

# AUR 2014 RESEARCH PAPER ABSTRACTS

Research papers are oral educational or scientific presentations that are 8 minutes in length, followed by a 2-minute discussion period. Presenting author is identified by institution name, city, and state (or country, if not United States or Canada). Presentations by trainees (residents, fellows, or 1st-year fellows) are noted in **purple**.

**Thursday, April 3, 2014**  
**2:00–3:30 PM**

## SS01: Education of Medical Students

**AMA PRA Category 1 Credits™: 1.50**

**Location: Grand Ballroom VII–VIII**

**Moderators: Christina A. LeBedis, MD**  
**David M. Naeger, MD**



**(SS01-01) 2:00 PM**

### How Competitive Is the Match for Radiology Residency? Present View and Historical Perspective

Jim Y. Chen, MD, *University of Pittsburgh Medical Center Presbyterian Shadyside, Pittsburgh, PA*; Matthew T. Heller, MD (*chenjy2@upmc.edu*)

**PURPOSE:** Interest in radiology as a career among U.S. medical students has changed. We sought to investigate the recent and historical trends in residency applications and how they have affected competitiveness in obtaining a position.

**METHOD AND MATERIALS:** We analyzed statistics published by the National Resident Matching Program in Results and Data: Main Residency Match from 1991 to 2013.

**RESULTS:** The number of radiology residency positions has increased steadily over the past 23 years; however, the number of U.S. senior applicants has been widely variable. The number of applicants peaked in 2009 but has since decreased every year. The number of positions per U.S. senior applicant (PPUSA) is a reflection of specialty competitiveness on a supply-and-demand basis. A lower PPUSA indicates a more competitive specialty. Radiology saw its most competitive year in 2001, with only 0.91 positions per U.S. senior applicant. PPUSA has been on the rise every year since 2009. From 2009 to 2013, the number of residency positions increased by 56, but there were 241 fewer U.S. seniors applying to radiology. In 2013, there were 1143 residency positions available for only 845 U.S. seniors. The PPUSA was 1.35, making 2013 the least competitive year in obtaining a radiology residency position since 1998. Over the past 23 years, 5.5% of all U.S. seniors applied to radiology for residency. Interest reached an all-time high in 2009, to almost 7%. In 2013, only 4.8% of all U.S. seniors applied to radiology, the lowest since 1999. The historical (1991–2013), current (2011–2013), and most recent (2013) PPUSAs for radiology were 1.19, 1.29, and 1.35, respectively. For comparison, the current PPUSAs for the following specialties were plastic surgery (0.74), orthopedic surgery (0.83), dermatology (0.95), general surgery (1.10), OB/GYN (1.24), anesthesiology (1.31), pediatrics (1.42), and internal medicine (1.80).

**CONCLUSION:** While radiology residency positions have increased, interest among U.S. seniors has dropped every year since 2009. The 2013 match was the least competitive since 1998. Over the past 3 years, the competitiveness of matching radiology on a supply-and-demand basis has been close to OB/GYN and anesthesiology.

**(SS01-02) 2:10 PM**

### Faculty Development Pilot Program: Planting a Seed in a Challenging Era

Marc H. Willis, DO, *Baylor College of Medicine, Houston, TX*; Shelley Kumar, MS (*mwillis@bcm.edu*)

**PURPOSE:** Our department's participation in faculty development was limited despite the nationally recognized excellence of our institution's faculty development program. An intradepartmental faculty development program was created to supplement the established institutional program. The objectives of the program were to promote faculty development awareness, increase participation in faculty development initiatives, and encourage educational scholarship.

**METHOD AND MATERIALS:** Lack of awareness and time constraints were identified as two key contributing factors. A monthly electronic faculty development newsletter was instituted. The newsletters consisted of announcements regarding the intradepartmental workshops, relevant reading, the institution's faculty development program, abstract deadlines, national meetings, and links to education support resources. Monthly departmental faculty development workshops were also implemented to provide convenient and efficient faculty development opportunities. An 18-month curriculum was constructed based on continuous feedback from the participants. Relevant journal articles were selected to promote small-group discussions. Each session was facilitated by the program director, a volunteer participant, or an invited guest. To measure the satisfaction with the program, online anonymous surveys were sent out every 6 months, and pre- and postsession skill level data were recorded and analyzed using Wilcoxon signed rank test.

**RESULTS:** The program provided 99 hours of faculty development. On a scale of 1 to 5, the average workshop satisfaction was  $4.83 \pm 0.31$  (mean  $\pm$  SD). The mean skill level before the session was  $2.85 \pm 0.27$  and after the session was  $4.66 \pm 0.22$  for 18 workshops ( $P < .001$ ).

**CONCLUSION:** Given our rapidly evolving health care enterprise, professional improvement is an essential ingredient for our future success. A departmental faculty development program can provide a convenient and efficient mechanism to engage faculty, plant a seed, and create a culture where faculty are more strongly motivated to pursue educational scholarship.

**(SS01-03) 2:20 PM**

### Evaluation of 3rd- and 4th-Year Medical Student Interdisciplinary Learning Experiences during the Radiology, Surgery, and Pathology Rotations

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**PURPOSE:** The purpose of this study was to assess 3rd- and 4th-year medical student perceptions and experiences during the clinical rotations of radiology, surgery, and pathology. A recent study has suggested that the current format of medical school curricula does not adequately expose students to the longitudinal care of patients, despite the reported benefits of learning about specific disease processes across multiple specialties. Although students can find aspects of radiology and pathology during the core clinical rotations, an in-depth knowledge of how radiologic or pathologic findings are interpreted is often not attained due to time constraints. The primary end point of this study was to determine if medical schools offer students multidisciplinary learning experiences during the radiology, surgery, and pathology rotations.

**METHOD AND MATERIALS:** Data were collected from 132 U.S. allopathic medical schools by e-mailing curriculum directors with details of the study, along with a link to an institutional review board-approved online survey.

**RESULTS:** Data from the 2012–2013 academic years showed that of responders who participated on a surgical rotation, 31.8% did not have aspects of radiology and pathology incorporated into the rotation. Of those who took care of a patient diagnosed with a tumor on a surgical rotation, 11.7% were always taught radiologic features of the diagnosis, and 7.1% were always shown the pathologic diagnosis and histology. 63.7% of responders had never followed a single patient through their radiologic diagnosis, surgical management, and pathologic diagnosis. 62.3% and 79.9% of students regarded radiologic and pathologic diagnoses as a very important aspect of the surgical management of disease, respectively.

**CONCLUSION:** Although the majority of medical students indicated that both radiologic and pathologic diagnoses were very important in the surgical management of disease, few schools offer an opportunity to learn radiology and pathology during the surgery rotation. Medical schools that offer multidisciplinary courses will expose students to the longitudinal care of patients and offer an integrated learning experience that could not otherwise be obtained on a stand-alone rotation.

#### (SS01-04) 2:30 PM Randomized Controlled Trial of Simulation to Enhance Medical Student Radiology Education

Daniel Strauchler, MD, *Jacobi Medical Center, Bronx, NY*; Mark Guelfguat, DO ([daniel.strauchler@nbhn.net](mailto:daniel.strauchler@nbhn.net))

**PURPOSE:** The purpose was to create an innovative experiential educational tool for medical students to enhance radiology education and encourage independent student engagement in radiological interpretation, without risk to patients. To validate this simulation system, we aimed to design and implement a randomized controlled trial to test both objective knowledge and subjective experience.

**METHOD AND MATERIALS:** We created a simulation experience that allows medical students to view selected cases, dictate and submit their interpretation, and receive immediate feedback as to the correct “attending” interpretation. Students first receive instruction on composing systematic reports of chest radiographs. Students then interpret 20 chest radiographs independently as if they were the radiologist on duty. The system utilized a DICOM viewer to simulate a PACS station and voice recognition software to make the experience similar to that of a radiologist on duty. Using AMSER’s Radiology ExamWeb, we designed an objective test of chest radiograph interpretation to be administered before and after simulation experience or control. We used pre- and posttest surveys to gauge students’ interest in radiology as a profession, confidence in ability to interpret radiological studies, level of enjoyment of the clinical rotation, engagement in learning radiology, and rating of radiology clerkship’s overall educational experience.

**RESULTS:** There has been a trend toward improved test scores, but it will require a larger student population to develop significant results. The experimental group averaged an increase of 6.4% correct, while the control group averaged an increase of 2.0% correct. On the subjective measures, there was nearly significant improvement in students’ confidence in ability to interpret radiological studies. There were also trends toward increased enjoyment of the clinical rotation, engagement in learning radiology, and rating of radiology clerkship’s overall educational experience, but results were not statistically significant.

**CONCLUSION:** Simulation is expected to be an effective tool to enhance medical student radiology clerkships.

#### (SS01-05) 2:40 PM Using Perceptual and Adaptive Learning Modules to Teach Medical Students Pattern Recognition of Anatomic Structures in Thoracic Radiographs and CT

Sally Krasne, PhD, *David Geffen School of Medicine, UCLA, Los Angeles, CA*; Megan Sue; Kathleen Brown, MD ([skrasne@mednet.ucla.edu](mailto:skrasne@mednet.ucla.edu))

**PURPOSE:** This study aims to determine the efficacy of teaching thoracic radiologic anatomy using perceptual and adaptive learning modules (PALMs) in multiple-choice question (MCQ) and image-mapped (IM) formats.

**METHOD AND MATERIALS:** Repeated exposures to different images with the same underlying pattern increase recognition accuracy and speed. Thoracic radiologic anatomy PALMs utilize this principle of perceptual learning by presenting learners with a sequence of images categorized by structure and asking them to identify specified anatomic structures. PALMs adapt to a learner’s ability by sequencing the structures to be identified according to the learner’s previous accuracy and response time (RT) for each structure and by removing learned structures as the module progresses. In MCQ PALMs, learners identify a structure from a list of five choices. IM PALMs ask the learner to click on the location of a given structure. Both formats provide feedback to the learner on accuracy, RT, and the correct identity or location of the structure. We developed IM and MCQ PALMs for PA and lateral chest x-rays and thoracic CT scans with and without contrast. We compared efficacy of the PALMs in enhancing performance of year 2, 3, and 4 medical students based on pre- and posttests. We used a year 2 focus group to compare the two formats and provide feedback about the PALMs.

**RESULTS:** The use of either MCQ or IM PALM format dramatically improved knowledge of thoracic anatomy (two-tailed  $P$  values  $< .001$ , and effect sizes  $> 2$ ) with minimal time investment. Some modules showed significant differences in RTs and accuracies between MCQ and IM PALMs, but we observed no systematic trends. Knowledge transfer from the MCQ to the IM format showed a significant decrement. Students found both types of PALMs useful but preferred the IM to MCQ versions.

**CONCLUSION:** Both MCQ and IM PALMs are highly effective in teaching thoracic radiologic anatomy, with some differences between them. Because of the efficacy of PALMs, the introductory thoracic radiology lecture in the internal medicine clerkship at our medical school has been revised, allowing greater focus on thoracic pathology and physiology and expanding the students’ knowledge of image interpretation.

#### (SS01-06) 2:50 PM iPad-driven Small-Group Radiology Sessions within Gross Anatomy Laboratory: Medical Student First Impressions

Robert J. Ward, MD, *Tufts Medical Center, Boston, MA*; Daniel H. Mac-arthur, MD; Katherine Malcolm, BA, MS; Rebecca S. Lufler, PhD; Walid El-Bermani, MBChB, PhD; Robert F. Willson, PhD ([robert.ward@tufts.edu](mailto:robert.ward@tufts.edu))

**PURPOSE:** The purpose was to evaluate perceptions of an iPad-driven imaging integration into small-group sessions within gross anatomy laboratory.

**METHOD AND MATERIALS:** The faculty and residents of the radiology department of Tufts Medical Center participated in 23 of 27 gross anatomy sessions. Groups of 7–12 students rotated through a 4–5-minute small-group discussion in front of a 65-inch wall-mounted flat-screen LCD display hooked up to an Apple TV (Apple, Inc; Cupertino, CA). An iPad 3 (Apple, Inc) equipped with iOS 5.1 and running OsiriX 3.5 (Pixmeo SARL, Bernex, Switzerland) was used to project DICOM images on the display. Projectional images as well as cross-sectional images specific to the laboratory curriculum were utilized. Images shown during the laboratory sessions were later used on the four lab practical examinations. Following completion

of the gross anatomy course, students were sent a survey (Survey Monkey). The survey contained 12 questions related to the impact of the sessions on the students' perceptions of radiology and impact on acquiring knowledge of anatomy.

**RESULTS:** A total of 124 (60%) of 208 first-year gross anatomy students responded to the survey. 70% of students agreed that incorporating radiology into the anatomy course improved their knowledge. 80% of respondents agreed that the laboratory sessions improved familiarity with imaging modalities. Nearly 80% stated that the sessions increased their understanding of radiology. 14% of students responded that they were more likely to consider a career in radiology. 84% of students indicated that the lab helped demonstrate the application of technology within medicine. 83% of respondents agreed that the iPad-driven lab helped demonstrate the application of anatomy in the practice of medicine, while 91% of respondents had improved understanding of how radiologists use anatomy in practice. 31% of students believed that the iPad-driven lab portion of the curriculum was superior to the didactic portion, while 32% stated that they thought both portions were equivalent.

**CONCLUSION:** Gross anatomy medical students believed the iPad-driven laboratory imaging sessions with radiologists were beneficial to their understanding of gross anatomy and radiology.

### (SS01-07) 3:00 PM

#### Teaching Medical Students about the History of Radiology with New Technology: Qstream—Is This Useful?

Judith K. Amorosa, MD, FACR, *Rutgers/Robert Wood Johnson Medical School, New Brunswick, NJ*; Alberto Goldszal, PhD, MS (*amorosa@rutgers.edu*)

**PURPOSE:** Having a background basic knowledge about the field of study's history may encourage learners' perception and enthusiasm for learning about the field. Several medical schools have electives about the history of medicine. Medical student curricula are saturated with content, and therefore new courses add to this, yet the history of radiology is rich with new scientific discoveries, practices, and applications by practitioners, scholars, educators, and scientists that may be interesting and may be inspirational to medical students. We designed a Qstream application to see how medical students respond to radiology historical events, persons, and discoveries without adding to the medical school curriculum.

**METHOD AND MATERIALS:** We identified six historical items in radiology and sent them to the mobile devices of M1, M2, M3, and M4 medical students at our medical school over a period of 6 weeks by using Qstream methodology. We used multiple-choice questions with four choices and only one correct answer. Immediate response was available, with explanation of correct and incorrect responses, along with hyperlinks to references. Comments about this experience were solicited from the students.

**RESULTS:** Ten percent of students had knowledge about some historical facts about radiology; 90% did not. Students commented positively about the importance of some historical background about radiology and agreed or strongly agreed that knowledge of the history made it easier and more interesting to learn about the field of radiology.

**CONCLUSION:** Historical events about radiology delivered to medical students via an up-to-date personal mobile device method (Qstream) were well received by them without adding a formal elective course to the curriculum.

### (SS01-08) 3:10 PM

#### A PowerPoint Alternative: Using Prezi to Teach Radiology to Medical Students

Molly C. Chapman, BA, MA, *University of Michigan Medical School, Ann Arbor, MI*; Gaurang V. Shah, MD; Marilyn A. Roubidoux, MD\*; Katherine A. Klein, MD (*kleink@med.umich.edu*)

**PURPOSE:** Most medical school lecturers rely on PowerPoint (Microsoft, Redmond, WA) to create lessons for students. While a useful

visual aid, it has been overused and often fails to engage students. Moreover, learning radiology requires students to make visuospatial associations; standard slide presentations' linear format does not always effectively lend itself to this end. We implement the online presentation platform of Prezi (Budapest, Hungary) in a pilot neuro-radiology lecture to explore this alternative medium for future use in this setting.

**METHOD AND MATERIALS:** The authors created a basic subscription to Prezi available free of charge at *prezi.com*. A Prezi presentation was created using the online editor and designed to introduce medical students to the basics of MRI sequences seen in neuroradiology. The presentation was saved online and made viewable via a hyperlink; however, the platform also allows users to download versions for use offline.

**RESULTS:** The following public link is a portion of the Prezi: <http://prezi.com/mxtra1cpgiha/mri-brain-for-m4s/>. We found the following to be the most useful aspects of Prezi: (1) dynamic visuospatial format: the "zooming user interface" (ZUI) allows each "slide" to be incorporated as a frame within a big-picture map of the lecture, so the user can creatively incorporate radiologic images; (2) ease of use: the editor is intuitive to learn, and users can import existing slides to serve as a starting point for new Prezi presentations; (3) adaptability: the Prezi may be "played" online as a stand-alone tool or can be used in the classroom as students follow the presentation on their own laptops; (4) collaborative potential: the online nature of the platform allows for collaborative work on the presentation. Downsides of the platform include (1) extra time required to learn to use the editor and (2) the creation of effective Prezi presentations may take more time and creative energy than a standard lecture.

**CONCLUSION:** Prezi is an appealing alternative visual aid to lecturers in clinical radiology. Its dynamic format allows for an engaging way to present sample case images. We plan to use this pilot Prezi as a model to design a series of lectures for clinical year medical students to learn how to approach basic studies encountered on the wards.

### (SS01-09) 3:20 PM

#### US Curriculum for Medical Students: Preliminary Draft

Donald N. Di Salvo, MD, *Dana Farber Cancer Institute, Boston, MA* (*ddisalvo@partners.org*)

**PURPOSE:** The purpose was to design a curriculum outlining the teaching of ultrasound to medical students.

**METHOD AND MATERIALS:** Interested members of the AMSER Education Committee convened via the Internet to consider the following questions: (1) What are the goals of this curriculum? (2) What should the content be? (3) How can this best be taught? Other resources consulted included the AMSER medical student curriculum and medical student competencies, as well as members from the Society of Radiologists in Ultrasound (SRU) working on a similar project.

**RESULTS:** A three-part document has been created and will be presented. The introduction outlines guiding principles behind the ultrasound curriculum. Part 1 outlines specific content, part 2 outlines a plan to incorporate this into the traditional 4-year medical school curriculum, and part 3 outlines how medical student competencies can be assessed. An overriding sentiment is that radiologists need to be actively involved in this project. However, how to accomplish making the curriculum a reality and what role nonradiologists should play are two key issues that remain debated.

**CONCLUSION:** A comprehensive curriculum for medical student ultrasound education has been proposed, using resources and interested persons from both AMSER and the SRU. How far this may be enacted at the medical school level remains to be seen.

Thursday, April 3, 2014  
2:00–3:30 PM

**SS02: Neuroradiology; Nuclear Medicine; Musculoskeletal; Interventional Radiology**

AMA PRA Category 1 Credits™: 1.50

Location: Grand Ballroom I–III

Moderators: Shadpour Demehri, MD  
Kelvin K. Hong, MD

  

(SS02-01) 2:00 PM

**Quantitative Diffusion-weighted MR Imaging for Differentiation of Benign and Malignant Osseous Lesions**

Paras Khandheria, MD, *Johns Hopkins Medical Institutions, Baltimore, MD*; Shivani Ahlawat, MD; Ty Subhawong, MD; Laura M. Fayad, MD\* (*pkhandh1@jhmi.edu*)

**PURPOSE:** The purpose was to investigate the accuracy of quantitative diffusion-weighted imaging (DWI) with apparent diffusion coefficient (ADC) mapping for characterizing bone lesions as benign or malignant.

**METHOD AND MATERIALS:** This retrospective study included 28 subjects with intraosseous lesions imaged by conventional MRI and DWI ( $b$  values: 50, 400, 800 s/mm<sup>2</sup>) with ADC mapping. Benign lesions ( $n = 15$ ) were diagnosed by histology or by typical benign characteristics and stability of at least 6 months. Malignant lesions ( $n = 13$ ) were diagnosed by histology or were presumed malignant in the setting of known metastatic carcinomatosis and multiple lesions. For each bone lesion, ADC values (minimum, mean, maximum) were recorded by two observers independently. Interobserver variability and differences between ADC values in benign and malignant lesions were assessed (unpaired  $t$  test, receiver operating characteristic [ROC] analysis).

**RESULTS:** Of 28 lesions, 15 were benign: enchondroma ( $n = 5$ ), unicameral cyst ( $n = 2$ ), aneurysmal bone cyst ( $n = 1$ ), hemangiomas ( $n = 1$ ), fibrocystic lesion ( $n = 1$ ), fibrous dysplasia ( $n = 2$ ), Langerhans cell histiocytosis ( $n = 1$ ), giant cell tumor ( $n = 1$ ), and osteomyelitis ( $n = 1$ ). Thirteen were malignant: osteosarcoma ( $n = 2$ ); chondroblastoma ( $n = 1$ ); plasmacytoma ( $n = 1$ ); angiosarcoma ( $n = 1$ ); and metastases from breast, renal, prostate, or skin ( $n = 8$ ). There were higher minimum (1.28 vs 0.73;  $P = .001$ ), mean (1.71 vs 1.12;  $P < .001$ ), and maximum (2.13 vs 1.64;  $P = .02$ ) ADC values (mm<sup>2</sup>/s) in benign lesions compared with those in malignancies, respectively. Measurements were made with high interobserver concordance ( $\rho = 0.87$ ). ROC analysis showed areas under the curve for minimum, mean, and maximum ADC values of 0.84, 0.88, and 0.76, respectively. Using threshold values of 1.09 (minimum ADC) or 1.40 (mean ADC) yielded sensitivities of 73% and 87% and specificities of 92% and 85% for identification of benign lesions, respectively.

**CONCLUSION:** Diffusion-weighted imaging with ADC mapping may have predictive value for characterization of bone lesions as benign or malignant. Benign lesions generally have higher minimum, mean, and maximum ADC values than malignancies, with the mean value offering the highest accuracy for characterization.

(SS02-02) 2:10 PM

**Radiation Safety in Interventional Radiology: Resident Perspective**

Jenanan Vairavamurthy, MD, *Beth Israel Medical Center, New York, NY*; George E. Lynskey III, MD; James E. Silberzweig, MD

**PURPOSE:** The purpose was to assess radiology resident attitudes toward radiation safety in interventional radiology. We aim to identify whether radiation safety concerns may affect a resident's decision to pursue fellowship training in interventional radiology.

**METHOD AND MATERIALS:** A 12-question online survey was sent to the program director of each residency program via the Association of Program Directors in Radiology. The program directors forwarded the survey to the residents in their respective programs. The anonymous responses were reviewed. Of the 154 resident responders, 111 (72.1%) were men, and 43 (27.9%) were women (age range = 28–47 years).

**RESULTS:** Table 1 summarizes the use of radiation exposure badges while on rotation. A total of 86.9% of responders reported always using a thyroid shield. With respect to radiation protective eyewear, 66.0% reported rarely or never wearing goggles, while 22.4% reported almost always or always wearing goggles. The factor reported as the most important in influencing goggle use was access (51.5%), as a majority of residents (51.9%) have to purchase their own. When asked how radiation exposure affects fellowship choice with respect to interventional radiology, 17.0% said it was a major consideration, and 49.7% said it was a minor consideration. Based on gender, 32.6% of women reported it as a major consideration, compared to 10.9% of men, a statistically significant difference ( $P = .007$ ).

**CONCLUSION:** Radiation exposure risk is a consideration by residents when considering a fellowship in interventional radiology. Women showed a significant tendency to respond that radiation exposure is a major consideration in fellowship choice compared to men. The current radiation safety practices are varied, and establishing a standard practice for residency programs may be helpful in improving attitudes toward pursuing a career in interventional radiology.

(SS02-03) 2:20 PM

**Focal FDG Avidity at the Hip Joint: A Benign Transient Process**

Shelby L. Kubicki, *Trinity University, San Antonio, TX*; Michael L. Richardson, MD; Thomas P. Martin, MD; Eric M. Rohren, MD, PhD; Behrang Amini, MD, PhD (*bamini@mdanderson.org*)

**PURPOSE:** The purpose was to report the prevalence and demographics of an FDG-avid focus in the hip joint, describe its natural history, and suggest an etiology.

**METHOD AND MATERIALS:** Waiver of informed consent was obtained from the institutional review board. PET-CT images from 2227 patients were reviewed for the presence in the hip joint of a focus of FDG avidity higher than adjacent vessels and soft tissues. Prevalence was calculated and demographics recorded. Imaging before and after the positive findings was used to define the natural history of the phenomenon.

**RESULTS:** The phenomenon had a prevalence of 0.45% (95% CI, 0.15%–1.04%) and was left sided in 62% of cases. A majority of patients with the phenomenon were male ( $P = .0007$ ). There was no significant difference with respect to age and race or the presence of symptoms related to the hips. For patients who had more than one PET-CT, the average follow-up duration was 23 months (range, 1–68 months). Forty-two percent of these patients had the finding on more than one study, and the average duration of the phenomenon in these patients was 10.5 months.

**CONCLUSION:** Recognition of this phenomenon as a benign process on PET-CT is important for avoiding unnecessary biopsy or initiation of therapy. The location of the phenomenon corresponds to that of the ligamentum teres of the hip.

### (SS02-04) 2:30 PM PET Imaging in Cardiac Sarcoidosis: Quantitative <sup>18</sup>F-FDG Uptake Analysis

Hatice Savas, MD, *University of Michigan, Ann Arbor, MI*; Venkatesh L. Murthy, MD, PhD\*; Jeff J. Meden, BS, CNMT\*; Edward P. Ficaro, PhD\*; James Corbett, MD\* (*jcorbett@med.umich.edu*)

**PURPOSE:** Inflammatory heart disease (InfHD) including sarcoidosis is an increasingly recognized etiology in many patients with congestive heart failure and life-threatening cardiac arrhythmias. Cardiac PET imaging techniques with <sup>18</sup>F-FDG are becoming more important for the identification of InfHDs. We aim to evaluate quantitative <sup>18</sup>F-FDG peak myocardial uptake, as well as background activity (liver and aorta), by using careful metabolic preparation with a high-fat preparatory diet (HFPD) plus heparin to minimize uptake in normal myocardial tissue when imaging InfHD.

**METHOD AND MATERIALS:** Study population consisted of 24 patients with known or suspected InfHD (sarcoidosis). Imaging was performed using 8–10 mCi of <sup>18</sup>F-FDG with Siemens mCT PET-CT (Siemens Medical Solutions, Knoxville, TN). Images were analyzed for standardized uptake values (SUVs) using Corridor4DM software (Invia, Ann Arbor, MI). For statistical purposes,  $P < .05$  was considered significant.

**RESULTS:** Patients had significantly increased uptake FDG SUVs in diseased compared to normal segments, and peak myocardial uptake varied depending on disease activity. Using this preparation, myocardial peak uptake was  $5.74 \pm 3.92$  and varied widely in the range 0.91–12.55, whereas background activity was highly predictable, measuring  $2.76 \pm 0.53$  in liver and  $1.99 \pm 0.44$  in aorta, particularly in patients with mild disease activity or those who do not have cardiac involvement.

**CONCLUSION:** Cardiac PET imaging has an important role in evaluating myocardium for sarcoidosis and requires different metabolic preparation than the traditional glucose-loading protocol for viability imaging. Quantitative myocardial FDG uptake varies depending on disease activity as well as metabolic preparation. Knowledge of expected values for the diseased and normal myocardium by using a careful metabolic preparation method may have important bearing on image interpretation and quantification for better evaluation of cardiac sarcoidosis.

### (SS02-05) 2:40 PM Osteochondral Lesions of the Talus: A Comparative Study of Plain Radiography and MR Imaging

Farshad M. Bahador, MD, *University of Missouri, Columbia, MO*; James P. Connors, MD; Deepak Raghu (*farshadbahador@gmail.com*)

**PURPOSE:** The purpose was to determine the accuracy of radiographs for detection and characterization of the morphology of nondisplaced osteochondral lesions of the talus (OCLTs).

**METHOD AND MATERIALS:** Forty-eight osteochondral lesions of the talus were reviewed in consensus by fellowship-trained musculoskeletal radiologist on radiographs and compared to MRI examinations. Size, location, and imaging characteristics of lesions were compared to each other.

**RESULTS:** From a total of 48 nondisplaced lesions, 19 (40%) lesions were only identified on MR images (group A). Twenty-two (46%) lesions were not initially detected by radiographs; however, they could be identified retrospectively following MRI review (group B). Seven (15%) lesions were primarily detected by radiographs and confirmed by MRI (group C). Average size of the lesions on MRI were  $7 \times 7 \times 4$  mm,  $9 \times 9 \times 6$  mm, and  $12 \times 10 \times 6$  mm, respectively. The radiographic dimensions of 20 (91%) lesions in group B and five (71%) lesions in group C underestimated their corresponding MR dimension in at least two planes. Cystic changes, fragmentation, and sclerosis were more prevalent on radiographs in lesions initially diagnosed with radiographs (group C). Eighteen (37%) lesions showed cystic changes, 12 (25%) showed fragmentation, and seven (15%)

lesions had avascular necrosis. Radiographs were less sensitive to detect these abnormalities in groups A and B, which constituted the majority of the lesions (85%).

**CONCLUSION:** Current study shows limited sensitivity of radiographs in detecting OCLTs less than 10 mm. Furthermore, not all lesions larger than 10 mm in at least one dimension could be reliably and consistently detected. Cystic changes and fragmentation, shown to be correlated with poor outcome following conservative treatment, were underestimated on radiographs. Inadequacy of radiographs in accurately evaluating nondisplaced OCLTs may delay appropriate surgical management and impact the overall patient outcome. It is unlikely that the diagnostic algorithm of ankle injury will change based on this study; however, we hope that clinicians will recognize the limitations of radiographs in the setting of persistent or unexplained ankle pain.

### (SS02-06) 2:50 PM C-Arm Cone-Beam CT: Application for Percutaneous Sacroplasty in the Treatment of Sacral Insufficiency Fractures

Christopher J. Mills, MD, *Aultman Hospital, Canton, OH*; Brian A. Aronson, MD (*cmillsmd@gmail.com*)

**PURPOSE:** Sacral insufficiency fractures (SIFs) are a relatively common cause of lower back pain in the increasing elderly population. Traditionally, the mainstay of therapy has been conservative management, consisting of physical therapy and analgesic medications. In recent years, sacroplasty, a variant of vertebroplasty, has emerged as a minimally invasive alternative treatment option. Although unconfirmed by randomized control trials, growing evidence suggests sacroplasty results in significant relief of symptoms, in both short- and long-term follow-up. A standard technique for sacroplasty has yet to be established. A large majority of cases described in the literature have been performed under fluoroscopy or CT guidance, each demonstrating limitations. The purpose of our study is to provide supporting evidence for the use of C-arm cone-beam computed tomography (CBCT) in the application of percutaneous sacroplasty. We describe two cases of SIFs successfully treated with sacroplasty from a posterior short-axis approach. CBCT was utilized for needle localization and posttreatment evaluation.

**RESULTS: Case 1:** A 55-year-old female with a known history of metastatic non-small cell lung cancer presented with low back pain. Radiographic workup revealed a T6 vertebral body compression deformity and left SIF. The patient was placed in a prone position on the angiography table. Moderate sedation was achieved by intravenous midazolam (Versed) and fentanyl, with continuous electrocardiogram and blood pressure monitoring. Initially, the vertebral body compression deformity was treated using standard vertebroplasty technique. Attention was then directed to the sacral fracture. A 13-gauge needle was advanced in the left sacral ala, using the short-axis posterior approach under real-time fluoroscopy. CBCT confirmed appropriate positioning in three orthogonal planes. The trocar of needle was exchanged for a larger biopsy trocar, and the specimen was sent to pathology, which demonstrated no evidence of osseous metastasis. A total of 3 mL of PMMA was injected under direct fluoroscopic visualization. CBCT confirmed appropriate position of PMMA, with no osseous extravasation or encroachment upon the neural foramina. The patient was transferred to the same-day surgery area, where she reported significant improvement of her pain. She was admitted for extended observation due to nausea. The following morning, patient's back pain had completely resolved, and she was discharged on home medications. **Case 2:** A 75-year-old male presented with acute on chronic back pain. Imaging demonstrated bilateral SIFs and an anterior S2 fracture. The patient was placed in prone position for short-axis posterior approach, in a similar fashion as the first patient. Under real-time fluoroscopy, the initial needle placement was inadequate due to proximity to the S1 neural foramen. Upon repositioning, CBCT confirmed appropriate

placement in the left sacral ala, lateral to the neural foramina. Attention was then drawn to the right, using a similar approach. A total of 2.5 mL of cement was deployed into each sacral ala under live fluoroscopy. CBCT demonstrated appropriate position of cement bilaterally, with a small amount of posterior osseous extravasation on the left. This was contained to the sacral soft tissues distant from the posterior neural foramen and therefore of no clinical significance. The patient was monitored in the postangiography holding area for 2 hours, at which point he continued to have moderate low back pain. A postprocedural CT was performed and confirmed appropriate position of cement, without evidence of neural foramina compromise. Pain control was achieved with oral analgesics, and the patient was discharged in stable condition.

**CONCLUSION:** SIFs are a significant cause of pain and disability in the increasing elderly population. It is estimated that up to 50% of postmenopausal women will suffer from an osteoporotic-related fracture in their lifetime, including SIFs. Other etiologic factors include metabolic derangements, such as hyperparathyroidism, and osseous metastasis. This leads to significant morbidity and mortality. Long-term complications include chronic lumbosacral pain, immobilization, and limitation of daily activities. The mainstay of conservative therapy includes analgesic medications, bed rest, and physical therapy. Sacroplasty is a relatively new interventional technique with promising results. A meta-analysis of 15 studies between 2002 and 2008 (108 total included patients) demonstrated a statistically significant improvement in back pain on short-term follow-up. The most common complication of sacroplasty is related to cement extravasation. This may result in encroachment and radiculopathy of the sacral nerves. In one report, postsacroplasty S1 radicular pain resolved following local anesthesia and steroid injections. Additional potential complications include pulmonary embolism, infection, and direct nerve injury, although none of these have been reported in the literature. No standard technique has been established in the practice of sacroplasty, although most approaches involve a combination of CT and fluoroscopy. CBCT is a relatively new diagnostic imaging modality available on current commercial flat-panel detectors in the angiography suite. CBCT offers many applications, including intra- and extracranial arteriography, preoperative tumor localization for external beam radiation, and axial skeletal intervention augmentation, among others. Advantages include rapid image acquisition times, a patient dose comparable to CT, and increased throughput in the department. Recent studies have examined the role of CBCT in sacroplasty. Our study provides further supportive evidence that utilization of CBCT for the application of percutaneous sacroplasty is reliable for both needle localization and postprocedural complications.

### (SS02-07) 3:00 PM CT and MR Imaging Findings of Myeloid Sarcoma

Ammar A. Chaudhry, MD, *Stony Brook University Medical Center, Stony Brook, NY*; Maryam Gul, MD, BS; Abbas A. Chaudhry; Jared Dunkin, MD ([ammar.chaudhry@stonybrookmedicine.edu](mailto:ammar.chaudhry@stonybrookmedicine.edu))

**PURPOSE:** The purpose of this study was to assess imaging characteristics of myeloid sarcoma on computed tomography (CT) and magnetic resonance imaging (MRI).

**METHOD AND MATERIALS:** A retrospective study of 100 patients with pathologically proven myeloid sarcoma included 29 patients (18 men, 11 women; mean age, 55 years; range, 9–80 years) who underwent pretreatment CT and/or MRI at our institution from January 1993 to December 2012. A total of 60 examinations (25 MRI and 35 CT) were evaluated by two radiologists in consensus.

**RESULTS:** A total of 82 sites of involvement of myeloid sarcoma were seen, most commonly involving CNS (36.6%), head and neck (19.5%), abdomen/pelvis (15.9%), thorax (13.4%), musculoskeletal (8.5%), lymphatics (7.3%), gonads (3.7%), and breast (2.4%). Most of these sarcomas were AML subtype, of which a majority were M3 and M5. Of all of the patients, only 40% had evidence of leukemia on

peripheral smear. The mean size of measurable lesions was 2.8 cm (range, 1–8 cm). On CT, 86% of the lesions were solid and measuring 40–70 HU on unenhanced CT. Twenty-five sites were noted on MR images obtained for evaluation of a new sign or symptom, most commonly CNS (20 sites), MSK (four sites), and abdomen (one site). Compared with gray matter and muscle, the lesions were isointense (78.4%) or hypointense (21.6%) on T1WI and hyperintense (96%) on T2/FLAIR images and enhanced homogeneously (88%). On DWI, 96% of images showed restricted diffusion. Only 16% of images showed susceptibility artifact on gradient sequence, and none of these lesions demonstrated observable calcium on CT.

**CONCLUSION:** Myeloid sarcoma is a rare form of extramedullary leukemia which can be the initial presentation of leukemia (*de novo*, concurrent, or recurrence) and commonly is seen without evidence of leukemia in peripheral blood. In patients with a history of leukemia or other lymphoproliferative disorder, identification of a soft-tissue mass can be indicative of myeloid sarcoma. Imaging characteristics of myeloid sarcoma include a homogeneous mass isodense to liver and muscle on CT, T1 isointense, T2/FLAIR hyperintense with restricted diffusion, and homogeneous after contrast enhancement without significant susceptibility artifact.

### AUR Trainee Prize: 2nd Place

### (SS02-08) 3:10 PM Comparison of Filtered Backprojection and Adaptive Statistical and Model-based Iterative Reconstruction Techniques for Postmortem Brain CT Acquired at Seven Different Dose Levels

Atul Padole, MD, MS, *Massachusetts General Hospital, Boston, MA*; Sarabjeet Singh, MBBS, MD; Diego Lira; Sarvenaz Pourjabbar, MD; Ranish D. Khawaja, MBBS, MD; Alexi Otrakji; et al ([apadole@partners.org](mailto:apadole@partners.org))

**PURPOSE:** The purpose was to evaluate diagnostic image quality in postmortem brain CT acquired at seven different dose levels and reconstructed with filtered backprojection (FBP), adaptive statistical iterative reconstruction (ASIR), and model-based iterative reconstruction (MBIR) techniques.

**METHOD AND MATERIALS:** In an IRB-approved study, postmortem brain CT was performed in 41 human cadavers ( $56.7 \pm 13$  years; body mass index,  $26.3 \pm 6$ ; F:M, 14:27) at seven different dose levels with mean  $CTDI_{vol}$  of 58–7.5 mGy at 100–120 kV (at 350, 180, 90, and 45 mA) on a 64-channel MDCT (Discovery CT750 HD; GE Healthcare, Little Chalfont, United Kingdom). The remaining scan parameters were held constant at pitch of 0.531:1, with rotation time of 1 second. Sinogram data at each dose level were reconstructed with FBP, ASIR (SS50; GE Healthcare), and MBIR (Veo; GE Healthcare) ( $n = 7 \times 3 \times 41 = 861$  series). Radiologists performed independent and blinded comparison of one image series at a time for lesion detection, lesion conspicuity, and visibility of small structures. In addition, subjective image noise artifacts were assessed, and objective image noise was measured.

**RESULTS:** There were 62 lesions detected on 58 mGy, including cerebral hypodensities (16), cerebral edema (19), cerebral hemorrhage (5), subarachnoid hemorrhage (6), ventricular hemorrhage (4), ventriculomegaly (5), cerebral infarct (3), and other lesions (4) (including cysts, meningioma, microangiopathic changes, and air in the ventricles). Only one false-positive lesion at  $CTDI_{vol}$  of 7.5 mGy and three artifacts were detected on MBIR. At  $CTDI_{vol}$  of 15 mGy, lesion conspicuity was acceptable for 18/61 with FBP, 30/61 with ASIR, and 43/61 with MBIR. Visibility of small structures was acceptable in 0/41 with FBP, 26/41 with ASIR, and 32/41 with MBIR. At  $CTDI_{vol}$  of 30 mGy, lesion conspicuity was acceptable for 54/61 with FBP, 55/61 with ASIR, and 57/61 with MBIR. Similarly, visibility of small structures was acceptable in 38/41 with FBP, 41/41 with ASIR, and 39/41 with MBIR. At  $CTDI_{vol}$  of 7.5–15 mGy, subjective and objective image noise was lower with MBIR compared to FBP and ASIR ( $P < .001$ ).

**CONCLUSION:** At CTDI<sub>vol</sub> of 30 mGy, lesion conspicuity and visibility of small structures in postmortem brain CT were equally seen with FBP, ASIR, and MBIR. However, at CTDI<sub>vol</sub> of 15 mGy, lesion conspicuity and visibility of small structures were better seen on MBIR when compared to ASIR and FBP.

**(SS02-09) 3:20 PM**

### Variant Arterial Anatomy in Hepatocellular Carcinoma and Its Importance in Treatment Planning for Transarterial Chemoembolization and in Follow-up Imaging

Kevan V. Stewart, MD, *Texas Tech University Health Sciences Center El Paso, El Paso, TX*; Nassim Akle, MD

**PURPOSE:** The purpose was to detail variant arterial anatomy found in hepatocellular carcinoma (HCC) and its impact on treatment using transarterial chemoembolization (TACE) and its presence on initial and follow-up imaging.

**METHOD AND MATERIALS:** A pictorial review demonstrates variant arterial anatomy in hepatocellular carcinoma with CT, MRI, and angiography at presentation, during treatment, and with follow-up imaging, including lesions that needed multiple treatments secondary to size and variant anatomy. Variant arterial supply to HCC to be considered includes replaced hepatic, inferior phrenic, adrenal, renal, gastric, omental branch, superior mesenteric branch, intercostal, and lumbar arteries.

**RESULTS:** TACE is the standard of care in treating many HCCs. Variant hepatic artery anatomy is common, with replaced right hepatic arteries occurring in 15%–20% of the population. Large and peripherally located HCCs frequently have variant arterial supplies. Arterial anatomic variations besides replaced hepatic arteries must also be considered, including extrahepatic collateral arteries, to achieve successful chemoembolization. The inferior phrenic artery is the most common extrahepatic collateral artery in HCC. If there is tumor recurrence in a peripheral location, a collateral vessel should be suspected.

**CONCLUSION:** Large and peripherally located tumors frequently have variant arterial supplies and may need more than one treatment session to be successfully treated with TACE. Evaluating variant arterial anatomy is necessary to successfully treat HCC with TACE; and if an HCC is present in segments 1, 2, or 7 and the lesion is in contact with the right hemidiaphragm, evaluation of the right inferior phrenic artery is mandatory during angiography.

**Thursday, April 3, 2014**

**2:00–3:30 PM**

### SS03: Education of Residents

**AMA PRA Category 1 Credits™: 1.50**

**Location: Grand Ballroom VI**

**Moderators: Jonathan O. Swanson, MD  
Peter S. Liu, MD**



**(SS03-01) 2:00 PM**

### Predictors of an Academic Career on Radiology Residency Applications

Lars J. Grimm, MD, MHS, *Duke University Medical Center, Durham, NC*; Lauren M. Shapiro; Terry Singhapricha; Maciej Mazurowski; Terry S. Desser, MD; Charles Maxfield, MD (*lars.grimm@duke.edu*)

**PURPOSE:** The purpose was to evaluate radiology residency applications to determine if any variables are predictive of a future academic radiology career.

**METHOD AND MATERIALS:** Application materials from 336 radiology residency graduates between 1990 and 2010 from the departments of radiology at the originating institutions were retrospectively reviewed. The institutional review boards approved this HIPAA-compliant study with a waiver of informed consent. Biographical (gender,

age at application, advanced degrees, prior career), undergraduate school (school, degree, research experience, publications), and medical school (school, research experience, manuscript publications, Alpha Omega Alpha membership, clerkship grades, U.S. Medical Licensing Exam Step 1 and 2 scores, personal statement and letter of recommendation reference to academics, couples match status, clerkship grades) data were recorded. Listing in the Association of American Medical Colleges Faculty Online Directory and postgraduation publications were used to determine academic status.

**RESULTS:** There were 72 (21%) radiologists in an academic career and 264 (79%) in a nonacademic career. Variables associated with an academic career were elite undergraduate school ( $P = .003$ ), undergraduate school publications ( $P = .018$ ), additional advanced degrees ( $P = .027$ ), elite medical school ( $P = .006$ ), a research year in medical school ( $P < .001$ ), and medical school publications ( $P < .001$ ). None of the other variables were associated with a career in academics. A multivariate cross-validation analysis showed that the variables are jointly predictive of an academic career ( $P < .001$ ).

**CONCLUSION:** Among 19 variables on radiology residency applications at two institutions over a 20-year period, we found an association between an academic career and undergraduate and medical school rankings and publications, as well as a research year in medical school and an additional advanced degree. Radiology residency selection committees should consider these results if they wish to recruit future academic radiologists.

**(SS03-02) 2:10 PM**

### Predictors of Radiology Resident Success: Are There Identifiers in Applications That Predict Performance during Residency?

Brandi T. Nicholson, MD\*, *University of Virginia, Charlottesville, VA*; Kaitlyn L. Stortz Powell, BS; Spencer B. Gay, MD; Talissa A. Altes, MD\* (*bte6v@virginia.edu*)

**PURPOSE:** Application data have mixed correlation with resident success during training; studies have shown that many of the factors that would seem to predict success do not correlate with performance. Our purpose was to identify factors from the residency applications of our trainees that could predict their success during residency and to use these to determine if there is a better way to recruit and select medical students into our residency to increase our residents' success.

**METHOD AND MATERIALS:** IRB-SBS approval was obtained for our retrospective study. We reviewed personnel files on prior residents over a 10-year time period, ending at a time where none of those reviewed were still in the program. These files included test scores, application materials, and letters of reference, as well as residency evaluations and test scores. We identified two select groups of residents from the total as "most successful" and "least successful" based on consensus opinion of three faculty, with the goal of identifying at least one resident in each category in each year. Chi-square test was used to compare the mean or percent for each category in the application material with residency evaluations and test scores.

**RESULTS:** Fourteen residents were identified as "most successful" and six residents as "least successful." Letters of recommendation including "one of the best students ever" and/or "we'd like them in our residency" were significantly ( $P = .03$ ) more likely to be present in the "most successful" group. Residents in one of the specialty tracks (research, vascular-interventional, or direct path) were significantly ( $P = .03$ ) more likely to be in the "least successful" group. There was a nonsignificant trend for those with three or more A's on core medical school rotations and for those who came from our own medical school to be "most successful." There were no significant relationships between other factors such as rank list location, prior research, or time off during training and resident success.

**CONCLUSION:** None of the typical metrics predict resident success, including location on rank list. One might carefully read reference letters and look for three or more A's on core rotations when selecting resident applicants.

\* Faculty financial disclosures are located in the Faculty Index.

(SS03-03) 2:20 PM

**Discrepancy Logger Software Identifies Trainee Knowledge Gaps by Radiologic Subspecialty, Imaging Modality, and Body Part: Our 5-Year Experience**

David Garas, *Jefferson Medical College/Thomas Jefferson University Hospital, Philadelphia, PA*; Richard E. Sharpe, Jr, MD, MBA; Richard J. Gorniak, MD; Levon N. Nazarian, MD; Vijay M. Rao, MD; Adam Flanners, MD (*David.Garas@jefferson.edu*)

**PURPOSE:** To recover the educational opportunities that are potentially lost with modern radiology work flow, we created an electronic feedback solution designed to provide direct trainee and attending radiologist communication. The purpose of this study is to describe the distribution of 5 years of report discrepancies by subspecialty, modality, and body part.

**METHOD AND MATERIALS:** A JavaScript and PHP plug-in for our PACS was developed that places a "Discrepancy Logger" button on cases in preliminary status. Discrepancies included missed findings, incorrectly interpreted findings, overcalls, and informational reporting critiques. For each feedback entry, the report accession number, examination body part, and examination modality descriptors were extracted. All logged discrepancies from 3/2/08 to 4/11/13 were included in this study. Discrepancy log entries were analyzed by subspecialty, imaging modality, and body part.

**RESULTS:** A total of 3252 feedback instances occurred using the Discrepancy Logger during the study period. On average, there were 1.7 feedback instances logged per day. The radiologic subspecialty with the largest number of logs entered was neuroradiology (2067 cases; 64% of entries). Entries were also logged for musculoskeletal imaging (484; 15%), abdominal imaging (326; 10%), cardiothoracic imaging (272; 8%), and nuclear medicine (3; 0.09%). The body part with the most logs entered was head (881; 27%). Logged entries also included spine (717; 22%), ENT (500; 15%), extremity (388; 12%) abdomen (291; 9%), and chest (262; 8%). Regarding imaging modality, the most logged entries were for computed tomography (CT) examinations (1860; 60%). Entries were logged for other imaging modalities, including magnetic resonance (574; 18%), radiographs (710; 22%), ultrasound (5; 0.15%), and nuclear medicine (3; 0.09%).

**CONCLUSION:** As the new Diagnostic Radiology Milestone Project requires program directors to evaluate trainee medical knowledge and reporting skills, the Discrepancy Logger is well poised to meet that need by providing quantitative performance evaluation metrics for trainees and by identifying and addressing specific needs and gaps in trainee education.

(SS03-04) 2:30 PM

**A Novel Approach to an Online Case Logbook**

Vikram Sundaram, BA, MD, *Mount Sinai Hospital, New York City, NY*; Amish H. Doshi, MD; Serge Sicular (*vk.sundaram012@gmail.com*)

**PURPOSE:** We propose a novel approach to an online case logbook, which seeks to minimize the disadvantages of other methods of producing and sharing teaching files, such as physical written logbooks, the Medical Imaging Resource Center (MIRC<sup>®</sup>), preinstalled software available on some picture archiving and communication systems (PACS), and public Web sites such as Wikipedia or hospital-affiliated sites.

**METHOD AND MATERIALS:** PubMed searches on current case file creation methods, as well as research on publicly available Web sites regarding the current uses and abilities of products such as MIRC<sup>®</sup> and PACS, were compared to the capabilities of our online logbook, "Rad Cases."

**RESULTS:** Although physical logbooks and public Web sites are cost-effective, they cannot be customized, are rarely searchable, and, in the case of physical logbooks, are not HIPAA compliant. Both MIRC<sup>®</sup> and preinstalled PACS systems, while HIPAA compliant and searchable to a limited extent, require separate extensive libraries of

images to maintain teaching files; and even then, it is not feasible to store and share multislice images such as CT scans. The online case logbook "Rad Cases" is low cost, is HIPAA compliant, can be secured by hospital IT, and can access the library of images already used by a hospital's radiology department. This online case logbook has the added benefit of easy customization and searchability of cases based on patient, image modality, body system, case file creator, or image interpreter, a major advantage over the above methods.

**CONCLUSION:** The online logbook is a cost-effective versatile method for achieving the numerous requirements for a superior teaching file system: HIPAA compliance and security, customization and search function, and ease of use. The online logbook functions without directly requiring a massive library of images aside from that already used by the hospital for day-to-day readings by the radiology department. Rad Cases is an organized method of providing cases for attendings to improve their lectures and instructions, as well as providing residents the chance to review and reinforce the numerous branches of knowledge that must be mastered to become successful attendings themselves.

(SS03-05) 2:40 PM

**The Effect of Overnight Attending Coverage on Resident Education at a Large Academic Medical Center**

John R. McGrath, MD, *University of Rochester Medical Center, Rochester, NY*; Soumya Mitra, PhD; Refky Nicola, DO

**PURPOSE:** At our large academic medical center, an 800-bed hospital and Level I Trauma Center, we have instituted around-the-clock in-house attending coverage and real-time finalization of reports, which started in July 2011. In this study, we aim to determine the effect of this policy change on the education of residents and assess its effects on their ability to learn.

**METHOD AND MATERIALS:** A 34-question Web-based survey was made available to current R2–R4 University of Rochester radiology residents and members of the graduating class who did not experience the overnight coverage. Members of the R2–R4 classes responded regarding experience following 24/7 attending coverage; those in the R4 and postgraduate classes answered regarding their experience prior to presence of overnight attending coverage. A total of 25/34 residents and fellows responded to the questionnaire. Each answer was assigned a ranking based on the Likert response scale (1–5), with 1 indicating never, or not all sufficient, and 5 indicating extremely effective, extremely satisfied, or very often. Data were analyzed using the Mann-Whitney *U* test, with  $P < .05$  being considered significant for assessing difference in medians between the pre- and post-overnight coverage sample groups.

**RESULTS:** Based on all 34 questions, two questions had a *P* value of less than .05, with the suggestion that the precoverage group had a more positive experience with regard to both these questions. These were regarding faculty spending sufficient time teaching and the ability of the night float rotation to prepare residents to formulate a definitive diagnosis. Contrary to the expected outcome, it is likely that the results were influenced by the fact that the individuals in the precoverage group were more experienced.

**CONCLUSION:** These results suggest that an in-house overnight attending at a large academic medical center did not provide residents with an additional positive educational experience. However, a more thorough analysis of the survey data based on the experience level of the responders will be performed to discern any potential contribution of experience level to the study outcome.

### (SS03-06) 2:50 PM The New Radiology Core Examination and Board Review Evolution: Understanding Radiology Resident Needs and Preferences

Allison Simons, MD, *Indiana University School of Medicine, Indianapolis, IN*; Bilal Tahir, MD; Darel E. Heitkamp, MD; Kelvin Visuth; S. Gregory Jennings, MD (*btahir@iupui.edu*)

**PURPOSE:** Radiology residency programs face new challenges transitioning to the computer-based ABR Core Exam. In order to understand the preferences of residents preparing for the exam and supply faculty valuable information on adapting teaching methods, we conducted a resident survey to analyze the Core Exam preparatory process and effective teaching strategies.

**METHOD AND MATERIALS:** Sixteen 4th-year radiology residents were surveyed using Likert scale, yes-no, rank ordering, and free-response question formats to determine their preferences regarding effective review for the Core Exam. Questions included (1) conference style (hot seat, multiple-choice question [MCQ], bulleted high yield points only), (2) case format (number of cases, number of images per case, number of questions per case), (3) answer style (aloud individually, electronic audience response system, aloud individually with electronic audience response system, individually on paper), and (4) answer organization (answers follow each question vs per 5 questions vs per 10 questions vs all questions vs pre-/post-testing with an interval didactic lecture). Free-response questions addressed their ideas for designing effective board reviews, use of ABR resources, favored study materials, and attendance of review courses.

**RESULTS:** MCQ style conference was most preferred (69%). The most preferred method to answer MCQs was individually aloud with concurrent electronic audience response (56%). The audience response system was felt to favorably impact conference (69%), despite the perception by 81% of residents that it slowed conference pace. Residents preferred 20–30 cases per hour (50%), 2–3 images per case (56%), 2–3 associated MCQs per case (81%), and discussion of the correct answer immediately following question (87%). Residents reviewed ABR resources (62%–94%); the rate of use depended on the individual ABR resource. RadPrimer and case review series were favored personal review resources. Review courses attended included Huda and Duke.

**CONCLUSION:** An understanding of resident perceptions is important for modification of board review sessions and faculty teaching style in order to most effectively prepare residents for the Core Exam.

### (SS03-07) 3:00 PM Tablet-based Curriculum for Radiology Resident Education

Summit Shah, MD, MPH, *Ohio State University Medical Center, Columbus, OH*; Mark King, MD (*summitshah@gmail.com*)

**PURPOSE:** The radiology resident learning experience is often varied and self-motivated, with a nonspecific curriculum. Little research has been done to set standards for efficient, innovative methods of delivering this information. The purpose of this study is to prospectively examine the impact of a complete tablet-based curriculum on radiology resident motivation, satisfaction, and engagement.

**METHOD AND MATERIALS:** A complete tablet-based curriculum was implemented, including development of subspecialty modules using the iBooks Author application for the iPad, which followed the American Board of Radiology Core Examination study guide. A virtual resident library with online access to most major radiology textbooks was also created. All 1st- and 2nd-year residents were provided with iPad tablets. Pre- and postsurveys were administered to all radiology residents at our institution in October 2012 and June 2013, respectively. Survey questions used a 5-point Likert scale.

**RESULTS:** Twenty-two residents (81%) completed both surveys. In comparing the presurvey vs postsurvey results, 32% versus 73% residents agreed or strongly agreed that study resources are well organized, 41% versus 91% agreed or strongly agreed that study resources are easily accessible, 27% versus 77% agreed or strongly agreed that study resources encourage active learning, 18% versus 82% agreed or strongly agreed that study resources motivate to study radiology on a daily basis, 36% versus 82% agreed or strongly agreed that study resources will adequately prepare for the radiology board exam, and 36% versus 82% agreed or strongly agreed that he or she is satisfied with the study resources provided by the residency program. The results were all statistically significant, with  $P < .05$ .

**CONCLUSION:** Our study demonstrates the positive impact of implementing a tablet-based curriculum on radiology resident motivation, satisfaction, and engagement. Applications such as iBooks Author have the potential to dramatically transform content delivery in residency education. Further study is necessary to determine whether there is a measurable effect on outcomes such as performance on exams.

### AUR Trainee Prize: 3rd Place

### (SS03-08) 3:10 PM CT Dose Reduction Workshop in Radiology Residency Program

Leonardo I. Valentin, MD, *Baylor College of Medicine, Houston, TX*; Erik Soloff, MD; Arun Nachiappan, MD; Zeyad A. Metwalli, MD; Rafael Vicens; Alfred E. Delumpa, MD; et al

**PURPOSE:** A system to reduce patient radiation dose from computed tomography (CT) is important and needs to be consistently implemented in the radiology department. A CT dose reduction group has the opportunity to assess and improve knowledge of radiology residents and faculty in regard to excessive radiation exposure related to CT protocol design.

**METHOD AND MATERIALS:** One-hour workshops were held for a year at monthly intervals, on average. Participants included diagnostic radiology residents, a physicist, a CT technologist, and attending radiologists. An academic article was presented during each session, followed by a brief discussion. Presenters reported on the current status, recent changes, and future changes involving a particular CT protocol, based on a literature search. Team-based decisions for further implementations of dose reduction techniques were made. An IRB-approved 20-item online questionnaire was sent to compare differences between workshop participants and nonparticipants.

**RESULTS:** Several CT protocols were updated, resulting in dose reduction of at least 50% for various CT protocols. Image quality was deemed diagnostic by subspecialty-trained attending radiologists. Response rate for the questionnaire was 51% (41), and 73.2% (30) were residents. Eighty percent (32) agreed or strongly agreed it is important to have a working group to periodically review and revise the protocols to reduce radiation exposure. The relationship between workshop participation and confidence in knowledge of dose reduction techniques showed the average score ( $\pm$  standard deviation) of the "not a participant" group is  $3.0 \pm 0.82$  (95% CI mean: 2.64, 3.36) and of the "participant in more than 5 sessions" group is  $4.5 \pm 0.55$  (95% CI mean: 3.93, 5.07). There is a significant statistical difference between the two groups ( $P < .0013$ ).

**CONCLUSION:** Focused workshops are effective in educating and ensuring continual implementation of radiation dose reduction techniques. A large majority of survey respondents believe a CT dose working group is essential to reduce radiation dose to patients.

### (SS03-09) 3:20 PM Radiation Doses of Radiology Residents

Christopher Conner, MD, *Medical University of South Carolina, Charleston, SC*; Walter Huda, PhD\*; Bayne Selby; Tina Rapstine

**PURPOSE:** The purpose was to determine the radiation exposure of radiology residents throughout training.

**METHOD AND MATERIALS:** MUSC takes an average of eight residents each year, and each resident's occupational doses are obtained using dosimeters (provided by Landauer Inc, Glenwood, IL). The deep dose equivalent (DDE) doses (mSv) received by radiology residents in our program over an 8-year period were reviewed. Average monthly doses were obtained separately for all recorded dose values and for all nonzero values ( $>0.01$  mSv). Average monthly DDE doses were analyzed to determine temporal trends over the 8-year period studied, as well as dose differences in each of the 4 years of the residency program.

**RESULTS:** The total number of monthly dose values was 2918, of which only 721 (25%) recorded nonzero values. The overall average whole-body dose was  $0.08 \pm 0.07$  mSv, and the corresponding average of nonzero values was  $0.17 \pm 0.13$  mSv. There were no notable temporal trends over the 8-year period covered in this study. The average monthly dose for 1st-year residents (0.15 mSv) was about three times higher than the corresponding doses in each of the three later years of residency.

**CONCLUSION:** Monthly occupational doses for radiology residents at MUSC obtained from 2005 to 2013 showed that on average, residents in our program receive an average annual occupational dose of about 1.0 mSv, or 2% of the current regulatory dose limit.

#### AUR Joseph E. and Nancy O. Whitley Award

### (SS03-10) 3:30 PM 24/7/365 In-house Radiologist Coverage: Effect on Resident Education

Jannette Collins, MD, MEd, FCCP, *University of Cincinnati College of Medicine, Cincinnati, OH*; Larry D. Gruppen, PhD; Janet E. Bailey, MD; Syed A. Bokhari, MD; Angelisa M. Paladin, MD; Jessica B. Robbins, MD; et al ([jannette.collins@uchealth.com](mailto:jannette.collins@uchealth.com))

**PURPOSE:** The purpose was to compare programs with and without 24-hour/7 days a week/365 days a year (24/7/365) in-house radiologist coverage regarding resident perceptions of their on-call experience, volume of resident dictations on call, and report turnaround time.

**METHOD AND MATERIALS:** Residents from six academic radiology departments were invited to participate in an 11-item online survey. Survey items were related to workload, level of autonomy, faculty feedback, comfort level, faculty supervision, and overall educational experience while on call from 8 PM to 8 AM. Each site provided data on imaging volume, radiologist coverage, volume of examinations dictated by residents, number of residents on call, and report turnaround time from 8 PM to 8 AM. F ratios and  $\eta^2$  were calculated to determine the relationships between dependent and independent variables. A  $P$  value  $< .05$  was considered statistically significant.

**RESULTS:** A total of 146 (67%) of 217 residents responded. Residents in programs with 24/7/365 in-house radiologist coverage dictated a lower percentage of examinations (46%) compared with other residents (81%) and rated faculty feedback more positively (mean, 3.8 vs 3.3) but rated their level of autonomy (mean, 3.6 vs 4.5) and educational experience (mean, 3.6 vs 4.2) more negatively (all  $P < .05$ ). Report turnaround time was lower in programs with 24/7/365 coverage than those without (mean, 1.7 hours vs 9.1 hours). Most resident comments were negative and related to loss of autonomy with 24/7/365 coverage.

**CONCLUSION:** More rapid report turnaround time related to 24/7/365 coverage may come at the expense of resident education.

### Thursday, April 3, 2014 2:00–3:30 PM

#### SS04: Women's Imaging; Health Services AMA PRA Category 1 Credits™: 1.50

Location: Kent

Moderators: Brandi T. Nicholson, MD\*  
Christopher P. Ho, MD

BR ED

#### (SS04-01) 2:00 PM Dedicated 3D Breast CT: Lesion Characteristic Perception by Radiologists

FDA

Cherie M. Kuzmiak, DO\*, *University of North Carolina, Chapel Hill, NC*; Elodia Cole, MS\*; Donglin Zeng, PhD; Laura Tuttle, BS; Doreen Steed, RT; Etta D. Pisano, MD\* ([Cherie\\_kuzmiak@med.unc.edu](mailto:Cherie_kuzmiak@med.unc.edu))

**PURPOSE:** The purpose was to assess radiologist confidence in the characterization of suspicious breast lesions with a dedicated 3D breast CT system, in comparison to diagnostic 2D full-field digital mammography.

**METHOD AND MATERIALS:** Twenty patients were consecutively recruited from women who were scheduled to undergo a breast biopsy for at least one mammography-detected BI-RADS 4 or 5 lesion detected with diagnostic 2D full-field digital mammography (dxDM) in this IRB-approved study. The enrolled subjects subsequently underwent imaging of the breast(s) of concern using a dedicated 3D breast CT system (CT). Seven experienced breast imaging radiologists reviewed the randomized cases in a reader study. Each reader was asked to compare side by side the breast CT exam to the dxDM exam including the lesion recommended for biopsy. Each reader was asked to specify the lesion type and BI-RADS score for each lesion for each modality, and then they were asked to compare the lesion characteristics—shape for masses or morphology for calcifications; and margins for masses or distribution for calcifications—between the two modalities using confidence scores (0–100).

**RESULTS:** There were 23 biopsied lesions included in this study: 13 (57%) masses, 7 (30%) calcifications, and 3 (13%) architectural distortions. Eight (35%) lesions were malignant, and 15 (65%) were benign. Across all lesions, there was no significant difference in the margin/distribution ( $\Delta = -0.99$ ;  $P = .84$ ) and shape/morphology ( $\Delta = -0.10$ ;  $P = .98$ ) visualization confidence scores of CT in relation to dxDM. However, analysis by lesion type showed a statistically significant increase in reader shape ( $\Delta = 11.34$ ;  $P = .013$ ) and margin ( $\Delta = 9.93$ ;  $P = .023$ ) visualization confidence with CT versus dxDM for masses and a significant decrease in reader morphology ( $\Delta = -29.95$ ;  $P = .001$ ) and distribution ( $\Delta = -28.62$ ;  $P = .002$ ) visualization confidence for calcifications.

**CONCLUSION:** Radiologists showed improved confidence in visualization of suspicious masses with 3D breast CT in comparison to diagnostic 2D mammography but decreased confidence in visualization of calcifications with 3D breast CT.

#### (SS04-02) 2:10 PM MR Imaging Surveillance of Women with a History of Breast Cancer: The Multiyear Experience of an Out-patient Imaging Center in Northeast Pennsylvania

Gary Ihnat, BS; John S. Farrell, MD, *Commonwealth Medical College, Scranton, PA*; Josh McCambridge, BS; Amanda Moyer, BS; Eleanor Gillis, MS; Megha Patel, MS; et al ([ihnatg2@gmail.com](mailto:ihnatg2@gmail.com))

**PURPOSE:** The use of screening breast MRI examinations in addition to mammography in women with a previous history of breast carcinoma, lobular neoplasia, and atypical ductal hyperplasia is a matter of ongoing investigation in the literature. To date, there have been no formal guidelines to implement such surveillance from the

\* Faculty financial disclosures are located in the Faculty Index.

American Cancer Society (ACS) or the American College of Radiology (ACR). The ACS and ACR suggest yearly MRI as an adjunct to yearly mammogram in high-risk women; however, both organizations categorize women with a prior breast cancer as intermediate risk. Some recent literature supports the use of screening breast MRI as an adjunct to mammography in these patients. This retrospective analysis contributes to the growing body of research on this topic by investigating the outcomes of screening MRI in women with a prior history of breast cancer, to evaluate the rate of biopsy and cancer detection.

**METHOD AND MATERIALS:** From 2005 to 2012, there were 499 patients with a previous history of breast cancer who had at least one MRI at this facility. Of those, 145 have received at least two screening breast MRIs no more than 2 years apart. The electronic medical records of these patients were reviewed with attention to abnormal findings on MRI examinations without a correlate finding on the patient's most recent mammogram, subsequent biopsies, and pathology results.

**RESULTS:** Of the 145 patients who have undergone regular screening MRI, 110 (75.9%) have had no biopsy or recurrent malignancy detected via MRI. The remaining 35 (24.1%) have had biopsies. Of the 35 biopsied patients, 16 (46%) had malignancies, and 19 (54%) had benign findings. In total, there were 17 malignancies found and 20 benign biopsies (two patients had two biopsies). Of the malignancies, 11 were ductal carcinoma in situ (DCIS), 1 was lobular carcinoma in situ, 3 were invasive ductal carcinoma, and 2 were invasive tubular carcinoma.

**CONCLUSION:** The analysis shows that screening breast MRI examinations in this patient population led to a 25.5% biopsy rate with an 11.0% recurrent malignancy detection rate and a positive predictive value of 45.9% (95% CI, 31%–62%). DCIS was the most likely malignancy to be detected on screening MRI.

#### (SS04-03) 2:20 PM Promising Method to Preoperatively Localize Sonographically Occult Breast Malignancies without a Wire

Jamie Hui, MD, *Virginia Mason Medical Center, Seattle, WA*; Beverly Hashimoto, MD\*; Joanna Haug, MS; Peter R. Eby, MD ([jamie.hui@vmmc.org](mailto:jamie.hui@vmmc.org))

**PURPOSE:** The purpose was to test the hypothesis that preoperative sonographic localization of sonographically occult breast malignancies using a hydrogel-based marker clip is equivalent to preoperative wire localization.

**METHOD AND MATERIALS:** We performed an institutional review board–approved retrospective single-institution study of all patients who underwent mammographic stereotactic vacuum-assisted breast biopsy from March 2011 to February 2012 for suspicious nonpalpable lesions. All of the lesions were only visible mammographically and were sonographically occult. We compared two groups with malignant pathology that required preoperative localization. Group 1 skipped wire localization and proceeded directly to the operating room for sonographic identification of a hydrogel-based marker clip. Using sonographic guidance, the surgeon excised the appropriate portions of the breast and removed the marker. Group 2 had standard preoperative wire localization performed by the radiologist. Primary outcome measures of positive margins and reexcision were compared with a  $\chi^2$  test, and a *P* value of  $<.05$  was considered significant.

**RESULTS:** A total of 336 sonographically occult lesions were mammographically biopsied. Of these biopsies, 59 malignant lesions required preoperative localization: 12/59 (20%) in group 1 and 47/59 (80%) in group 2. Three of 12 (25%) cases from group 1 and 12/47 (26%) cases from group 2 had positive margins with reexcision. Chi-square analysis revealed no statistical difference in margin positivity (*P* = .97) or reexcision rate (*P* = .97) between groups 1 and 2.

**CONCLUSION:** Preoperative sonographic localization targeting hydrogel-based marker clips was equivalent to wire localization for

sonographically occult malignancies. Eliminating preoperative wire localization could improve the patient experience by reducing the procedure time, anxiety, pain, radiation exposure, and potential complications, as well as medical costs.

#### (SS04-04) 2:30 PM Automated Breast Volumetric Scanning: Effect of Education on the Diagnostic Performance and Interobserver Agreement of Radiologists

Cherie M. Kuzmiak, DO\*, *University of North Carolina, Chapel Hill, NC*; Eun Young Ko, MD, PhD; Doreen Steed, RT; Donglin Zeng, PhD ([Cherie\\_kuzmiak@med.unc.edu](mailto:Cherie_kuzmiak@med.unc.edu))

**PURPOSE:** The purpose was to assess the effect of education on the performance of readers and on interobserver agreement in evaluating lesions with automated breast volumetric scanning (ABVS).

**METHOD AND MATERIALS:** The data set consisted of 25 patients with 30 biopsied masses who underwent ABVS prior to a breast biopsy. Seven (23.3%) masses were malignant, and 23 (76.6%) were benign. Five breast imaging radiologists reviewed the randomized cases in a reader study. Each reader was asked to specify the lesion type, imaging features, BI-RADS score, and probability of malignancy for each lesion for each case. The time of review of each case for each radiologist was recorded. After a washout period, each reader met with the study PI for a dedicated ABVS tutorial. Information regarding image acquisition, display, and interpretation was reviewed both in didactic form and at a dedicated workstation. The readers again reviewed the randomized cases, scored them, and were timed. The data were then analyzed.

**RESULTS:** The analysis of diagnostic performance between the two conditions was not significant. The *P* values for sensitivity and specificity were .89 and .39, respectively. Education did not have a statistically significant effect on interreader agreement for all lesions (*P* = .17). However, analysis demonstrated interreader improvement in benign (*P* = .22) versus malignant lesions (*P* = .5). The average time of interpretation of each case decreased by 1.9 minutes but was not significant (*P* = .06).

**CONCLUSION:** Dedicated modality training of radiologists decreased interpretation time but did not have a significant effect on diagnostic performance or interobserver agreement.

#### (SS04-05) 2:40 PM Tumor Growth Kinetics versus RECIST to Assess Response to Locoregional Therapy in Breast Cancer Liver Metastases

Adeel R. Seyal, MD\*, *Northwestern University-Feinberg School of Medicine, Chicago, IL*; Keyur Parekh, MD\*; Yury Valichko, PhD; Riad Salem\*; Vahid Yaghamai, MD

**PURPOSE:** The purpose was to evaluate growth kinetics changes in breast cancer liver metastases in response to locoregional therapy and to compare with RECIST.

**METHOD AND MATERIALS:** This HIPAA-compliant study was IRB approved. Thirty-four chemorefractory breast cancer liver metastases from 21 patients treated with yttrium 90 ( $^{90}\text{Y}$ ) were evaluated. Pre- and posttreatment CT scans were used to calculate tumor volume and growth kinetics. The growth parameters analyzed were percentage growth rate (%GR) and reciprocal doubling time (RDT). A lesion with negative %GR and RDT was determined to show response to treatment, whereas a positive %GR and RDT value indicated progression of disease. Comparison was made with tumor response classification according to percentage change in the lesion's maximal diameter per RECIST. Student *t* test was used for analysis. Significance was set at .05.

**RESULTS:** Mean time interval between  $^{90}\text{Y}$  treatment and posttreatment CT scan was 27.7 days. Fifteen (55.6%) lesions were classified as stable by RECIST but responded to treatment according to growth kinetics (mean %GR and RDT of  $-0.96$  and  $-7.32$ , respectively), whereas

\* Faculty financial disclosures are located in the Faculty Index.

12 (44.4%) lesions did not respond (mean %GR and RDT of 0.72 and 3.1, respectively). Growth kinetic parameters were significantly different between responders and nonresponders ( $P < .0001$ ).

**CONCLUSION:** In patients with breast cancer liver metastases undergoing locoregional therapy, there is discrepancy between RECIST classification and growth kinetics for tumor response assessment. RECIST stable disease may not be an accurate reflection of alterations in tumor growth kinetics.

#### (SS04-06) 2:50 PM

### Improving Patient Histories on Abdominal CT Examinations: A Quality Improvement Project in a Large County Hospital Radiology Department

Mary E. McCrate, MD, *Indiana University School of Medicine, Indianapolis, IN*; Bilal Tahir, MD; Elise Miller, MD; S. Gregory Jennings, MD; Jennifer L. Steele, MS; Temel Tirkes, MD (*btahir@iupui.edu*)

**PURPOSE:** A large number of abdominal CT scans were being sent to PACS with inadequate histories, ranging from nonbillable indications such as “no contrast needed” to poor descriptors such as “pain.” As part of a quality improvement initiative, an analysis of the process, from physician ordering to technologist completion of examinations, was conducted to identify both systemic and departmental contributing factors. A subsequent technologist-driven initiative was enacted to resolve underlying barriers.

**METHOD AND MATERIALS:** The stepwise process of CT order entry, examination completion, and transmission to PACS was analyzed to understand the origin of inadequate patient histories. Educational steps were implemented to train radiologic technologists to obtain and enter useful patient information into the PACS system. Initiatives included formal protocoling of technologist-patient interaction and computer data entry training specifically tailored to the PACS display at the completion of studies. Retrospective analysis was performed to calculate and compare the percentage of studies performed with and without useful patient histories from abdominal CT scans performed in 1-month intervals before and 3 months after initiative implementation.

**RESULTS:** The total number of abdominal CT scans performed for each 1-month interval was not significantly different (508 in April 2012; 525 in March 2013). A 61% improvement in the number of scans completed with adequate patient histories was demonstrated in the posteducation month ( $P < .01$ ), such that 90% of studies included adequate patient histories. Technologists responded favorably to the new protocol, with a 13 times greater likelihood of technologists adding helpful comments to studies. Resident and faculty radiologists had an overwhelmingly positive response to this initiative.

**CONCLUSION:** A radiologic technologist-driven quality improvement initiative can be used to remarkably improve the availability of an adequate patient history for the interpreting radiologist within a large county hospital. These comments can theoretically provide billable diagnoses and potentially improve diagnostic accuracy, thus positively impacting patient care and ordering physician satisfaction.

#### (SS04-07) 3:00 PM

### Image Interpretation in Radiology: A Conceptual Framework of Knowledge and Skills

Anouk van der Gijp, MD, *University Medical Center Utrecht, Utrecht, Netherlands*; M.F. van der Schaaf; I. C. van der Schaaf; C. J. Ravesloot; T. J. ten Cate; Jan P. Van Schaik, MD

**PURPOSE:** Image perception in current radiology practice involves 2D images as well as volumetric image data sets that radiologists can navigate through in different planes. It is largely unknown which knowledge and skills are necessary for 2D and volumetric

image interpretation. Insight into this process is essential for the development of radiology education and assessment. In this study, we investigated the image interpretation process with a literature search, expert interviews, and verbal protocols. We aimed to create a framework with knowledge and skills necessary for 2D and volumetric image interpretation.

**METHOD AND MATERIALS:** First, a literature search was conducted to identify knowledge and skills that are considered important for radiologic image interpretation. We searched the databases PubMed, Embase, PsycINFO, and ERIC for “image interpretation skills,” “visual expertise,” and “radiology” and synonyms. All relevant articles published before January 2012 were included if knowledge and skills with empirically established relevance for radiologic image interpretation were described. A framework of knowledge and skills was designed, and a preliminary version of it was discussed in semistructured interviews with nine experts (five radiologists with educational expertise, two educationalists with research experience in radiology education, and two psychologists). The importance of the knowledge and skills was discussed, and formulations and definitions were adjusted when necessary. Finally, a study was conducted among medical students. Ten clerks were asked to think aloud while interpreting 2D and volumetric images. The framework was used as a coding scheme to score the verbal protocols, and it was refined based on the verbal protocols.

**RESULTS:** The study resulted in a framework of the image interpretation process, divided into three main components: perception, analysis, and synthesis, subdivided into 16 knowledge and skill items required for radiologic image interpretation.

**CONCLUSION:** We created a literature-based and expert-supported framework of knowledge and skills that are important for radiologic 2D and volumetric image interpretation. The framework can serve as a tool for development of radiology education and assessment.

#### (SS04-08) 3:10 PM

### Imbalance of Opinions Expressed on Twitter Relating to CT Radiation Risk

Vinay Prabhu, MD, MS, *New York University School of Medicine, New York, NY*; Andrew B. Rosenkrantz, MD (*Vinay.Prabhu@nyumc.org*)

**PURPOSE:** Twitter, a social network with over 500 million users, has become an important venue for exchange of health care information and ideas, with potential to influence public opinion and behavior. In this study, our aim was to assess perspectives and sources of information on Twitter relating to CT radiation risk.

**METHOD AND MATERIALS:** Beginning August 1, 2012, consecutive publicly available tweets meeting the search criteria “CT radiation” were jointly coded by two reviewers for relevancy to radiation risk and further categorized by (1) type of user posting, (2) opinion expressed regarding CT benefit/risk ratio (favorable, unfavorable, etc), and (3) content of linked information. Tweets posted by computer-generated news aggregators were excluded.

**RESULTS:** A total of 180 consecutive relevant tweets were tweeted by 166 unique users: 31 (19%) physicians (including four radiologists), 24 (14%) businesses, 22 (13%) other health professionals, 20 (12%) health-related associations, 14 (8%) news reporters/networks, 8 (5%) medical practices/hospitals, 3 (2%) physicists/technologists, 3 (2%) patients, and 41 (25%) other user types. Seventy-four tweets included user commentary: 37 (50%) unfavorable, 11 (15%) concerned, 6 (8%) favorable, 14 (19%) neutral, and 6 (8%) informative relating to CT risk reduction strategies. A total of 157 tweets included active links to 45 unique articles: 14 articles were unfavorable, 3 concerned, 1 favorable, 6 neutral, and 21 informative relating to CT risk reduction strategies. Article sources were as follows: 13 lay press, 13 non-peer-reviewed medical sources, 9 peer-reviewed medical journals, 4 individual opinions/blogs, 3 advertisements, and 3 informational pamphlets/Web sites.

**CONCLUSION:** A large majority of posts on Twitter had a concerned or unfavorable view regarding CT radiation risk, both in user commentary and posted links. A majority of posts were by nonphysicians, and posts by physicians were largely by nonradiologists. Most links were to lay press and other non-peer-reviewed sources. More active engagement by radiologists and physicists on Twitter may achieve a more balanced representation and help alleviate concerns relating to CT radiation risk that appear to dominate the social media atmosphere.

#### (SS04-09) 3:20 PM

##### Improving the Quality and Efficiency of Research Imaging for Clinical Trials

Nicholas P. Grusauskas, PhD, *University of Chicago, Chicago, IL*; Michael D. Torno, DSc; Jonathan S. Marino, BS; Faustino D. Santiago, BA; Samuel G. Armato III, PhD (*ngrusz1@uchicago.edu*)

**PURPOSE:** Medical imaging is often an integral part of clinical research across all departments. Coordinating this imaging can be complicated and time-consuming, particularly in an academic medical center with multiple trials in progress simultaneously. The issue of acquiring and distributing medical images in a compliant manner is critical and challenging. A dedicated infrastructure was created at our institution to assist with these issues and improve collaborations between radiology and research staffs.

**METHOD AND MATERIALS:** The Human Imaging Research Office (HIRO) was created to facilitate investigators at our institution conducting research that requires medical imaging and to ensure that the necessary imaging is performed and images distributed in compliance with the research protocol, IRB requirements, and HIPAA regulations. After 3 years of operation, a survey regarding the HIRO's effectiveness was conducted among 61 clinical research coordinators within our institution. Recipients were asked about their use of HIRO services, the amount of time saved, and overall satisfaction.

**RESULTS:** Thirty-four recipients responded, with 33 stating they routinely utilize HIRO services. Twenty-eight respondents indicated the HIRO saved time and increased accuracy, with an average time savings of 256 hours per person per year. Seventeen respondents indicated that, if left to their own resources, they would not have been able to comply with the imaging requirements of the studies they manage. Based on the average time savings, it is estimated the HIRO provides approximately 7.5 FTEs of productivity per year. With the HIRO's staff of 6.5 FTEs, the net savings for our institution is 1 FTE per year.

**CONCLUSION:** Implementation of the HIRO has increased the level of satisfaction and interaction among clinical investigators and imaging professionals at our institution. Those who utilize the HIRO have benefited from a more efficient imaging experience. In addition, the HIRO reduces institutional liability and increases our competitiveness. The need for imaging infrastructure continues to grow as the requirements of clinical research become more complex, and although it is not cost neutral, it is becoming more cost-effective and is nonetheless essential for compliance.

## Thursday, April 3, 2014

### 2:00–3:30 PM

#### SS05: Radiology Potpourri

AMA PRA Category 1 Credits™: 1.50

Location: Essex

Moderators: David V. Schacht, MD  
Siva P. Raman, MD

ED

#### (SS05-01) 2:00 PM

##### Author Inflation: Does It Occur in the Field of Radiology? Review of 143,315 Articles Published by Radiologists over the Past 20 Years

Daniel S. Chow, MD, *Columbia University Medical Center, New York, NY*; Richard Ha, MD; Christopher G. Filippi, MD

**PURPOSE:** There is evidence in academic medicine that the number of authors per paper (NAPP) has increased over time. The goal of this study is to quantitatively analyze authorship trends in the field of radiology over the past 20 years for the United States and other developed nations.

**METHOD AND MATERIALS:** This retrospective bibliometric analysis of public data was exempt from institutional review board approval. All articles published by radiology departments between 1991 and 2011 were identified in the National Library of Medicine MEDLINE database. Country of origin, article study design, and journal of publication were recorded. Growth in NAPP was performed using linear and nonlinear regression.

**RESULTS:** A total of 143,315 articles and 704,746 authors were identified during the study period. The mean NAPP displayed a linear growth from 3.9 to 5.8. The proportion of single authors declined from 11% (507/4583) in 1991 to 5.1% (468/9116) in 2011. Among differing study methodologies (review articles, case reports, comparative studies, and clinical trials), the NAPP all rose in a linear fashion from 2.6 to 4.0, 3.6 to 4.5, 5.0 to 7.0, and 5.9 to 7.5, respectively. Globally, countries with the highest NAPP were Japan (6.5), South Korea (5.8), Ireland (5.6), China (5.4), and Italy (5.1). United States was the ninth highest, with 4.9 NAPP. The leading five radiology journals by number of publications (*AJR: American Journal of Roentgenology, Radiology, American Journal of Neuroradiology, European Radiology, Journal of Computer Assisted Tomography*) all displayed linear growth in NAPP in the past 20 years. In addition, journals sub-categorized by impact factor did not show any significant differences in observed linear growth pattern of NAPP in the past 20 years.

**CONCLUSION:** Similar to trends observed in other disciplines in medicine, the field of radiology also demonstrates a steady increase in mean NAPP over the past 20 years. The trend of rising NAPP is seen across varying study methodologies, developing nations, and leading radiology journals. With current trends, it is likely that these propensities will continue. Findings support the need for reemphasis of authorship criteria to preserve authorship value and accountability.

#### (SS05-02) 2:10 PM

##### Program Director's Guide to the Medical Student Performance Evaluation (Dean's Letter) with a Database

James B. Naidich, MD, *North Shore University Hospital, Manhasset, NY*; Pamela J. Lombardi, MD; Gregory M. Grimaldi, MD; Lawrence P. Davis, MD; Jason J. Naidich, MD, MBA (*jnaidich@yahoo.com*)

**PURPOSE:** A common recurrent complaint of those who interpret deans' letters of evaluation is that too often it is impossible to estimate how a candidate performed in medical school in comparison to his or her peers. This information is important to program directors in deciding who to invite for an interview and is not otherwise available in the application. To remedy the situation, we set out to develop a database. Our purpose was to create a tool to enable

program directors to quickly extract the useful information from the Medical Student Performance Evaluation (MSPE) letter.

**METHOD AND MATERIALS:** Institutional review board approval was obtained for this project. From a list of 138 AAMC member schools and 1007 applications for residency training positions, we sought to determine to what extent and in what manner individual schools reveal how their students performed relative to their peers. We then set out to create a database pairing the individual schools with the information obtained from the MSPE.

**RESULTS:** We were able to obtain complete information concerning how a medical student was evaluated relative to their peers for 89 medical schools, partial information for 38 schools, and no data for 11 schools. We found that only 11/138 (8%) would routinely include comparative information in the MSPE.

**CONCLUSION:** Although to some extent a work in progress, this database will inform the reader if comparative information is available in the MSPE, guide the reader to its location, and explain the meaning of the language different schools use to rank or classify their students.

#### (SS05-03) 2:20 PM

### Mini-OSCE (Objective Structured Clinical Examination) for Assessment of Diagnostic Radiographic Skills, Professionalism, and Communication as Part of a 4-Week Medical Student Radiology Selective

Maria C. Shiao, MD, *New York University Medical Center, New York, NY*; Sheryl Tulin-Silver, MD; Nancy Kim (*Maria.Shiao@nyumc.org*)

**PURPOSE:** The purpose was to assess feasibility, reliability, validity, and value added of a radiology OSCE assessment for the radiology selective.

**METHOD AND MATERIALS:** A four-station radiology OSCE was created. Stations were as follows: (a) telephone call requesting a contrast-enhanced CT examination for a patient, (b) development of a differential diagnosis and selecting the most appropriate imaging test for three clinical scenarios, (c) hands-on right upper quadrant ultrasound (US), and (d) interpretation of an unknown radiology study while generating a radiology report using voice recognition software. A clinician educator, assessment specialist, and standardized patient (SP) coordinator, each with extensive OSCE experience, were consulted. Each station was allotted 15 minutes, with 5 minutes in between stations. Total completion time for a single round of the OSCE was 1.25 hours. Post-OSCE student survey was administered.

**RESULTS:** Using the Angoff procedure, a scoring system was devised. Mean station scores were US skills, 92.3% (SD, 14.6); US SP evaluation, 93.6% (SD, 10.8); telephone case, 88.3% (SD, 10.03); voice dictation, 75.2% (SD, 19.2); and ddx/most appropriate imaging test range, 79.49% (SD, 7.3) to 92.3% (SD, 14.6). Eleven line items were assessed on the post-OSCE student survey using a 4-point scale; for all but two, scores ranged from 3.1 to 3.8. Comparison of students' performance on the dictation station versus classroom simulation dictation exercises was statistically different ( $P = .00327$ ). Insufficient time and fast-playing movie files likely contributed to lower OSCE scores. Only one case of the ddx/imaging management station showed a statistical difference in performance ( $P < .01$ ) compared to classroom performance. Reason for lower scores was likely lack of reinforcement of the curricular material. Variability among evaluators was not statistically significant, except between US evaluators ( $P = .0266$ ).

**CONCLUSION:** Debriefing and student feedback identified areas for improvement. For example, the dictation software will be installed nearby to reduce travel time between stations. Scoring sheets and student responses will be entered online during the exam, and imaging will be added to the ddx/imaging selection station to enhance clinical relevance.

#### (SS05-04) 2:30 PM

### Perceptions of Radiology, Imaging Utilization, US, and the ACR Appropriateness Criteria® in Preclinical Medical Students

Robert J. Ward, MD, *Tufts Medical Center, Boston, MA*; Troy Maetani, MD; Rajeev C. Saxena, BA; Daniel M. Adams, MD; Michael Lanfranchi, Jr, MD; Gene M. Weinstein, MD

**PURPOSE:** The purpose was to evaluate perceptions of preclinical medical students with respect to radiologists, imaging utilization, ultrasound, and the ACR Appropriateness Criteria®.

**METHOD AND MATERIALS:** A total of 135 Tufts School of Medicine class of 2015 students attended 2.5 hours of radiology lectures given by faculty and residents from the Tufts Medical Center department of radiology. The five lectures were interactive case-based presentations emphasizing utilization and the role of the ACR Appropriateness Criteria® (ACR/AC). The students were sent an online survey (Survey Monkey) comprised of 12 questions. Three questions focused on over- or misutilization of imaging, five questions on the ACR/AC, three questions on ultrasound in medical student education, and one question on which subspecialty was best equipped to guide the imaging workup.

**RESULTS:** Sixty-six (49%) 2nd-year medical students responded. Approximately 80% of students agreed that overutilization is currently a problem in health care. 50% of respondents indicated that imaging utilization had been adequately discussed, while 50% indicated that utilization education was insufficient. The students viewed the ACR/AC favorably and suggested that a mobile device app would be useful. The students indicated how much money they might be willing to spend on such an app. The students overwhelmingly agreed that ultrasound should play a role in their basic science education. Seventy percent responded that radiologists are best equipped to guide the imaging workup.

**CONCLUSION:** Following an introduction to diagnostic radiology lecture just prior to the start of 3rd-year clerkships, students agreed utilization was an important topic and that the ACR/AC were a useful tool that they planned to utilize on clinical services. Students indicated interest in an ACR/AC app. Ultrasound was considered an important tool for teaching in the basic sciences.

#### (SS05-05) 2:40 PM

### Radiology Curriculum for Physician Assistants: A Practical Approach

Sumir S. Patel, MD, *Georgia Regents University, Augusta, GA*

**PURPOSE:** Instruction in diagnostic radiology for physician assistants currently comprises a minority of the allotted time for a standard postgraduate curriculum. At our institution, the 27-month curriculum is divided into didactic and clinical components, with radiology instruction taking place during the didactic 1st year. Because of the unique constraints of an abbreviated medical curriculum and the limited possibilities for radiology specialization for physician assistants, it was imperative to create an approach with both a limited scope and a high impact.

**METHOD AND MATERIALS:** The aspects of the curriculum pertaining to radiology were first reviewed by the faculty, and areas of apparent insufficiency were identified. We implemented the new structure of didactic teaching throughout the students' various clinical modules. Since all radiology instruction was incorporated into systems-based modules, new test questions were created and integrated into these comprehensive examinations.

**RESULTS:** Our approach integrated a curriculum based on the Alliance of Medical Student Educators in Radiology (AMSER) online curriculum with inclusion of certain core topics that a practitioner should be able to identify and manage. Furthermore, a central element of the new curriculum is based on the understanding that as physician assistants, there is a reduced emphasis on the interpretation of high-level diagnostic studies. Instead, an emphasis on the

American College of Radiology Appropriateness Criteria® was introduced with the creation of case-based modules that students would work through in small groups. The new curriculum comprised eight 1.5-hour sessions, with 1 hour spent in a didactic session and 30 minutes spent in ACR Appropriateness Criteria® case-based small groups.

**CONCLUSION:** A radiology curriculum for physician assistants must be of utmost practicality, considering the time and educational constraints inherent in such a program. A limited scope with a focus on both core diagnostic modules and the ACR Appropriateness Criteria® is essential in creating conscious providers. As physician extenders continue to grow in health care in this country, this approach at comprehensive radiological education is fundamental.

**(SS05-06) 2:50 PM**

### Who Owns the Image? Archiving and Retention in the Digital Age

Jonathan Mezrich, MD, *University of Maryland Medical Center, Baltimore, MD*; Eliot L. Siegel, MD\* ([jmezrich@umm.edu](mailto:jmezrich@umm.edu))

**PURPOSE:** Patients are often confused as to their rights to diagnostic imaging under the current regulatory environment. Facilities which generate imaging retain ownership rights, although use/maintenance of those images is impacted by HIPAA, HITECH, and a variety of image retention laws. To what extent do patients understand who owns their imaging and to what extent images may be used without their consent?

**METHOD AND MATERIALS:** An online survey was conducted of approximately 210 members of the U.S. general public through SurveyMonkey ([surveymonkey.com](http://surveymonkey.com)) online Audience service, regarding their understanding as to the ownership of imaging. There were 51 responses, representing a 24.2% response rate.

**RESULTS:** Thirty-eight percent (38%) of respondents believe that radiologic images generated become their personal property and that their ownership rights include having images modified or deleted at will, while 56.0% believe that the acquiring facility retains ownership of imaging. 53.1% incorrectly believe that the images could not be used for any purpose without express consent; 30.6% believe images could be used without their consent for purposes of quality, research, and education; and 16.3% believe that a facility has an unlimited right to use imaging without consent.

**CONCLUSION:** It is clear that many patients do not understand who owns their diagnostic imaging. While most understand that the acquiring facility retains ownership, a minority appreciate the extent to which facilities are allowed to use images without their consent. We are increasingly in an era where cloud technology makes intra-facility sharing of patient imaging more commonplace. This survey suggests that additional education of patients with respect to image ownership is warranted.

**(SS05-07) 3:00 PM**

### Patient Perceptions of Participation in the RSNA Image Share Project: A Preliminary Survey

Atheeth Hiremath, *University of Maryland School of Medicine, Baltimore, MD*; Joseph J. Chen, MD; Eliot L. Siegel, MD\* ([atheeth.hiremath@som.umaryland.edu](mailto:atheeth.hiremath@som.umaryland.edu))

**PURPOSE:** Our academic center helped to create software/infrastructure for the RSNA Image Share Project (ISP) for secure and persistent patient-controlled storage of medical images. The ISP was designed to improve access to images at the clinical point of care and to enhance patient involvement by providing access to images and reports.

**METHOD AND MATERIALS:** Our study used two anonymous IRB-exempted surveys of patients that differed depending on their decision to enroll in the ISP. For ISP-enrolled patients, a survey assessed computer and Internet usage, perceptions of online access to images and system security, alternative uses of images, and effects on

patient-physician relationships. For those who declined, the survey documented age, ethnicity, education, ownership of Internet-connected devices, and reasons for not enrolling in the ISP.

**RESULTS:** ISP-enrolled patients responded (456 survey responses) positively to having direct access to exam images (97%) and medical records (98%) and maintaining health record privacy (93%) and reported general comfort with ISP security (84%). Patients found it unacceptable when physicians could not easily access images at appointments (79%), when appointments were delayed because of such challenges (75%), and when repeat scans were required (71%). Patients also reported personally downloading images (79%), e-mailing these to family/friends (32%), providing password and access information to family/friends (25%), and asking physicians "new" questions after viewing images (97%). The other surveyed group (94 survey responses) cited unreliable Internet access (38%) and availability of non-Web-based images to physicians (35%) as reasons for not enrolling in the ISP.

**CONCLUSION:** The majority of patients planned to review their own images, one-third would e-mail them to family/friends, and almost all reported that they would pose "new" questions to their physicians. Patients find having a measure of control over their own medical images to be beneficial. The high rate of image sharing with friends/family was an unexpected and yet-to-be explored result and raises concerns about privacy issues when individuals themselves share their health data through electronic/social media.

**(SS05-08) 3:10 PM**

### Cost-effectiveness of Utilizing MR Imaging in Early Detection of Rheumatoid Arthritis

Sahar J. Farahani, *Johns Hopkins Hospital, Baltimore, MD*; Saurabh Jha, MBBS ([sjalali2@jhmi.edu](mailto:sjalali2@jhmi.edu))

**PURPOSE:** The purpose was to determine the cost-effectiveness of utilizing MRI in diagnosis of early rheumatoid arthritis (RA) in comparison to American College of Rheumatology (ACR)/European League against Rheumatism (EULAR) 2010 criteria.

**METHOD AND MATERIALS:** A Markov decision model was developed to estimate incremental costs per quality-adjusted life-year (QALY) when using focused MRI over ACR/EULAR criteria for the diagnosis of early RA in patients with undifferentiated arthritis. The model incorporated sensitivity and specificity of MRI and ACR criteria in the detection of early RA, ability of MRI and conventional risk stratification criteria suggested by ACR in determining the patients with poor prognosis and the need to initiate treatment with biologic disease-modifying antirheumatic drugs (DMARDs), probability of response to three different therapies based on the stage of RA, efficiency of rate of DMARDs in preventing permanent functional disability, mortality and morbidity from side effects, and direct and indirect costs associated with each diagnostic and therapeutic strategy. The incremental cost-effectiveness of each strategy was calculated. Threshold analysis was performed, and one-way sensitivity analysis was done to evaluate stability of the model to clinically plausible changes in variables.

**RESULTS:** The base case was considered as a 44–55-year-old male with undifferentiated arthritis for less than 1 year. A Monte Carlo microsimulation was run 10,000 times, and the results demonstrated an incremental cost-effectiveness ratio of \$46,497 per QALY for using MRI over ACR. Threshold analysis revealed a sensitivity of 90% and specificity of 84% are required for MRI to justify its utilization in detection of early RA regarding its costs and effectiveness over ACR criteria. The model was stable to change in clinically plausible range for other variables.

**CONCLUSION:** MRI can be a cost-effective modality in diagnosis of early RA, depending on the societal willingness to pay.

**(SS05-09) 3:20 PM****Electronic Breast Imaging Learning Module: A Way to Improve the Breast Imaging Rotation for Residents**

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**PURPOSE:** The purpose of this study was to investigate the effectiveness of using an electronic learning module on the breast imaging rotation to improve resident learning, decision-making ability, and overall experience on the rotation.

**METHOD AND MATERIALS:** From September 2013 to September 2014, residents rotating on breast imaging were required to review an electronic learning module to improve their learning and overall experience on the rotation. Residents first take a pretest on concepts in breast imaging that are appropriate to their year of training. The resident then reviews the electronic learning module. The electronic learning module is composed of training level-appropriate interactive cases that allow residents to make the findings, dictate the next step in management, and come up with a final diagnosis. A posttest is taken at the end of the rotation and the score compared to the pretest score. A survey was completed by the residents after the rotation, which assessed how the learning module affected their learning, their overall feeling about breast imaging, and, for those who had rotated on breast imaging before, if it improved their experience from the prior rotation.

**RESULTS:** Of the 11 residents who rotated through breast imaging and used the electronic learning module, 90% said it improved their knowledge of breast imaging. 81% said it helped them better know what was expected of them on the rotation. 81% said it made them feel more confident interpreting studies. When rating ease of use on a scale of 1 (easy) to 5 (difficult), 100% of residents rated the learning module a 1 or 2. All of the residents gave an overall rating to the module on a scale of 1 (excellent) to 5 (poor); 100% gave a score of 1 or 2. Of the residents who previously rotated on breast imaging before the electronic learning module, 88% said use of the electronic learning module improved their experience on the rotation compared to their prior rotation. All residents scored higher on the posttest than on the pretest.

**CONCLUSION:** The use of an electronic learning module on the breast imaging rotation improved resident knowledge, confidence interpreting studies, and overall rotation experience.

**AUR Memorial Award****(SS05-10) 3:30 PM****Real View Radiology: Impact on Search Patterns and Confidence in Radiology Education**

Jared Bailey, MD, *Indiana University School of Medicine, Indianapolis, IN*; Trenton D. Roth, MD; Darel E. Heitkamp, MD ([jarebail@iupui.edu](mailto:jarebail@iupui.edu))

**PURPOSE:** Search patterns are important for radiologists, since they enable systematic case review. Because radiology residents are exposed to so many imaging modalities and anatomical regions and because they rotate on and off service so frequently, they may have difficulty establishing effective search patterns. We developed Real View Radiology (RVR), an educational system founded on guided magnetic resonance imaging (MRI) case review, and evaluated its impact on search patterns and interpretative confidence of junior radiology residents.

**METHOD AND MATERIALS:** RVR guides learners through unknown exams by sequentially prompting learners to certain aspects of a case via a comprehensive question set and then providing immediate feedback. Junior residents first completed a brief evaluation regarding their level of confidence when interpreting certain joint MRI cases and frequency of search pattern use. They spent 4 half days interpreting cases using RVR. Once finished, they repeated the evaluations. The junior resident results were compared to 3rd-year residents who

had not used RVR. The data were analyzed for change in confidence, use of search patterns, and number of cases completed.

**RESULTS:** Twelve 1st-year and thirteen 2nd-year residents (trained cohort) were enrolled in the study. During their 4-week musculo-skeletal rotations, they completed, on average, 29.3 MRI knee (SD, 1.6) and 17.4 shoulder (SD, 1.2) cases using RVR. Overall search pattern scores of the trained cohort increased significantly, both from before to after training (knee  $P < .01$ ; shoulder,  $P < .01$ ) and also compared to the untrained 3rd-year residents (knee,  $P < .01$ ; shoulder,  $P < .01$ ). The trained cohort confidence scores also increased significantly from before to after training for all joints (knee,  $P < .01$ ; shoulder,  $P < .01$ ; pelvis,  $P < .01$ ; ankle,  $P < .01$ ).

**CONCLUSION:** Radiology residents can increase their MRI case interpretation confidence and improve the consistency of search pattern use by training with a question-based sequential reveal educational program. RVR could be used to supplement training and assist with search pattern creation in areas in which residents often do not acquire adequate clinical exposure.

**Thursday, April 3, 2014****2:00–3:30 PM****SS06: RAHSR Session****AMA PRA Category 1 Credits™: 1.50****Location: Grand Ballroom IV****Moderators: Annette J. Johnson, MD, MS****Ritu R. Gill, MBBS\***

QA

**(SS06-01) 2:00 PM****Cost-effectiveness Analysis for Imaging Strategies Following Acute Wrist Trauma: A Comprehensive Conceptual Framework**

Sahar J. Farahani, *Johns Hopkins Hospital, Baltimore, MD*; John A. Carrino, MD, MPH\*; Shadpour Demehri, MD ([sjalali2@jhmi.edu](mailto:sjalali2@jhmi.edu))

**PURPOSE:** The purpose was to determine the cost-effectiveness of CT over follow-up for detecting wrist fracture in active adult patients with acute wrist trauma and negative initial x-ray examination.

**METHOD AND MATERIALS:** Analytic decision model was conducted to compare the cost-effectiveness of CT over follow-up x-ray in management of acute wrist trauma. We used two different clinical scenarios as performing CT versus immobilizing the wrist and series of follow-up x-rays in patients with negative x-ray and positive clinical findings such as focal tenderness and positive scaphoid compression test. Outcome was calculated as the gain of quality-adjusted life-years (QALYs) by following each scenario, and the direct medical and indirect costs due to loss of productivity in active adult patients were analyzed. One-way sensitivity analysis was performed for all variables over the clinically plausible range to determine stability of the model. Two-way sensitivity analysis was used for the correlated variables.

**RESULTS:** The base case was considered as an active adult with a minimum-wage salary reported by U.S. labor statistics for 2013. We ran Monte Carlo microsimulation 10,000 times, considering an unnecessary immobilization rate of 30% for the follow-up strategy. The analysis demonstrated CT has an incremental cost of \$1764 for the gain of 1 QALY, while this is calculated as \$2306 for the other strategy. These results were derived when the absence from work in case of unnecessary cast was considered only 1 week. By increasing the absence from work to 4 weeks, the costs associated with follow-up strategy increased to \$2917. The threshold analysis indicated that adopting CT strategy in management of occult wrist fracture will not be cost-effective if the combination of initial x-ray and clinical findings could reach a sensitivity and specificity of 100% and 90%, respectively. The model was stable to change in clinically plausible range for the other variables.

\* Faculty financial disclosures are located in the Faculty Index.

**CONCLUSION:** CT can be cost-effective in selected patients who presented with acute wrist trauma, negative x-ray, and positive clinical findings suggestive of carpal bone fracture in the emergency room, even when compared to 1 week of immobilization and follow-up x-ray examinations.

#### RAHSR Harvey L. Nieman Award

(SS06-02) 2:10 PM

### Comparative Effectiveness of Contrast-enhanced Abdominal CT versus Noncontrast plus Contrast-enhanced CT in the Evaluation of Patients with Possible Hypervascular Liver Metastases or Hepatocellular Carcinoma

Gelareh Sadigh, MD, *Emory University, Atlanta, GA*; Sahnha Nandwana, MD; Courtney A. Coursey, MD\*; Kelly Cox, MD; Deborah A. Baumgarten, MD, MPH; Tiffany Easter; et al (*gsadigh@emory.edu*)

**PURPOSE:** The purpose was to assess the added value of noncontrast CT (NECT) versus contrast-enhanced CT (CECT) of the abdomen for evaluation of patients with possible hepatocellular carcinoma (HCC) or hypervascular liver metastases.

**METHOD AND MATERIALS:** Our imaging database was searched for patients 18 years and older with melanoma, neuroendocrine tumor (NET), or thyroid cancer, or suspected to have HCC, who visited our institution during 2012. The first available triple-phase CT scan of the abdomen within 1 month prior to diagnosis or any time after diagnosis was reviewed by three board-certified abdominal radiologists, blinded to patient's final diagnosis of liver pathology. The number of liver lesions and the reviewers' characterization of masses as benign or malignant were recorded for CECT and again after the addition of NECT. Pathology and imaging reports were reviewed to determine, on a per-patient basis, which patients had malignant liver pathology.

**RESULTS:** Sixty-eight patients were included, with mean (SD) age of 55 (1); 56% were male. Thirty (44%) had melanoma, 30 (44%) had NET, 2 (3%) had thyroid cancer, and 6 (9%) were suspected for HCC. 65% (44/68) of patients had liver lesions. The sensitivity/specificity and 95% confidence intervals (CIs) of CECT for characterization of patients with malignant liver masses were 95.2% (76.2%–99.9%)/93.6% (82.5%–98.7%) for reviewer 1, were 89.5% (66.9%–98.7%)/87.2% (74.3%–95.2%) for reviewer 2, and were 95.2% (76.2%–99.9%)/89.1% (76.4%–96.4%) for reviewer 3. The sensitivity/specificity and 95% CIs for combination of CECT and NECT were 95.2% (76.2%–99.9%)/91.5% (79.7%–97.6%) for reviewer 1, were 84.2% (60.4%–96.6%)/89.1% (76.4%–96.4%) for reviewer 2, and were 100% (83.9%–100%)/87% (73.7%–95.1%) for reviewer 3. There was no significant difference after the addition of NECT ( $P > .05$ ). Interobserver variability for characterization of malignancy for CECT and its combination with NECT was 73.5% and 62.7%, respectively, consistent with substantial agreement.

**CONCLUSION:** There is no significant added value of NECT to CECT for characterization of liver lesions in patients with hypervascular cancers or possible HCC. This study supports a more-efficient and lower-radiation-dose protocol omitting NECT.

(SS06-03) 2:20 PM

### Measuring the Impact of Whole-Body CT on Length of Stay in Patients with Blunt Trauma

Jessica Chan, BSE, MSE, *University of Utah, Salt Lake City, UT*; Raminder Nirula; Marta E. Heilbrun, MD (*marta.heilbrun@hsc.utah.edu*)

**PURPOSE:** The more than 200% increase in emergency department CT utilization over the past decade demands scrutiny. In blunt trauma, imaging facilitates rapid accurate assessment of the extent of injury. While most trauma centers in the United States tailor CT utilization based on mechanism and severity (selective CT), whole-body imaging, including CT of the head, c-spine, chest, abdomen, and pelvis (PanScan), is becoming standard in Europe. This practice

is based on retrospective studies showing improved 30-day mortality rates in cohorts who received a PanScan routinely. The purpose of this study was to assess the value of PanScan versus selective CT imaging within the first 24 hours of blunt trauma by retrospectively comparing patient length of stay (LOS) and 30-day mortality at a single U.S. academic Level I Trauma Center.

**METHOD AND MATERIALS:** A retrospective review of an institutional trauma registry database of blunt trauma patients  $\geq 18$  years old treated in 2012 was performed and cross-matched with a radiology information system database for imaging records. Demographics, injury severity score (ISS), LOS, and mortality data were collected.

**RESULTS:** The trauma registry identified 1639 patient encounters; complete imaging records were obtained for all patient encounters. PanScan and selective CT were performed in 184/1639 (11.2%) and 990/1639 (60.4%) of subjects, respectively; the remainder of patients had no CT imaging. PanScan is associated with greater mean ISS, LOS, and mortality than selective CT ( $16.9 \pm 11.4$  vs  $10.2 \pm 8.5$ ;  $7.9 \pm 10.0$  vs  $3.7 \pm 4.5$  days; and 7.6% vs 3.0%, respectively). Within ISS categories, there was no significant difference between hospital and ICU LOS by imaging strategy for mild ( $<9$ ), moderate (9–14), or severe ( $>14$ ) injuries.

**CONCLUSION:** Our findings suggest that PanScan CT may neither reduce cost nor improve patient outcomes, and perhaps selective CT imaging in the setting of blunt trauma remains a better strategy for hospital and patient alike. Additionally, because the PanScan strategy is employed selectively, rather than routinely, in the United States, the results from ongoing prospective European trials may not be generalizable to the United States.

(SS06-04) 2:30 PM

### Practice Quality Improvement as the Final Piece in the Maintenance of Certification Program: How Are We Doing?

Pina C. Sanelli, MD, MPH, FACR, *New York-Presbyterian Hospital, New York, NY*; Kimberly E. Applegate, MD, MS

**PURPOSE:** Practice quality improvement (PQI) was recently incorporated into the maintenance of certification (MOC) program. The purpose of this study was to assess both participation and barriers in PQI.

**METHOD AND MATERIALS:** An electronic survey was sent anonymously to board-certified radiologists at two academic practices. It was separated into the following sections: demographics; number and types of PQI projects; PQI experience, using a series of statements to assess level of satisfaction and barriers for participating in PQI; and access to resources.

**RESULTS:** We had an 87% (116/134) response rate, of which 26% of respondents had 1–3 years of practice experience, 34% had 4–10 years, 19% had 11–20 years, and 21% had  $>20$  years. 91% (105/116) of respondents have participated in PQI, with the majority (79%) performing 1–3 projects. Most projects were performed in group settings rather than individually. The most common PQI category was "Accuracy of Interpretation," followed by "Patient Safety" and "Report Timeliness." The most commonly reported barriers were (descending order): limited time available, lack of resources, limited understanding/knowledge, and lack of interest. Table 1 provides survey responses to assess effect on practice and level of satisfaction.

**CONCLUSION:** Although the PQI requirement was recently initiated in the MOC process, 91% of respondents have participated thus far. The majority of respondents indicated a favorable effect in their practice, with improvement in patient safety, quality of care, work flow, and satisfaction of care. Most respondents also indicated an overall improvement in their level of satisfaction and culture.

\* Faculty financial disclosures are located in the Faculty Index.

### (SS06-05) 2:40 PM Low-Dose Abdominal CT Using Iterative Model Reconstruction Technique: Comparison with iDose and Filtered Back Projection

Ranish D. Khawaja, MBBS, MD, *Massachusetts General Hospital, Boston, MA*; Sarabjeet Singh, MBBS, MD; Michael Blake, MD; Diego Lira; Atul Padole; Sarvenaz Pourjabbar, MD; et al (*ali.ranish@gmail.com*)

**PURPOSE:** The purpose was to evaluate iterative model reconstruction (IMR) in randomized and blinded fashion for lesion detection and image quality of abdominal CT, with subsequent comparison to iDose<sup>4</sup> (ID) (Philips Healthcare, Andover MA) and filtered backprojection (FBP).

**METHOD AND MATERIALS:** Nineteen consecutive patients (mean age, 54.5 ± 20 years; M:F = 12:7; mean weight, 207.3 ± 34 lb) underwent unenhanced abdominal CT on a 256-slice CT scanner (iCT; Philips) for kidney stone evaluation in an IRB-approved, HIPAA-compliant clinical study. Average CTDI<sub>vol</sub> was 7 ± 2 mGy. Raw data were exported and reconstructed with five different IMR settings (i1–i5): L1 soft tissue (i1), L2 soft tissue (i2), L1 routine (i3), L1 SharpPlus (i4), and L2 SharpPlus (i5), where L2 has higher noise reduction than L1. Two radiologists performed independent randomized blinded evaluation of eight image data sets (FBP, ID2, ID4, i1–i5) for lesion detection, lesion margins, visibility of small structures, and overall diagnostic acceptability. Objective noise was measured at the level of abdominal aorta for each image series. Pattern of noise distribution and spectrum was assessed in MATLAB program for FBP, ID2, ID4, and i1–i5.

**RESULTS:** Margins for 30% of the lesions (liver parenchyma and kidney stones) were seen as more conspicuous across IMR (settings: i1–i3), compared to FBP and iDose<sup>4</sup>. Most of the 32 lesions were kidney stones or renal cysts that measured <1 cm and were seen on all image series. The most preferred IMR setting to visualize liver parenchyma and the common bile duct was i3 (L1 body routine) and i2 (L2 body soft tissue), respectively. The interobserver agreement between radiologists was statistically significant ( $\kappa$  value, 0.72;  $P < .01$ ). Noise spectrum density curves showed noise reduction for all IMR settings (maximum reduction for i2 setting) compared to iDose<sup>4</sup> and FBP. Compared to FBP (29 ± 4 HU), IMR setting i2 (6 ± 1 HU) had significantly lower objective noise ( $P < .0001$ ).

**CONCLUSION:** Lesion margins are better seen in almost one-third of the lesions with IMR, compared to iDose<sup>4</sup> and FBP. Across IMR settings, “soft tissue” (i1–i2) and “body routine” (i3) were most acceptable for lesion margin conspicuity for kidney stones and renal cysts. IMR also had the highest objective noise reduction compared to iDose<sup>4</sup> and FBP.

### (SS06-06) 2:50 PM Errors of Epinephrine Administration during Severe Allergic-Like Contrast Reactions: Lessons Learned from a Bi-institutional Study Using High-fidelity Simulation Testing

Carolyn L. Wang, MD, *University of Washington, Seattle, WA*; Matthew S. Davenport, MD; Jennifer G. Schopp, MD, RN; Kimia Kani, MD; Sankar Chinnugounder, MD; Sadaf Zaidi, MD; et al (*wangcl@uw.edu*)

**PURPOSE:** The purpose was to determine the most common errors of epinephrine administration during severe anaphylactoid contrast reaction management using high-fidelity simulation surrogates.

**METHOD AND MATERIALS:** IRB approval and informed consent were obtained for this HIPAA-compliant multi-institutional prospective study of 40 radiology residents, fellows, and faculty who were asked to manage a structured high-fidelity severe anaphylactoid contrast reaction scenario (ie, mild hives progressing to mild bronchospasm, then bronchospasm unresponsive to bronchodilators, and finally anaphylactic shock) on an interactive manikin. Intravenous

(IV) and intramuscular (IM) epinephrine ampules were available to all participants, and the manikin had a functioning intravenous catheter for all scenarios. Video recordings of their performance were reviewed by experts in contrast reaction management, and errors in epinephrine administration were recorded and characterized.

**RESULTS:** No participant (0/40) failed to give indicated epinephrine, but more than half (58% [23/40]) committed an error while doing so. The most common mistake was to administer epinephrine as the first-line treatment for mild bronchospasm (33% [13/40]). Other common errors were to administer IV epinephrine without a subsequent IV saline flush or concomitant IV fluids (25% [10/40]), to administer an overdose of epinephrine (8% [3/40]), and to administer epinephrine 1:1000 intravenously (8% [3/40]).

**CONCLUSION:** Epinephrine administration errors are common. Many radiologists fail to administer albuterol as the first-line treatment for mild bronchospasm and fail to flush the IV catheter when administering IV epinephrine. High-fidelity contrast reaction scenarios can be used to identify areas for training improvement.

### AUR Trainee Prize: 1st Place

### (SS06-07) 3:00 PM More Jobs on the Horizon? Work and Retirement Preferences of Practicing Radiologists Predict an Impending Workforce Shortage

Andrew K. Moriarity, MD, *Henry Ford Hospital, Detroit, MI*; Manuel L. Brown, MD\*

**PURPOSE:** There is currently a perceived surplus of radiologists; however, the exact workforce needs are difficult to determine due to multiple factors. Previous studies have shown mixed results predicting future workforce needs. We examine current workforce estimates in the literature and then estimate potential work output and future workforce needs under various preferences for work rates and retirement preferences among practicing radiologists.

**METHOD AND MATERIALS:** After IRB approval, 1840 responses were collected from practicing radiologists, which included demographic information, work satisfaction, current full-time work level, desired work rate, expected retirement age, and desired retirement age. The average percent effort of current work rate was computed on a sliding scale and applied to the AMA practicing numbers to obtain current AMA full-time equivalent (FTE) estimates. FTE estimates were summed over gender and generation to represent current 2011 FTE values going forward and were weighted using the response rates for both “expected” and “desired” retirement in each 5-year interval from 2016 to 2031.

**RESULTS:** The age and gender distribution of respondents was reflective of the overall workforce. Both genders reported a desire to work fewer hours than they currently work, with females and older workers wanting the largest reductions. When different scenarios were modeled to estimate radiology FTEs by current and desired work rates and retirement ages, there is a predicted initial surplus of radiologists with a nadir in 2016, followed by a progressive shortage over the next 15 years.

**CONCLUSION:** If practicing radiologists reduce current workloads to the desired rate and retire at their desired time, FTE values would be immediately reduced by almost 20% and would not reach 2011 levels until approximately 2030. However, if radiologists continue working at current rates and do not retire until their expected age of retirement, there will be a more modest 7% initial reduction in FTE levels, and output in 2021 will surpass the current 2011 estimates.

\* Faculty financial disclosures are located in the Faculty Index.

**(SS06-08) 3:10 PM****Imaging Patterns in Adult Patients with Back Pain Who Are Privately Insured**

Brian W. Bresnahan, PhD\*, *University of Washington Harborview Medical Center, Seattle, WA*; Sean Rundell, MS

**PURPOSE:** The purpose was to assess imaging patterns and factors related to imaging variation in back pain patients using commercial insurance data from the United States.

**METHOD AND MATERIALS:** We used the Market Scan® claims national data warehouse to identify persons more than 18 years of age with an ICD-9 code (index visit) related to spine conditions. We used a comprehensive set of diagnosis codes for back-related provider visits, allowing for a 6-month clean period of having no similar ICD-9 codes and no spine surgeries during the previous year. We describe imaging use during 1 year after diagnosis for three groups: acute (no interventions after 3 months), chronic (ongoing interventions), and recurrent (interventions in months 1–3, no interventions for ≥6 months, and then resumed an intervention). Interventions included imaging, office visits, procedures (injections and surgeries), and other CPT/ICD-based back-specific care, based on an established algorithm. We used logistic regressions to assess factors associated with imaging use, including age, gender, region, plan type, physical therapy (PT) use flag, and comorbidities.

**RESULTS:** We identified 2,244,208 persons having back-related index diagnoses and subsequent interventions between 2008 and 2011 (53% female; mean age, 45 years), with 1,167,869 (52%) persons only having acute care during year. During the initial 3-month period, MRI (11%) and x-ray (29%) were used most prominently, with 1.42 MRIs per person for those having an MRI and 1.44 average x-rays for those having x-ray. The chronic group had decreasing quarterly rates of imaging during the year (MRI: 2%–6%; x-ray: 3%–9%). The West had lower rates of imaging compared to other regions (eg, OR: 1.46, 1.44–1.48; Northeast compared to West); patients having back-related physical therapy were more likely to have MRI (OR: 1.56, 1.55–1.58).

**CONCLUSION:** In a large privately insured cohort of patients, substantial proportions receive back-related x-ray and MRI during the initial 3 months since having an office-based diagnosis. Regional variability, PT use, and comorbidities influence imaging likelihood.

**(SS06-09) 3:20 PM****Variations in the Availability of Advanced Breast Imaging Based on Radiology Facility Characteristics**

Eniola Obadina, *University of Washington, Seattle, WA*; Andy Bogart; Christoph I. Lee, MD\*; Rebecca Hubbard; Deirdre Hill; Brian Sprague, PhD; et al

**PURPOSE:** The purpose was to determine the relationship between facility characteristics and the availability of advanced breast imaging modalities.

**METHOD AND MATERIALS:** We analyzed data collected on Breast Cancer Surveillance Consortium (BCSC) facilities from seven regions (New Hampshire, North Carolina, San Francisco, Vermont, Chicago, New Mexico, and western Washington) for calendar years 2011–2012. Each registry and the BCSC statistical coordinating center obtained IRB approval for this HIPAA-compliant analysis. We collected data on facility characteristics, including academic affiliation and practice type (eg, multispecialty breast center). We also collected data on the availability of advanced breast imaging modalities at each facility, including ultrasound (US), MRI, and image-guided biopsy. We performed generalized estimating equations regression analyses and report proportions of advanced imaging availability across several facility characteristics.

**RESULTS:** We obtained complete data from 119 active BCSC imaging facilities, including 80 (67.2%) full diagnostic radiology practices, 24 (20.2%) multispecialty breast centers, 8 (6.7%) nonradiology practices, and 7 (5.9%) breast imaging-only practices. Of the 119 facilities, eight (6.7%) had academic affiliations. Breast MRI services were not available at any breast imaging-only or nonradiology practices. Image-guided biopsy services were available at 91.7% (95% CI: 79.7%, 100%) of multispecialty breast centers, compared to 44.7% (95% CI: 26.6%, 62.9%) of full diagnostic radiology practices ( $P = .0018$ ). Similarly, a combination of US, MRI, and image-guided biopsy services was available at 70.8% (95% CI: 43.6%, 98.1%) of multispecialty breast centers, compared to 22.9% (95% CI: 9.1%, 36.6%) of full diagnostic radiology practices ( $P = .02$ ). This same combination of advanced imaging services was available at 62.5% (95% CI: 27.5%, 97.5%) of academic facilities, compared to only 28.0% (95% CI: 18.1%, 37.9%) of nonacademic facilities ( $P = .04$ ).

**CONCLUSION:** Radiology practice type is related to availability of advanced breast imaging. This could have important implications for patient access and timely resolution after abnormal screening, depending on the type of facilities patients visit.