Two-Tiered Solution

Ultimately, burnout solutions occur at two levels — organizational (system level) and individual — and successful solutions take both into account, Dr. Canon said. A culture shift must take place in which healthcare engages in a dialogue with physicians to develop solutions that can be implemented on both levels.

Another common source of radiology burnout — lack of leadership skills — is one area the organization and physician can work on together, Dr. Restauri said.

For example, a second case in her vignette involves a radiologist whose once positive work attitude spiraled after he was asked to lead a committee — with disappointing results. Even though he completed significant goals, he felt that his recommendations were disregarded and the institution failed to implement key components, negating the value in hours of hard work.

"Communication at this radiologist's practice was poor and he did not receive the proper amount of feedback, promoting a diminished sense of accomplishment in a physician who was initially engaged and productive," Dr. Restauri said.

Possible solutions include leadership training and regular assessment of leadership performance, programs focusing on communication skills and conflict management, and productive feedback. Dr. Restauri also recommends using both executive and personal coaches — the latter charged with treating burnout with mindfulness practices and values clarification.

Validated assessment tools including the Maslach Burnout Inventory and the Mayo Clinic Physician Well–Being Index are available to measure burnout, Dr. Restauri said. Self-monitoring will become an important aspect of mitigating burnout, but only if organizations begin to engage in a dialogue with physicians to develop solutions that can be implemented on an organizational as well as individual level, she said.

On an individual level, experts suggest solutions that center on physical and psychological well-being and create a healthy work-life balance. Dr. Canon suggests exercise, yoga, mindfulness practice, adequate sleep and nutrition to name a few.

"Taking care of our own bodies is the first step toward being effective at taking care of others," she said.

# Art and Radiology Intersect in 2017 RSNA Image Contest

BY JENNIFER ALLYN

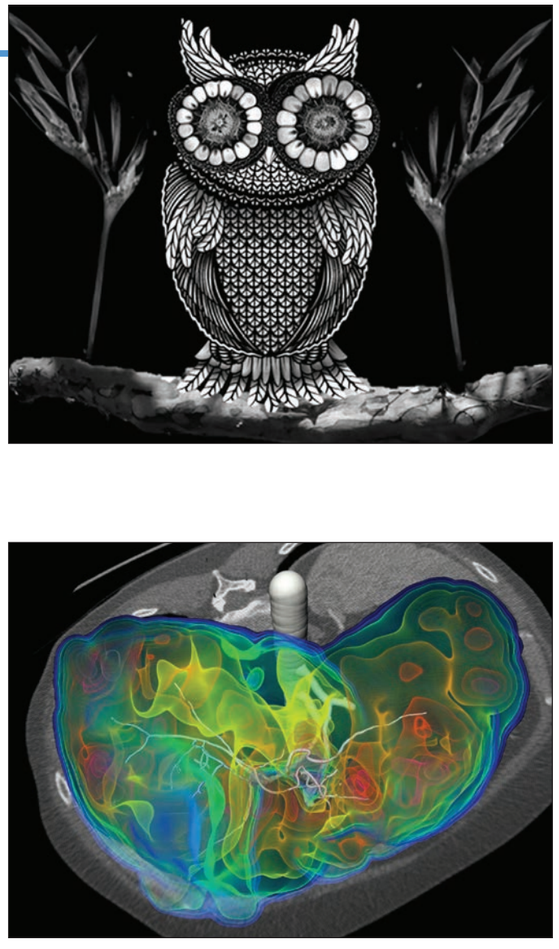
Much like beauty, art is in the eye of the beholder. When viewing art, each of us will have our own interpretation. And interpretation — on the part of the viewer and the artist — was key to the submissions and winners of the online 2017 RSNA Image Contest.

A SAMPLING OF SUBMISSIONS ALONG WITH THE WINNING IMAGE IN EACH CATEGORY ARE PICTURED BELOW. ALL IMAGES SUBMITTED FOR THE RSNA IMAGE CONTEST CAN BE VIEWED AT *RSNA.ORG/IMAGE-CONTEST*.

## *Radiology Art*

### Bad Omen or Wise Advisor?
*(First Place)*

Junren Ong
*Singapore*



### Multimodality Contortionist v 2.0

Marin Halut, MD
*Belgium*





### Individual Dose of Color

Nadine Spahr
*Germany*

More than 275 creative submissions from around the world were judged in three categories: Radiology Art, Radiology Hobbies and Best Photo.

This was the fourth year of the RSNA Image Contest that asked radiologists to go beyond their daily medical imaging and demonstrate their artistic flair. Throughout October, visitors were invited to view submissions on the RSNA website and vote for their favorites. Top vote-getters were announced during the annual meeting and the top five winners in each category were on display at RSNA 2017 and posted online (see Web Extras).

For Yu Luo, PhD, MD, who placed first in the Best Photo category with his submission, "Planet Crowded Outer Space" and second in the Radiology Art category with his submission, "Low Dose 'High Resolution' CT Scan," revealing the beauty beyond the limitations of the naked eye is something radiologists do every day.

"I always try to extract as much information as possible from images, so while I am doing my job, I also may notice little extras, such as the text on the patient's shirt seen in my Radiology Art submission," said Dr. Luo, chief of pediatric musculoskeletal radiology at Monroe Carell Jr. Children's Hospital at Vanderbilt University, Nashville. "I'm always amazed by how much information is in a CT scan — even beyond the medical imagery."

Revealing the potential design within an image was a new experience for the winner of the Radiology Art category, Junren Ong, a radiographer from Sengkang General Hospital, Singapore. "Prior to this image contest, I would have expressed doubts about what a radiology image can do other than answer clinical questions," Mr. Ong said. "Now I see that radiology art can be make a statement and communicate thoughts and feelings in a different way."

#### Artwork Can Educate Patients

Communicating in a different way is at the crux of many of the submissions, since the image work that radiologists do on a daily basis is often black-and-white, literally.

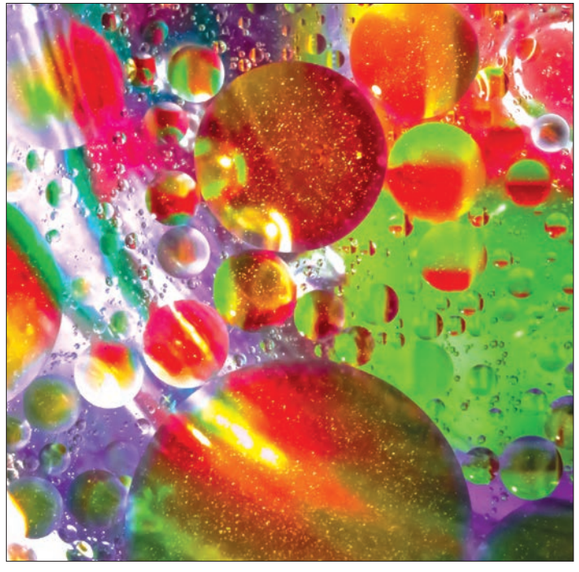
"When we produce materials to show data or ideas, radiologists focus on accuracy and being concise, but we are rarely influenced by whether or not the material is visually appealing," said Belén Del Rio, MD, a radiology resident at Consorci Sanitari de Terrassa Hospital, Barcelona, Spain and winner of the Radiology Hobbies category for his submission, "Need to Know:

*Continued on next page*

## *Best Photo*

### Planet Crowded Outer Space *(First Place)*

Yu Luo, MD, PhD
*United States*

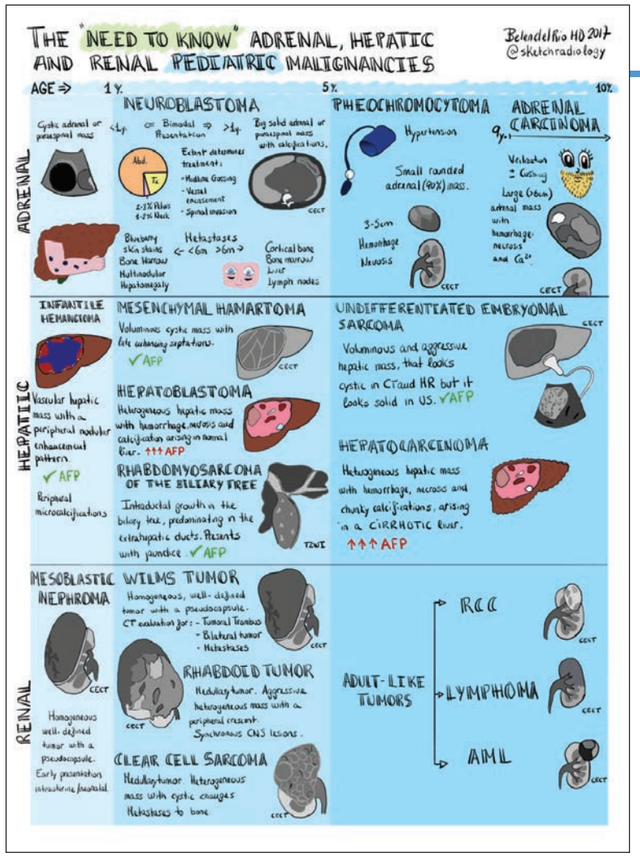


**ON THE COVER**

## *Best Photo*

### Art

Yu-hui Huang, MSc
*United States*




*Continued from previous page*

## *Radiology Hobbies*

### The "Need to Know" Adrenal, Renal and Hepatic Pediatric Malignancies

*(First Place)*

Belén Del Rio, MD
*Spain*

Adrenal, Renal and Hepatic Pediatric Malignancies."

"With my drawings, I try to present the same information in a way that is simple and attractive, and I believe this helps to educate the audience."

Many RSNA Image Contest participants agree that such contests can help patients, and even other physicians, better understand radiology.

Dr. Luo, who shares his creations in photography and video on Instragram (*@yu.luo.01*), knows that art can have a big impact on patient understanding.

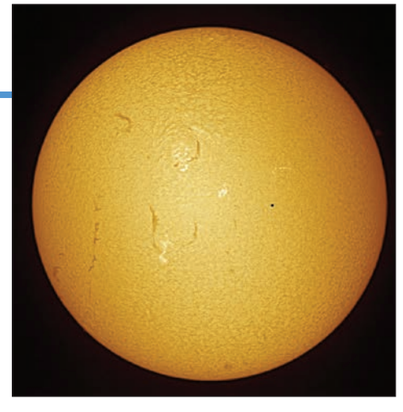
"When I showed patients my submission where the CT revealed the text on a t-shirt, they were amazed and asked questions not just about the submission, but about the technology," Dr. Luo said. "That is where art and radiology intersect, at the point where a patient's questions move from, 'How did you do that?' to 'What can this machine do and how does the radiologist use it to help me?'"

Dr. Del Rio, who has always been an enthusiast of illustration and graphic design and posts his designs on Twitter (*@sketchradiology*), would agree. "I think that presenting information in a graphic way makes understanding easier," Dr. Del Rio said. "Since radiologists link concepts with images, this has helped me in my training to remember ideas and can also help patients understand what we do in radiology."

## *Radiology Hobbies*

### Mercury Eclipse

Asif Iqbal, MBBS
*United Kingdom*



*"Now I see that radiology art can make a statement and communicate thoughts and feelings in a different way."*

JUNREN ONG, MD

**WEB EXTRAS**

View all images submitted for the RSNA 2017 Image Contest at *RSNA.org/Image-Contest*.

# Radiology Experts Aid in Updating New Cancer Staging Manual

BY STEPHAN BENZKOFER

Although the *American Joint Committee on Cancer (AJCC) Staging Manual* was first published 40 years ago, it was not until its newest edition that the manual was edited with radiologists in mind.

For the first time, the *AJCC Staging Manual,* Eighth Edition, which was published on Jan. 1, includes input from expert radiologists and was edited to bring consistency to the imaging sections, said Daniel C. Sullivan, MD, professor emeritus, the Department of Radiology, Duke University, Durham, NC.

Dr. Sullivan, who recommended imaging experts for each cancer specialty, was recruited by AJCC and the Union for International Cancer Control, which maintains and updates the manual and its tumor, node, metastasis (TNM) staging classification.

"These organizations recognized that imaging is important for staging in all solid tumors," said Dr. Sullivan, who is hopeful that the new edition will win over more radiologists who traditionally have not been rigorous in explicitly including cancer staging data in their reports (e.g., specific statements about tumor size, status of nodes and presence or absence of invasion or metastases).

The manual serves a dual purpose. First, it helps oncologists and hospital tumor boards more quickly and accurately classify a cancer and discern the most effective course of action for treatment.

Arguably more important is the consistency the manual provides. The updated manual now allows doctors and researchers to speak the same language and build databases of vital information about how different cancers present at different stages and how they react to treatment, which will in turn become the basis for updating future editions.

"We can begin to better understand tumor treatment and the tumor pathophysiology," said Christine Glastonbury, MD, a neuroradiologist at the University of California, San Francisco, who served as an expert on the head and neck chapter of the manual.

A prime example in the eighth edition occurs with the human papillomavirus (HPV)-related oropharyngeal cancers. It is more likely now in the U.S. and many other parts of the world that these throat cancers are caused by the virus rather than tobacco and alcohol use, Dr. Glastonbury said.

*"These organizations recognized that imaging is important for staging in all solid tumors."*

DANIEL C. SULLIVAN, MD

"These often present with large neck nodes and such tumors are frequently designated as stage 4," Dr. Glastonbury said. "But, it turns out that HPV-related tumors respond much better to treatment than tobacco-related tumors and the patients have a much better prognosis, so in the new staging system, HPV-related oropharyngeal cancers will be lower in staging and more frequently stage 1 or 2. It reflects what we have learned in the last seven years."

Such a staging change would greatly benefit patients on an emotional level as well, Dr. Glastonbury said. "If somebody tells you that you have stage 4, can you imagine how that feels? This will be a huge mental relief."

**Glastonbury**

**Sullivan**

### Personalization Increases Complexity

But as treatment becomes ever more personalized, cancer staging becomes even more complicated.

According to the AJCC website, "This edition features 12 entirely new staging systems, a wide range of changed or new staging definitions, and a refined emphasis on a personalized-medicine approach."

That added complexity creates a challenge for physicians like Drs. Sullivan and Glastonbury, who believe passionately that medical outcomes — and the radiology field — benefit greatly when more of their peers are more closely involved.

First, some radiologists may not understand what information is needed for staging. Second, doctors may be reticent to report an exact measurement — of a tumor mass or node, for example — when the vagaries of the modality, the machine and the image might make exactitude impossible.

But being familiar with the cancer staging manual doesn't mean memorizing it. But recognizing the nuances of different cancers — for example, knowing which nodes are important in a lung CT — will aid radiologists in writing a report that is as useful as possible for the patient's doctor.

And new tools are available to make the manual more accessible, including an abridged version of the Eighth Edition. In addition, structured dictation templates are available for each cancer type.

"Radiologists often feel we have to prove our value," Dr. Glastonbury said. "That is the new catchword in radiology, actually: Value. You hear it everywhere. And it is valuable to the surgeons and oncologists we work with to provide as much information as possible from the scan that is going to affect the patient's stage. What we as radiologists do is very important. We want to be as good at it as we can be. The new cancer staging manual helps with that."

**WEB EXTRAS**

Access the American Joint Committee on Cancer (AJCC) Staging Manual at *Cancerstaging.org*.

*Editor's Note*: *RSNA News* will continue to focus on machine learning in a series of articles in 2018.

# Machine Learning is Revolutionizing Radiology

## The Reality of Deep Learning/Artificial Intelligence in Radiology: They Will Redefine the Specialty

BY MIKE BASSETT

While there has been a lot of hype — and even fear — about the role deep learning (DL) and artificial intelligence (AI) play in radiology, the reality is that they are both potentially useful technologies that will add value to the specialty in a number of ways.

"Deep learning is not going to replace us," said Paul Chang, MD, of the University of the Chicago School of Medicine, during an RSNA 2017 session. "But it will redefine us."

And radiology will need this technology more than ever due to the increasing demands on clinical imaging. Data sets are getting more complex and there is an increasing need to correlate images with other clinical information in order to implement practices such as radiogenomics, Dr. Chang said.

"So deep learning will help us because we are going to need something — we need some tool — some mechanism — to meet these new imaging challenges," Dr. Chang said. "We are going to need some kind of cybernetic help to get through a day's work and help us maintain and improve quality.""

### Infrastructure Remains a Challenge

But these are early days when it comes to incorporating DL and AI into the practice of radiology, and numerous challenges still exist.

> *"We should be looking for the minimially heuristic use case sweet spot like workflow optimization."*
>
> PAUL CHANG, MD

For example, how can radiology confidently validate the performance of these new technologies?

"Deep learning is a great name for it because it has two meanings," Dr. Chang said. "It can mean 'very capable' or deep as in 'deep waters' or 'obscure,' and that's the problem.

"There are very deep layers to deep learning systems and it's very difficult to understand why they work."

Comprehending DL requires the use of cases and tons of data.

But radiologists really can't get compelling use cases unless they have the necessary data and infrastructure, Dr. Chang said.

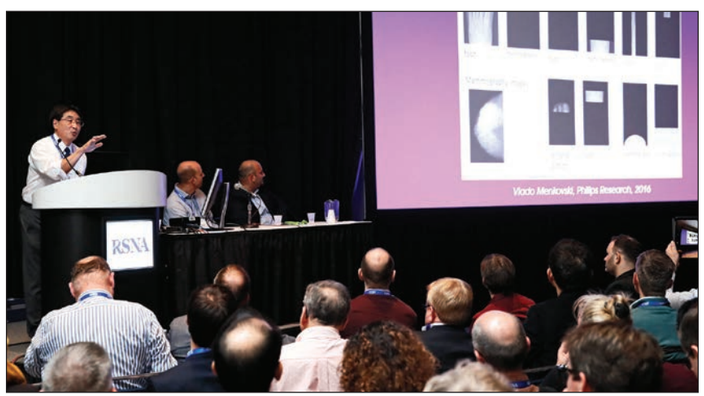
Which brings up another challenge. Radiology doesn't have the infrastructure to either feed, train or consume these systems.

"Other industries have really revved up for cloud computing and big data and are ready to consume deep learning, because deep learning loves that kind of environment," Dr. Chang said. "Radiology is still struggling with electronic medical records and PACS and we generally don't have a true IT infrastructure that can feed and consume these systems."

The specialty should first pursue a "hedge strategy" by building infrastructures necessary to prepare for the cloud and big data, registries and advanced analytics, as well as DL, he said.

Dr. Chang offers an analogy: "During the Gold Rush," he said, "everyone went out west to dig for gold. Most miners either failed or died, but there were people who thrived — the people selling the miners the shovels."

"The bottom line is that deep learning won't replace people — it will enhance them," Dr. Chang said. "We should be looking for the minimally heuristic use case sweet spot like workflow optimization. Something that isn't sexy, but is an easy win, saves money, and improves lives."




**Chang**

**WEB EXTRAS**

View a video interview with Dr. Chang discussing machine learning at RSNA 2017 at *RSNA.org/News*.

## AI Key to Noninvasive Biomarker Development in Lung Cancer

BY RICHARD DARGAN

Artificial intelligence (AI) is playing a pivotal role in the development of new imaging biomarkers for lung cancer, according to recent research.

Researcher Hugo Aerts, PhD, from Harvard University in Cambridge, MA, likened the impact of AI on radiology to that of self-driving cars on transportation. Just as self-driving is capable of exceeding human performance in some instances, AI can assist radiologists in areas where they have limitations, such as determining if a lung nodule found on screening is benign or malignant.

"Benign and malignant nodules often look similar to humans," Dr. Aerts said during an RSNA 2017 session. "By finding very subtle differences in the nodules, AI can go beyond human performance."

Current methods for sampling lung tumors such as invasive needle biopsy have limitations, Dr. Aerts said, as they are often unable to fully capture the spatial state of the tumor. In contrast, radiomics, which represents the quantification of tumor characteristics through medical imaging, is ideally suited to tracking a tumor's ph ysical characteristics before, during and after treatment. Medical imaging offers the additional advantage of being a noninvasive technique that can be performed with minimal risk or inconvenience to the patient. And the use of deep learning (DL), a subset of AI, provides access to an immense amount of data that allows the radiologist to draw more accurate conclusions.

"Through the application of AI in radiology, we can extract more information from the image than meets the eye, improving treatment for the patient," Dr. Aerts said.

Dr. Aerts cited a 2014 study in which he and colleagues performed a radiomic analysis of 440 features quantifying tumor image intensity, shape and texture, extracted from CT data of 1,019 patients with lung or head-and-neck cancer. The results showed that a large number of radiomic features have prognostic power in independent data sets from these patients, many of which were not identified as significant before.

**Aerts**

> *"AI will change how radiology is practiced, but will not remove the need for radiologists."*
>
> HUGO AERTS, PHD

"You need to know the volume and extent of a tumor for treatment, but it's much more difficult to predict survival," Dr. Aerts said. "Through DL, we can find characteristics that predict if patients will have good outcomes. It is replacing what is already done and improving it."

**Daily Bulletin coverage of RSNA 2017 is available at *RSNA.org/Bulletin*.**

In a 2017 study of 262 North American and 89 European patients with lung cancer, Dr. Aerts and colleagues identified previously undescribed associations among radiomic imaging features, molecular pathways and clinical factors. A number of imaging features like intra-tumor heterogeneity showed predictive value for specific disease pathways.

"Several biomarkers have been discovered in research settings and hopefully will be in the clinic within the next few years," Dr. Aerts said.

While interest in AI is high, he cautioned that the hype around AI might have negative consequences for radiology if it encourages the mistaken notion that machines will eventually take over.

"AI will change how radiology is practiced, but will not remove the need for radiologists," Dr. Aerts said.

***MACHINE LEARNING*** *continued on next page*

# Deep Learning Shows Potential for Accurately Reading Mammograms

BY MIKE BASSETT

The use of deep learning (DL) technology could help radiologists increase the quality of breast cancer screening programs, lower costs, and reduce the variability in the cancer detection process.

And the role of DL technology in imaging doesn't stop there. In fact, it is likely that DL computers can be trained to read mammograms as well as radiologists and — in the future — maybe even outperform them, said presenter Nico Karssemeijer, PhD, a professor of computer-aided diagnosis (CAD) at Radboud University Medical Center Nijmegen, the Netherlands, during an RSNA 2017 session.

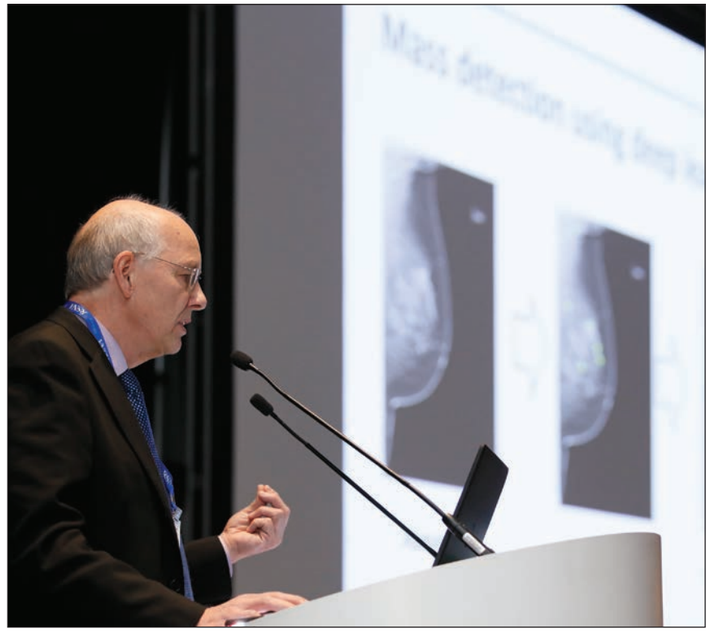
It is possible that radiologists — even when working with high performance equipment under optimal conditions — can fail to detect breast cancer. Dr. Karssemeijer said that the development of CAD systems was supposed to help address the problem of undetected cancers in screening mammography.

"But CAD hasn't delivered on what it was intended to do," said Dr. Karssemeijer, also director of ScreenPoint Medical BV, a developer of DL and image analysis technology in Nijmegen.

Advances in DL technology, however, show that artificial neural networks can be trained to perform the same tasks as humans. And, according to Dr. Karssemeijer, reading screening mammograms is a task where the conditions are ideal for the application of DL, considering it is a repetitive task for which large amounts of data are available for training.

An example of the potential utility of DL in screening mammography was demonstrated in another presentation, "Detecting Breast Cancer in Mammography: How Close Are Computers to Radiologists?" by Dr. Karssemeijer and colleagues.

In the study, researchers compared the performance of a DL computer detection system to that of six radiologists in detecting breast cancer using digital mammography.



**Karssemeijer**

The radiologists retrospectively reviewed 155 exams (73 malignant and 82 negative exams, of which 42 were biopsy-proven benign lesions, and 40 normal cases defined as BIRADS 1 or 2). The DL computer system was applied to the same dataset.

The researchers found that the receiver operating characteristics area under the curve was 0.83 (CI: 0.76-0.90) compared to 0.79 (CI: 0.72-0.86) for the DL system, suggesting that there was no statistical difference in the average performance of the six radiologists compared to the DL system.

## DL Aids Radiology Decisions

According to Dr. Karssemeijer, the key to improving the reading of screening mammograms is not necessarily the detection of suspicious areas on mammograms, but in making decisions about which ones radiologists should act on.

"When we develop these systems further we can get beyond the level of human performance and move to a situation where radiologists will always be involved, but more in the sense of checking computer output rather than doing first reads themselves. So that's a good sign for the future of screening mammography."



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### *NIH Grant Awarded to RSNA Research Scholar Grant Recipient*

**Manu S. Goyal, MD, MSc,** a 2015 ASNR/RSNA Research Scholar Grant recipient, secured a Research Project Grant (R01) from the National Institutes of Health (NIH) National Institute on Aging, along with co-principal investigator, Andrei Vlassenko, MD.

Dr. Goyal, assistant professor of radiology and neurology at the Mallinckrodt Institute of Radiology at Washington University School of Medicine, St. Louis, and fellow researchers will study whether levels of aerobic glycolysis in the brain provide resilience against aging and neurodegeneration. Specifically, researchers will study brain atrophy, aging-related changes in cognition and clinical conversion to mild-cognitive impairment or Alzheimer's disease (AD). Dr. Goyal is also a co-investigator on a separately funded R01 project with Dr. Vlassenko and Marcus Raichle, MD, focusing on how brain metabolism relates to AD biomarkers.

"The RSNA Research Scholar Grant was critical in getting me to this point, both in terms of protecting my research time and also in providing access to the RSNA NIH Grantsmanship Workshop, where I was able to develop my protocol for this R01 submission," Dr. Goyal said.

**Goyal**

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## Education and Funding Opportunities

### Register Now for the RSNA Writing a Competitive Grant Proposal Workshop

**March 16-17**
**RSNA Headquarters**
**Oak Brook, IL**

To secure your seat for this 1.5-day workshop or to get more information, visit: *RSNA.org/CGP.* The registration fee is $225. Contact the department of research with questions at *DOR@rsna.org* or 1-630-368-3742.

### RSNA/ASNR Comparative Effectiveness Research Training (CERT) Program

**Application Deadline**
**April 30**

RSNA and the American Society of Neuroradiology (ASNR) jointly sponsor the Comparative Effectiveness Research Training (CERT) Program, an interactive course in comparative effectiveness research (CER), targeted to junior faculty and senior trainees in imaging science.

The CERT program provides an introduction to the methodology and tools for performing CER, including technology assessment, risk benefit analysis, cost-effectiveness evaluation, decision analysis, meta-analysis and systematic review.

Beginning in July 2018, the CERT program includes a series of online modules, a 1½ day in-person workshop (held October 4–8 at RSNA Headquarters in Oak Brook, IL) and web-based didactic lectures and grant proposal review discussions.

Accepted participants are responsible for travel expenses and hotel accommodations. There is no fee for this course. Apply at *RSNA.org/CERT* or contact RSNA staff at *dor@rsna.org* with questions.

# Journal Highlights

The following are highlights from the current issues of RSNA's two peer-reviewed journals.

## Shoulder Injuries in the Overhead-Throwing Athlete: Epidemiology, Mechanisms of Injury, and Imaging Findings

Radiology

The unparalleled velocity achieved by overhead throwing subjects the athlete's shoulder to extreme forces, resulting in both adaptive changes and pathologic findings that can be detected at imaging, according to an online article in the February issue of *Radiology* (*RSNA.org/Radiology*).

Dana J. Lin, MD, from Columbia University Medical Center, New York, and colleagues discuss the epidemiology and biomechanics of throwing injuries.

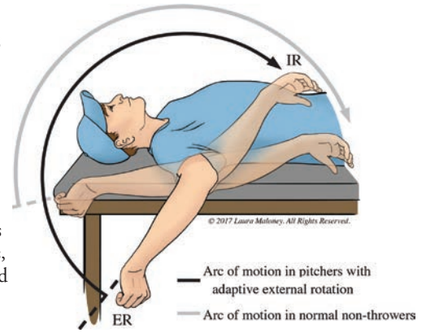
The dominant shoulder of the throwing athlete develops an adaptive increase in external rotation through both soft tissue and osseous changes, including asymmetric capsular tightness, with loose anterior and tight posterior capsules, humeral retrotorsion and glenoid retroversion.

Most shoulder injuries occur at extremes of external rotation, therefore this initially adaptive change can lead to pathologic injury. Glenohumeral internal rotation deficit (GIRD) and internal impingement are closely related entities that explain other associated pathologic findings that can be concurrently seen at imaging, such as superior labrum anteroposterior (SLAP) tears and partial-thickness rotator cuff tears.

In addition, several less well-known but unique injuries can occur elsewhere around the shoulder, including anterior capsular tears, subscapularis tendon and lesser tuberosity injuries, posterior muscle injuries and glenoid osteochondral injury.

MRI is the preferred imaging modality for evaluation of overhead throwing patients after initial x-rays. Ultrasound can be used to evaluate for rotator cuff tendinopathy or tendon vascularity, or with dynamic maneuvers, to replicate posterosuperior impingement. CT is helpful to evaluate for osseous pathologic findings, such as a Bennett lesion or lesser tuberosity avulsion.

"Given the widespread popularity of baseball, and other sports relying on overhead throwing motions at all playing levels from recreational to professional, it is important for radiologists in various practice settings to be familiar with the special mechanisms, locations and types of shoulder injuries seen in the overhead throwing population," the authors write.




**The normal total arc of motion in nonthrowers is approximately 180° with equal degrees of external rotation (ER) and internal rotation (IR) (gray arc). To achieve higher velocities, overhead athletes develop adaptive osseous and soft tissue changes that allow for increased maximum external rotation (black arc), which can be detected with passive manipulation of the shoulder at physical examination when the patient is lying supine on the examination table.**

Listen to former *Radiology* Editor Herbert Y. Kressel, MD, deputy editors and authors discuss the following articles in the December issue of *Radiology* at *RSNA.org/Radiology-Podcasts.*

Radiology PODCASTS

- "BI-RADS Category 3 Comparison: Probably Benign Category after Recall from Screening before and after Implementation of Digital Breast Tomosynthesis," Elizabeth S. McDonald, MD, and colleagues.
- "Feasibility of Dose-reduced Chest CT with Photon-counting Detectors: Initial Results in Humans," Rolf Symons, MD, and colleagues.
- "Automated Critical Test Findings Identification and Online Notification System Using Artificial Intelligence in Imaging," Luciano M. Prevedello, MD, MPH, and colleagues.

Listen to *RadioGraphics* Editor Jeffrey S. Klein, MD, and authors discuss the following articles in recent issues of *RadioGraphics* at *RSNA.org/RG-Podcasts*.

RadioGraphics PODCASTS

- "Acute Radiologic Manifestations of America's Opioid Epidemic," David D.B. Bates, MD, and colleagues.
- "Strengths and Weaknesses of Synthetic Mammography in Screening," Linda Ratanaprasatporn, MD, and colleagues.
- "Traumatic Hip Dislocation: What the Orthopedic Surgeon Wants to Know," Jacob C. Mandell, MD, and colleagues.



## Acute Radiologic Manifestations of America's Opioid Epidemic

RadioGraphics

In the wake of the opioid epidemic in the U.S., emergency department radiologists are faced with examining patients who present with complications from either direct drug toxicity or nonsterile injection of the drugs.

In an article published in the January-February issue of *RadioGraphics* (*RSNA.org/RadioGraphics*), David D.B. Bates, MD, from Massachusetts General Hospital and Boston University Medical Center, both in Boston, and colleagues review the opioid-related acute conditions and complications that emergency department radiologists may be responsible for identifying.

The direct results of opioid abuse may be seen at cross-sectional imaging of the head, neck and spine, where neurologic conditions, including ischemic stroke, cerebral septic emboli, brain abscess, ventriculitis, intracranial mycotic aneurysm, heroin-induced leukoencephalopathy and hypoxic ischemic injury may be noted.

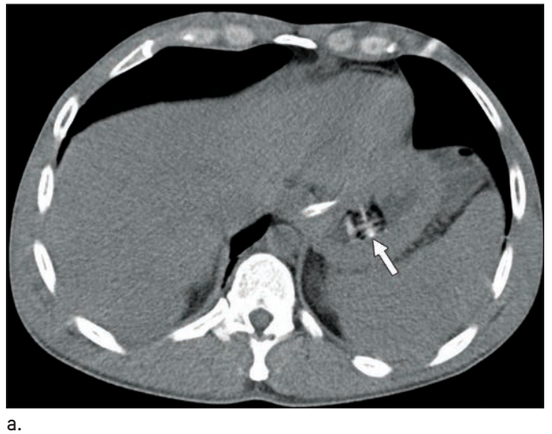
Cardiopulmonary manifestations include bacterial and fungal infections due to the repeated injection of nonsterile material directly into venous circulation. As venous blood returns to the heart, the cardiac valves, pulmonary vasculature and lung parenchyma may be affected by infective endocarditis, septic pulmonary emboli, pulmonary artery mycotic aneurysm or noncardiogenic pulmonary edema.

Infectious complications, such as soft-tissue infections and retained needle fragments, are the most common reason (in 60 to 80 percent of cases) for hospital admission due to intravenous or subcutaneous drug injection.

Intracorporeal concealment of drugs in the gastrointestinal tract or vagina is often seen during imaging. In addition, intravenous drug use predisposes patients to endocarditis and the associated embolic sequelae.

"Familiarity with the wide range of potential complications associated with opioid abuse will assist emergency radiologists in making timely diagnoses. Prompt diagnoses will aid in giving these patients the best chance for recovery," the authors write.

The article is also the focus of a recent *RadioGraphics* podcast (See page 20).


a.


b.

**Intracorporeally concealed heroin in a 35-year-old man who was brought to the emergency department after a motor vehicle accident and found to be somnolent. (a, b). Axial (a) and coronal (b) CT images of the abdomen and pelvis show multiple high-attenuating structures (arrows) in the gastric lumen. *Bottom right*: Photograph shows multiple packets of heroin that were retrieved from this patient at endoscopy.**

# Radiology in Public Focus

Press releases were sent to the medical news media for the following articles appearing in recent issues of *Radiology*.

## MRI Shows Brain Differences Among ADHD Patients

Information from brain MRIs can help identify people with attention deficit hyperactivity disorder (ADHD) and distinguish among subtypes of the condition, according to new research.

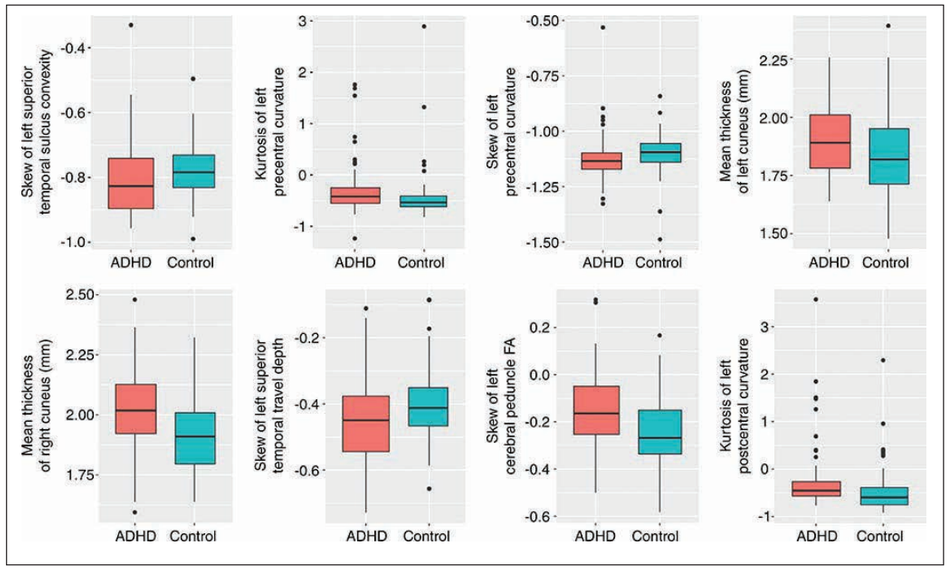
Qiyong Gong, MD, PhD, at West China Hospital of Sichuan University in Chengdu, China, and colleagues studied 83 children, ranging in age from 7 to 14 years, with newly diagnosed and never-treated ADHD. The group included children with the inattentive ADHD subtype and the combined subtypes of hyperactive/impulsive and inattentive/hyperactive.

The authors used anatomic and diffusion-tensor MRI and compared the results with those of a control group of 87 healthy, similarly aged children. Then, they performed a random forest-based feature selection algorithm that allowed them to screen relevant radiomics signatures from more than 3,100 quantitative features extracted from the gray and white matter.

While no overall difference was found between ADHD and controls in total brain volume or total gray and white matter volumes, alteration in cortical shape in the left temporal lobe, bilateral cuneus and regions around the left central sulcus contributed significantly to group discrimination.

Overall, the radiomics signatures allowed discrimination of ADHD patients and healthy control children with 74 percent accuracy and discrimination of ADHD inattentive and ADHD combined subtypes with 80 percent accuracy.

"The results of this study provide preliminary evidence that cerebral morphometric alterations can allow discrimination between patients with ADHD and control subjects and also between the most common ADHD subtypes. By identifying features relevant for diagnosis and subtyping, these findings may advance the understanding of neurodevelopmental alterations related to ADHD," the authors write.




**Distribution of significant features that discriminated ADHD-I and ADHD-C. FA = fractional anisotropy.**

**WEB EXTRAS**

Access the *Radiology* study, "Psychoradiology Utility of MR Imaging for Diagnosis of Attention Deficit Hyperactivity Disorder: A Radiomics Analysis," at *RSNA.org/Radiology*.

## Football Position and Length of Play Affect Brain Impact

Damage to white matter in the brains of former college and professional football players due to recurrent head impacts can be related to playing position and career duration, new research shows.

Kevin Guskiewicz, PhD, research director for the Center for the Study of Retired Athletes at the University of North Carolina at Chapel Hill, and colleagues recruited 61 cognitively unimpaired former collegiate and professional football players, aged 52 to 65 years, who were stratified across three crossed factors: career duration, concussion history and primary playing position.

Diffusion tensor imaging (DTI) and functional MRI (fMRI) were used to examine the former players. The results showed a significant interaction between career duration and concussion history.

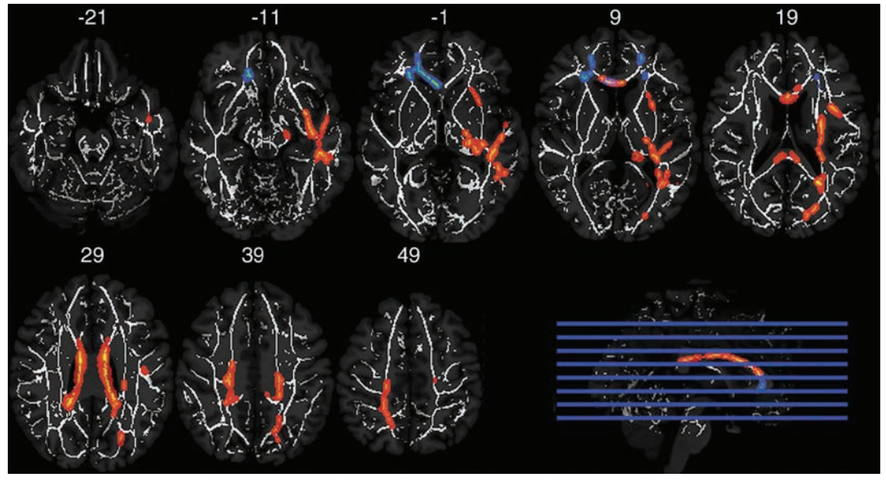
Former college players with more than three concussions had lower fractional anisotropy (FA) in a broadly distributed area of white matter compared with those with zero to one concussion (t29 = 2.774; adjusted P = .037), and the opposite was observed for former professional players (t29 = 3.883; adjusted P = .001).

Nonspeed players with more than three concussions had lower FA in frontal white matter compared with those with zero to one concussion (t25 = 3.861; adjusted P = .002). Analysis of working memory-task blood oxygen level-dependent (BOLD) personal signal changes (PSC) revealed a similar interaction between concussion history and position (all adjusted P < .004). Overall, former players with lower FA tended to have lower BOLD PSC across three levels of a working memory task.

"Career duration and primary playing position seem to modify the effects of concussion history on white matter structure and neural recruitment. The differences in brain structure and function were observed in the absence of clinical impairment, which suggested that multimodal imaging may provide early markers of onset of traumatic neurodegenerative disease," the authors concluded.

**WEB EXTRAS**

Access the *Radiology* study, "Effects of Career Duration, Concussion History, and Playing Position on White Matter Microstructure and Functional Neural Recruitment in Former College and Professional Football Athletes," at *RSNA.org/Radiology*.

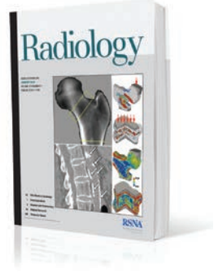



**Axial MRIs show results of tract-based spatial statistics analysis of white matter fractional anisotropy clusters of voxels with a significant crossover interaction (P < .05, corrected) between concussion history and career duration (red and orange) and between concussion history and playing position (blue). Clusters are overlaid on the mean white matter skeleton (white) in Montreal Neuroimaging Institute space (y coordinates are shown in millimeters).**

# Media Coverage of RSNA

In October, 1,715 RSNA-related news stories were tracked in the media. These stories reached an estimated 943 million people.

Coverage included *The Wall Street Journal*, Yahoo! Finance, HealthDay, WebMD, *Daily Mail*, *BBC.com, Scientific American, Philly.com, Houston Chronicle, San Francisco Chronicle*, Reuters Health, *The Arizona Republic*, *Pittsburgh Post-Gazette, Health Imaging & IT, Auntminnie.com* and ScienceDaily.




# February Public Information Outreach Activity Focuses on Heart Health

In honor of American Heart Month in February, RSNA is educating the public through a series of public service announcements (PSAs) discussing the risks associated with coronary artery disease. The PSAs will focus on available screening methods such as calcium scoring with cardiac CT.

# New Videos on *RadiologyInfo.org*

Visit *RadiologyInfo.org*, the public information website produced by RSNA and ACR, to view new videos featuring Jay Pahade, MD, describing various imaging procedures, including:

- Abdominal Ultrasound
- Body CT
- Bone X-ray
- Pelvic Ultrasound
- Spine MRI

RadiologyInfo.org
For patients

## Annual Meeting Watch

# RSNA 2018 Online Abstract Submission Now Open

The online system to submit abstracts for RSNA 2018 is open. The submission deadline is noon Central Time (CT) on Wednesday, April 11, 2018. Abstracts are required for scientific presentations, education exhibits, applied science, quality improvement reports and quantitative imaging reading room showcases.

To submit an abstract online, go to *RSNA.org/Abstracts*. The easy-to-use online system helps the Scientific Program Committee and Education Exhibits Committee evaluate submissions efficiently. For more information about abstract submissions, contact the RSNA Program Services Department at 1-877-776-2227 within the U.S., or 1-630-590-7774 outside the U.S.

The top neuroradiology scientific paper as selected by the Scientific Program Committee will receive a $3,000 award at RSNA 2018.

Students, clinical trainees and post-doctoral trainees are eligible to receive $500 travel awards for top-rated abstracts accepted for presentation at RSNA 2018. Trainees are also eligible to receive a $1,000 research prize.

Full eligibility requirements for all awards are available with the 2018 Call for Abstracts.

**RSNA® 2018**

**November 25-30**
104th Scientific Assembly & Annual Meeting

**Reserve your RSNA 2018 Hotel Now!**
Hotel reservations with discounted rates for all RSNA 2018 attendees are available at *RSNA.org/Annual-Meeting*.

## GET NOTICED

**Present at RSNA 2018:**

- Scientific Presentations
- Applied Science
- Education Exhibits
- Quality Improvement Reports
- Quantitative Imaging Reading Room


# Access the RSNA 2017 Virtual Meeting Through Feb. 28

Whether or not you attended RSNA 2017, you can still access all Virtual Meeting programming on demand through February 28 at 4 p.m. Central Time (CT). If you have not already done so, register now at *RSNA.org/Register* to access over 100 on-demand courses and 23 CME-eligible courses on demand.



## Value of Membership

# New Courses on the RSNA Online Learning Center

Start the new year off right by setting continuing education goals and earning *AMA PRA Category 1 Credit*™ when and where you choose.

The new RSNA Online Learning Center is your comprehensive source for SA-CME credits. Visit the online library at *Education.RSNA.org* and log in to filter and search the educational portfolio of over 600 courses. Many of the courses are discounted or free for members.

New to the online library are many of the Educational Courses from RSNA 2016, including popular sessions such as, "Emerging Technology: Dual Energy CT," "Advances and Updates in SPECT/CT," "Thoracic Aortic Emergencies," and "Strategies for ABR Exam Preparation."

New courses are released almost every week. Content from the 2017 annual meeting will be available in the spring. Continue to check the Online Learning Center and *RSNA News* for updates.


**COMING NEXT MONTH**

Next month, *RSNA News* will feature a story on paleoradiology and the role of imaging in scanning ancient mummies.

# GET NOTICED

## Present at RSNA 2018:

- Scientific Presentations
- Applied Science
- Education Exhibits
- Quality Storyboards
- Quantitative Imaging Reading Room

## EARN RECOGNITION!

**The RSNA Travel Award Program for Students**
Up to 430 top-rated abstracts from current RSNA members will earn a $500 travel stipend.

**Kuo York Chynn Neuroradiology Research Award**
The top scientific paper as selected by the Scientific Program Committee will earn a $3,000 award recognition.

Visit ***RSNA.org/Abstracts*** for complete guidelines.

**Submit online**
beginning January 2018 at *RSNA.org/Abstracts*
through Wednesday, April 11, 2018, 12 NOON Chicago Time.

**Questions?**
Call 1-877-776-2227 *(within U.S.)*
or 1-630-590-7774 *(outside U.S.)*
Includes courses in joint sponsorship with the American Association of Physicists in Medicine

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