



AUR 2015 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, medical students, or 1st-year fellows) are noted in **maroon**.

Thursday, April 16, 2015

2:00–3:30 PM

SS01: Clinical Imaging

AMA PRA Category 1 Credits™: 1.50

Location: La Galerie 3

**Moderators: Lumarie Santiago, MD
Priscilla J. Slanetz, MD, MPH**

BR GI CT NM US ED PD

(SS01-01) 2:00 PM

Tumor Growth Kinetics versus RECIST in Colorectal Liver Metastases Treated with Antiangiogenics: Is Stable Disease Really Stable?

Atilla Arslanoglu, MD*, *Northwestern Memorial Hospital, Chicago, IL*; Adeel R. Seyal, MD*; Yuri Velichko, PhD; Keyur Parekh, MD*; Vahid Yaghmai, MD (*v-yaghmai@northwestern.edu*)

PURPOSE: The purpose was to correlate growth kinetics and RECIST performance to FDG-PET in assessing stable disease in colorectal liver metastases treated with antiangiogenic therapy.

METHOD AND MATERIALS: This HIPAA-compliant retrospective study was IRB approved. Thirty-two colorectal cancer liver metastases from 20 patients treated with bevacizumab-containing chemotherapy were evaluated. Pre- and posttreatment CT scans were used to calculate reciprocal of doubling time (RDT) for each lesion. Percentage change in the lesion's maximal diameter was used to classify them according to RECIST 1.1 guidelines. The percentage change in body surface area-normalized standard uptake value (SUV) at FDG-PET was determined for individual lesions from pre- and posttreatment FDG-PET scans. The correlation between FDG-PET response based on European Organisation for Research and Treatment of Cancer (EORTC) PET study group and response according to RDT was evaluated for RECIST stable lesions.

RESULTS: Twenty (62.5%) of 32 lesions were classified as stable according to RECIST. Based on RDT, three of these 20 lesions were classified as stable, whereas based on FDG-PET, four of these 20 lesions were categorized as stable. For RECIST stable lesions, RECIST was concordant with FDG-PET in 4/20 (20%) lesions; however, growth kinetics was concordant with FDG-PET in 19/20 (95%) lesions.

CONCLUSION: RECIST stable disease may not be an accurate reflection of treatment response in colorectal liver metastases treated with antiangiogenics. Growth kinetics may be a better alternative to RECIST in this setting.

AUR Trainee Prize: 1st Place

(SS01-02) 2:10 PM

Assessment of Submillisievert Abdominal CT with Nine Iterative Reconstruction Techniques for Four Different Vendors

Atul Padole, MD, *Massachusetts General Hospital, Boston, MA*; Diego Lira; Nisha Sainani; Roberto Lo Gullo; Ranish D. Khawaja, MBBS, MD; Mannudeep Kalra; et al (*apadole@mgh.harvard.edu*)

PURPOSE: The purpose was to assess submillisievert (submSv) abdominal CT with nine iterative reconstruction techniques (IRTs) for four

different vendors in a triple-blinded study compared to the standard-dose (SD) CT.

METHOD AND MATERIALS: In an IRB-approved prospective clinical study, 66 patients (mean age, 60 ± 13 years; weight, 82 ± 20 kg; M:F, 44:22) undergoing routine abdomen CT on vendor A, B, and C multi-detector CT scanners (22 patients each) gave written informed consent for acquisition of an additional submSv series. The submSv series were acquired with reduced mA and reconstructed with two IRTs from each vendor plus a vendor-neutral technique (A-1, A-2, A-3 for vendor A; B-1, B-2, B-3 for vendor B; C-1, C-2, C-3 for vendor C) and standard dose reconstructed with S-1 ($n = 22 \times 3 \times 4 = 264$ series). Two radiologists performed independent and blinded assessment for lesion detection, conspicuity, and visibility of small structures, first for all submSv images and subsequently for standard-dose images. Objective image noise and HU values were measured for all image series.

RESULTS: Mean CTDI_{vol} values for vendors A, B, and C were 9 ± 3.7 , 10 ± 3.4 , and 9 ± 5.3 mGy for standard-dose CT and 1.2 ± 0.1 , 1.3 ± 0.1 , and 1.4 ± 0.1 mGy for submSv, respectively ($P > .01$). A total of 159 lesions were detected on SD CT. For vendors A, B, and C, there were 13/56, 16/63, and 8/40 lesions missed on submSv. Missed lesions include liver cysts, kidney cysts and stones, gallstones, fatty liver, and pancreatitis. Pancreatic duct could not be seen on any submSv CT images (0/11). Lesion conspicuity was sufficient for diagnostic performance for 14/24 (A-1: 10/24; A-2: 14/24; A-3: 9/24) for A, 8/23 (B-1: 5/23; B-2: 5/23; B-3: 8/23) for B, and 8/17 (C-1: 3/8; C-2: 7/8; C-3: 8/8) for C. The liver margin was sufficient for diagnostic performance for 21/22 (A-1: 18/22; A-2: 21/22; A-3: 16/22) for A, 18/22 (B-1: 15/22; B-2: 7/22; B-3: 18/22) for B, and 15/22 (C-1: 6/22; C-2: 13/22; C-3: 15/22) for C. However, visibility of liver parenchyma was limited for diagnostic performance for all three vendors (A: 16/22; B: 21/22; C: 20/22) regardless of IRT.

CONCLUSION: Clinically significant lesions can be missed for abdominal CT at 1.3 mGy. A-2, B-3, and C-3 IRTs performed better for evaluation of lesion conspicuity and liver margins. Visibility of liver parenchyma was limited for diagnostic performance at CTDI_{vol} of 1.3 mGy.

(SS01-03) 2:20 PM

Liver Lesion Margin Intensity Slope to Quantitatively Differentiate Cysts from Colorectal Metastases

Adeel R. Seyal, MD*, *Northwestern University, Chicago, IL*; Fernanda Gonzalez, MD; Atilla Arslanoglu, MD*; Yuri Velichko, PhD; Thomas O'Donnell, PhD*; Vahid Yaghmai, MD (*v-yaghmai@northwestern.edu*)

PURPOSE: The purpose of our study was to distinguish cystic from low-density solid liver lesions by quantitative analysis of lesion margins at MDCT.

METHOD AND MATERIALS: The HIPAA-compliant study was IRB approved. Two patient cohorts were selected for evaluation. The first cohort comprised 15 patients with 19 liver cysts. A second cohort comprised 49 colorectal cancer liver metastases in 24 patients treated with bevacizumab. Both cohorts were imaged by contrast-enhanced MDCT scan. Lesion margin intensity slope (LMIS), a quantitative measure of margin sharpness, was measured for both liver cysts and metastases. LMIS values of cysts and liver metastases were compared. Independent sample *t* test was used for comparison. Significance was set at 0.05.

RESULTS: Mean LMIS value for liver cysts was -22.3 ± 4.8 HU/layer. For colorectal liver metastases, mean LMIS value was -8.3 ± 5.0 HU/layer. Margin sharpness value for liver cysts was significantly different from liver metastases ($P < .0001$).



CONCLUSION: Lesion margin intensity slope may differentiate liver cysts from noncystic liver masses and can be incorporated into semi-automated liver lesion characterization algorithms.

(SS01-04) 2:30 PM

Radiation-augmented Cervical Cancer Metastasis through Galectin-3/K-Ras/c-Raf/p38 Pathway

Pei-Chin Chuang, PhD, *Chang Gung Memorial Hospital at Kaohsiung, Kaohsiung, Taiwan*

PURPOSE: Cervical cancer is the second most common cancer in women worldwide, and radiotherapy is an established treatment method. However, metastasis often circumvents the efficacy of radiotherapy, and mechanisms remain largely elusive. This study was conducted to elucidate the molecular mechanism of radioresistance-associated metastatic potential of cervical cancer cells.

METHOD AND MATERIALS: We established three radioresistant cervical cancer cell lines from HeLa, C33A, and CaSki cells by treatment with a sublethal dose of radiation and observed radioresistant cell lines that exhibited an increased migration phenotype for at least 6 months before undertaking mechanistic studies. Metastatic potential was evaluated using a time-lapse recording of cell migration, wound-healing assay, and in vivo cell locomotion into the lungs of BALB/c nude mice.

RESULTS: Our results showed that the radioresistant HeLa, C33A, and CaSki cells exhibited a dramatic enhancement in cell migration compared to parental wild-type cells. We found higher expression of galectin-3, an endogenous β -galactoside-binding protein, in radioresistant cells than in wild-type cells. Knockdown or overexpression of galectin-3 was reciprocally related to cell migration. Further studies demonstrated K-Ras played a pro-metastatic role to delivery galectin-3 signal in modulating the cell migration via c-Raf/p38 but not via ERK or JNK activation. Inhibition of the K-Ras/c-Raf/p38 signaling pathway by RNAi or by using chemical inhibitors substantially reversed the radioresistance-induced cell migration. In addition, injection of radioresistant CaSki cells into the tail vein of nude mice significantly enhanced cell locomotion into the lungs. More important, clinical examination further showed the greater activation of the galectin-3/K-Ras/c-Raf/p38 signaling cascades in local recurrence and distant metastatic cancer cells compared with those of primary cervical tumors.

CONCLUSION: These findings demonstrate that a sublethal dose of radiation can enhance the metastatic potential of human cervical cancer cells via galectin-3/K-Ras signaling, highlighting the potential development of specific inhibitors for reducing metastatic potential during radiotherapy.

(SS01-05) 2:40 PM

Development of a US-guided Breast Biopsy Workshop for Radiology Residents

Lindsay M. Griffin, BS, MD, *New York University School of Medicine, New York, NY*; Cecilia L. Mercado, MD; Cathleen C. Heffernan, MD

PURPOSE: Proficient and safe performance of ultrasound-guided breast biopsy is an important component of residency education in breast imaging. Many residents perform biopsies for the first time directly on patients, with little opportunity to develop the technical skill of ultrasound-guided biopsy prior to the procedure. This can compromise patient care and comfort, in addition to resident education. Our purpose was to design and implement a sustainable workshop to fill this need.

METHOD AND MATERIALS: A workshop utilizing a 15-minute instructional video, commercially purchased self-healing breast phantoms, and the simulation center at our institution was developed to teach and reinforce the technical skills required for successful safe biopsy. The workshop was run by two fellowship-trained breast imagers on faculty. Residents of all years participated, taking a short anonymous exam before and after to assess general knowledge of how to perform a US-guided breast biopsy and resident comfort level with the procedure.

RESULTS: Seventeen residents participated in two workshops (nine PGY4/5 and eight PGY 2/3). Most residents (88%) reported seeing more than 10 US-guided biopsies, and all but two reported they had performed at least one US-guided breast biopsy. Preworkshop, the mean comfort level was 2.7 on a scale of 1–5 (5 representing complete comfort). After the workshop, this rose to 3.7 ($P < .01$). The number of incorrect answers about technique (specifically, US probe placement in relation to needle and throw of the biopsy device) decreased from 39 to four ($P < .0001$).

CONCLUSION: Residents have exposure to and are asked to perform US-guided breast biopsies during their education. However, they do not necessarily have the opportunity to develop the technical skills needed to perform safe and effective biopsies. A faculty-led workshop with commercial ultrasound models and hands-on practice increases residents' confidence and technical knowledge of the procedure. Use of commercially available models provides simple setup and storage, allowing for the focus to be on resident education.

(SS01-06) 2:50 PM

Evaluation of a Lesion Mapping, Removal, and Reinsertion Tool for Radiation Dose Reduction in Abdominal CT: A Validation Study

Atul Padole, MD, *Massachusetts General Hospital, Boston, MA*; Sarvenaz Pourjabbar, MD; Diego Lira; Mark Madsen, PhD; Sarabjeet Singh, MBBS, MD; Ranish D. Khawaja, MBBS, MD; et al (*apadole@mgh.harvard.edu*)

PURPOSE: The purpose was to validate application of a lesion mapping, removal, and insertion tool in coregistered abdominal CT images acquired at different radiation dose levels. Such a tool will help in education and research in CT radiation dose reduction.

METHOD AND MATERIALS: In an IRB-approved study, we scanned 10 human cadavers on a 64-slice MDCT scanner at five different mAs (373, 200, 150, 100, and 50) with corresponding $CTDI_{vol}$ of 25, 14, 10, 6, and 3 mGy, respectively. Remaining scan parameters were kept constant at 120 kV, 0.5-second rotation time, and 0.984:1 pitch. We used abnormality manipulation software (Iowa MIPL) for manipulating the images. For each dose level, liver lesions were mapped in original image series (OL) and saved in an abnormality library. Series (OL-) was generated by removing the original lesion, and another series (OL+) was created by reinserting the mapped lesion at a different location in the liver or spleen in the same image. In addition, we inserted mapped lesion in the liver or spleen on a different image without lesion (DL) to generate additional image series with lesion (DL+: lesion inserted). Thus, five image series were generated for each dose level (OL, OL-, OL+, DL, and DL+). Two radiologists evaluated the images for lesion number, location, attenuation, lesion, and image appearance (real or unreal) at each dose level.

RESULTS: Following lesion removal, images were deemed as "real" at all dose levels. None of the radiologists could differentiate real (OL, DL) or unreal (OL-, OL+, DL+) lesions or appearance of images acquired at radiation doses between 6 and 25 mGy. However, lesion insertion did not perform as well at the lowest dose level (3 mGy), since the radiologists were able to see/identify altered lesion texture or margin with inserted lesions at this dose level. 91/120 unreal lesions reinserted at different image or slice location were labeled as real, whereas 8/40 real lesions or images were deemed unreal.

CONCLUSION: Lesion mapping, removal, and reinsertion tool can work effectively at different radiation doses in abdomen ($CTDI_{vol}$, 6–25 mGy), although the performance at the lowest dose level needs further improvement at lower dose levels of 3 mGy for lesion reinsertion.

**(SS01-07) 3:00 PM****Educational Videos: An Effective Tool to Improve Training in Interventional Breast Procedures**

Jordana Phillips, MD, *Beth Israel Deaconess Medical Center, Boston, MA*; Irene Tseng, MD; Richard E. Sharpe, Jr, MD, MBA; Alexander Brook; Valerie Fein-Zachary, MD; Priscilla J. Slanetz, MD, MPH; et al (*jphilli2@bidmc.harvard.edu*)

PURPOSE: Engaging millennial learners entails incorporating new approaches to teaching into a traditional educational program. Using the iPad application Explain Everything™, we created a how-to video for stereotactic breast core biopsy to enhance our breast imaging curriculum. This video simulates teaching that currently occurs at the workstation and in the procedure room. Our objective was to show that new methods of teaching like this video could enhance resident learning.

METHOD AND MATERIALS: A pretest was provided to all 40 radiology residents at our institution. The test included 20 questions on the video content, 15 similarly framed control questions on material that was not included in the video, and general demographic questions. Questions were randomly ordered, and trainees were not informed that both types of questions were included. Residents then had 1 week to watch the 20-minute video on stereotactic breast core biopsy prior to completing a posttest that included the same 35 content questions but in a different sequence. Questions on logistics were also included. Results for the video and the control questions were analyzed separately and compared to determine the educational value of this intervention.

RESULTS: 30/40 (75%) residents participated, with 6–9 residents per PGY year. The average scores for the video and control pretest were 7.7/20 (38.5%) and 7.8/15 (52%). The average scores for the video and control posttest were 13.8/20 (69%) and 7.8/15 (52%). This corresponds to a 30.7% mean improvement on the video content questions, compared to a 0% improvement for the control test ($P < .001$). Similar improvement was seen across all four PGY years. PGY-5 residents showed the greatest improvement, with a mean increase of 39% on the video questions and a mean decrease of 3% on the control questions. 28/30 (93.3%) residents felt the video was helpful. 27/30 (90%) felt that the video length and 28/30 (93.3%) felt that the video content were “just right.”

CONCLUSION: Including instructional videos in the breast curriculum contributed positively to resident learning across all years of training. Further study on the role of educational videos in radiology residency training seems warranted.

(SS01-08) 3:10 PM**FDG PET/CT Volumetric Parameters in Recurrent Lung Cancer: Predictive Value of Tumor Burden for Overall Survival**

Alexander Antoniou, MD, MA, *Johns Hopkins, Baltimore, MD*; Vasavi Paidpally, MD; Charles Marcus, MD; Rathan M. Subramaniam, MD, PhD, MPH* (*antoniou@jhmi.edu*)

PURPOSE: The purpose was to establish the predictive value of FDG parameters for overall survival (OS) in recurrent non-small cell lung cancer patients after definitive therapy.

METHOD AND MATERIALS: We conducted a retrospective study on 128 patients (63 males; 65 females) with proven recurrent lung cancer after definitive therapy, between 2003 and 2008. SUV_{max} , metabolic tumor volume (MTV), and total lesion glycolysis (TLG) were measured for each recurrence at primary site and nodal and distant metastases. This was calculated using two contouring tools: 50% threshold and gradient segmentation. The primary outcome measure is OS. Analyses with univariate and multivariate Cox regression models included age, gender, stage, SUV_{max} , MTV, and TLG.

RESULTS: The mean SUV_{max} , MTV, and TLG of the study population using the 50% threshold tool were 9.1 ± 5.7 mL, 15.3 ± 28.5 mL, and 85.2 ± 198.8 mL, respectively. Corresponding values using gradient segmentation were 9.1 ± 0.5 mL, 25.2 ± 5.1 mL, and 122.3 ± 311 mL, respectively. Mean OS for those who died was 27.1 ± 2.4 months and was 44.1 ± 6.4 months for those who survived. Univariate analysis showed age, histology, SUV_{max} (50% threshold), and MTV (gradient) to be predictive of OS. In multivariate analysis, total MTV ($P = .0178$) was the only significant predictor of OS when adjusted for all other covariates. There was a significant difference in OS between patients above and below an ROC optimal MTV threshold (18 mL; $P = .0022$) or median threshold (9 mL; $P = .0002$). No significant difference in OS was seen when optimal or median thresholds of SUV_{max} were used.

CONCLUSION: The FDG PET/CT tumor burden parameter, MTV, provides prognostic information in recurrent lung cancer after definitive therapy.

(SS01-09) 3:20 PM**Impact of Multiphase Scanning on Ionizing Radiation Exposure during Pediatric Abdominal CT: A Persistent Source of Excess Radiation in the Community**

Joseph Loeb, DO, *University of Missouri-Kansas City, Kansas City, MO*; Tyson Finlinson, DO; Charlene Lava, MD; Joshua Knowlton, MD; Christopher Keup, MD; Lisa H. Lowe, MD (*joeloeb@gmail.com*)

PURPOSE: The purpose was to determine if community hospitals are still utilizing multiphase scanning protocols for their abdomen CTs in their pediatric patient population.

METHOD AND MATERIALS: A retrospective review of abdomen CTs from community hospitals entered into a picture archiving and communication system at a regional children's hospital was completed. Data collected included demographics, number of scan phases (single or multiphase), CT dose-length product, and CT dose index volumes. Comparison to published American College of Radiology (ACR) diagnostic reference level recommendations for CT dose index volumes was made.

RESULTS: CTs including two or more phases accounted for 33.07% (85/257) of cases at community hospitals, compared to 0.85% (2/234) at the children's hospitals ($P < .0001$). The mean dose-length product at the community ($n = 193$) and children's hospitals ($n = 229$) was 472.78 mGy·cm and 214.38 mGy·cm, respectively ($P < .0001$). The average CT dose index volume at the community and children's hospitals was below the ACR diagnostic reference level recommendations in 81.63% (160/196) and 96.97% (224/231) cases, respectively ($P < .0001$).

CONCLUSION: Multiphase CT was nearly 40 times more likely to be performed on children imaged in the community compared to a regional children's hospital, which caused the average CT dose-length product to be 2.2 times higher in the community. However, both community and children's hospitals met ACR-recommended CT dose index volumes, indicating initial parameters were child sized. These results suggest that multiphase CT scanning is a significant underrecognized source of pediatric radiation exposure in the community.



Thursday, April 16, 2015
2:00–3:30 PM

**SS02: Informatics and Health Services in Radiology
AMA PRA Category 1 Credits™: 1.50**

Location: Bissonet

Moderator: Tharakeswara K. Bathala, MD



**(SS02-01) 2:00 PM
Effect of Gender on Radiology Resident Selection**

Lara Hewett, BS, *Medical University of South Carolina, Charleston, SC*;
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(hewettll@muscc.edu)

PURPOSE: We investigated whether there is a bias in the residency selection process that influences the proportion of females entering diagnostic radiology residencies.

METHOD AND MATERIALS: A total of 2752 U.S./Canadian applications to one diagnostic radiology residency program from 2009–2014 were analyzed. Invitations to interview were evaluated by each year, specifically looking at gender. Ranking of applicants, especially those placed in the top 25% of the rank, was also assessed. Data analyzed included USMLE Step 1 board examination score (a proxy for academic performance), interview scores, and final position on rank list.

RESULTS: Female applicants averaged 23% of the total applicant pool during the years 2009–2014. However, females comprised 30% of the applicants invited to interview ($P < .001$) and 38% of the top 25% of ranked individuals ($P < .001$). This trend was not attributable to superior academic performance. Also of interest, the percentage of females in the applicant pool has decreased in the years studied (supported by a slopes test showing the difference between males and females, $t(8) = 3.71$ ($P < .006$)).

CONCLUSION: Our findings suggest that program directors want to increase gender diversity, but the number of females applying to radiology residencies has decreased over the past 5 years. This trend indicates that the pipeline of female medical students pursuing a career in the resident selection process. Identifying such trends is important, as it provides a better understanding of the etiology for an overall lack of gender diversity within the field of radiology. Furthermore, it may lead to closing the gender gap in radiology. Additional research is required to see if this local observation is mirrored in national trends.

**(SS02-02) 2:10 PM
Can Resident Report Modification Become a Tool for Measuring Outcome of a Residency Training Program? Preliminary Analysis of Report Modification by Attending Radiologists Based on Training Level of Resident**

Supriya Gupta, MD, MBBS, *Georgia Regents Medical Center Hospital, Augusta, GA*; Yulia Melenevsky, MD (sugupta@gru.edu)

PURPOSE: Learning to create accurate, concise, and clinically relevant reports is a critically important part of radiology resident education. Resident reports are subsequently reviewed and modified by attendings prior to signing. Feedback from this review is crucial to resident development and education. We wanted to assess differences between resident and attending reports at our institution, based on the postgraduate training year (PGY) of the resident.

METHOD AND MATERIALS: In this ongoing retrospective study, 145 resident and corresponding final attending reports from musculoskeletal radiology were collected. For resident reports, PGY level and work setting (call vs regular workday) and, for attending reports, experience of attending (<5 years, junior; >5 years, senior) were recorded. Report differences were analyzed broadly under three categories: gram-

matical or spelling mistake changes, misinterpretation of findings, and missed findings. The χ^2 test was used to assess variance in degree of report changes based on PGY of the resident.

RESULTS: Of 145 reports, most were from PGY-3 (63/145 = 43.4%), followed by PGY-2 (39/145 = 26.9%), PGY-4 (28/145 = 19.3%), and PGY-5 (15/145 = 10.3%) residents. Among total reports, 18/145 (12.4%) had missed findings (incidental or significant), 29/145 (20%) had misinterpreted findings, and only 6/145 (4.1%) reports had major grammatical mistakes. Highest number of reports with grammatical errors were from PGY-2 (5/6), and most reports with missed findings and misinterpretation of findings were from PGY-3 (10/18 missed; 19/29 misinterpreted). Even though the number of PGY-3 cases was highest, χ^2 analysis showed statistical significance ($P < .001$). Study shows least discrepancy between reports dictated by PGY-4 and PGY-5 residents.

CONCLUSION: Our study demonstrated improved resident performance for report dictation with lower report discrepancy among senior residents and the attendings. Such an analysis can provide valuable quality metrics for augmenting resident feedback and education, thereby serving as a potential marker for measuring quality of a training program. It can also provide insight into practice behavior and teaching styles of attending radiologists.

**(SS02-03) 2:20 PM
ResFolio: A Web-based Tool for Creating and Managing Residents' Learning Portfolios**

Neil A. Shah, MD, *Emory University, Atlanta, GA* (neil.atul.shah@gmail.com)

PURPOSE: Our institution has no straightforward way of uploading, organizing, and verifying learning portfolio content. To solve this problem, we created ResFolio, a Web-based tool for creation and management of resident' learning portfolios.

METHOD AND MATERIALS: Currently, our institution uses a residency management suite (New Innovations, Uniontown, OH) to manage each resident's learning portfolio. The New Innovations suite is excellent for duty hours and evaluations; however, residents complain that the learning portfolio interface is cumbersome, and customization capabilities are limited. The RSNA offers a solution that is tailored toward diagnostic radiology residents and does offer some customization options for administrators, but these options are limited. We desired to have a "checklist view," where residents log in to a Web site, get a dashboard view of their portfolio, and easily determine what they have already completed and need to complete. We used the open-source MySQL database and the general-purpose Web-development scripting program PHP to create our own customized solution. Our creation process is outlined in the "Results" section.

RESULTS: A general overview of our process is as follows: (1) Create a MySQL database with resident names and learning portfolio (LP) items. Each resident is tied to their LP items by a unique ID. (2) Create a dashboard to display LP items. The dashboard is accessed with the same username and password used for our institution's e-mail and handbook. (3) Create queries to the database for each LP item to see if it is populated. If it is populated, display something indicative of that (a green check, for example) along with options for editing the contents. If it is not populated, provide options for adding content specific to the LP item. For example, "Scholarly Activity" might have an input form for a PubMed ID that would automatically pull a paper and upload it to the database; or "Learning Plan" may have a fillable form with results stored in the database when submitted.

CONCLUSION: We believe ResFolio is the first custom learning portfolio creation and management tool of its kind for diagnostic radiology residents. Our hope is that residents can use this tool to facilitate their educational development.

**(SS02-04) 2:30 PM****Creation and Implementation of an Imaging Informatics Elective for 4th-Year Diagnostic Radiology Residents**

Neil A. Shah, MD, *Emory University, Atlanta, GA*; Nabile M. Safdar, MD*

PURPOSE: The rapid growth of imaging informatics has generated increasing interest in an imaging informatics elective for diagnostic radiology residents, especially with the recent increase in elective time during the R4 year (with the ABR Core Exam now administered at the end of the R3 year). We describe our experience with creation and implementation of an imaging informatics elective for 4th-year diagnostic radiology residents.

METHOD AND MATERIALS: We used multiple sources to tailor our curriculum to best suit the needs of our residents: A 2004 article in the *Journal of Digital Imaging* outlined a subspecialty training curriculum put forth by the Society for Computer Applications in Radiology (now the Society for Imaging Informatics in Medicine). In 2011, the University of Maryland put forth a curriculum for an elective and outlined a sample curriculum with a list of activities and topics covered. We also wanted an elective reference and/or text and found two sources: The American College of Radiology (ACR) published an information technology reference guide to serve as a manual for practicing radiologists. Additionally, the text *Practical Imaging Informatics: Foundations and Applications for PACS Professionals* contains information for residents with varying levels of informatics knowledge.

RESULTS: We structured the elective to be a combination of a core curriculum and an experience tailored to the residents' interests. For the core portion, we created a required reading list based on the ACR manual and the *Practical Imaging Informatics* text. A research component involves the resident seeing a project in a subfield of their interest from creation to implementation. The course preceptor will meet with the resident twice per week to discuss the topics covered in the reading. Additionally, we are considering self-administered pre- and postrotation assessments for the residents to gauge how much knowledge they've gained and to help identify deficiencies in the rotation.

CONCLUSION: By creating an R4 informatics elective, we hope to develop a new generation of informatics leaders.

(SS02-05) 2:40 PM**Teaching the Future of Radiology: Our Experience and Work Flow Creating and Developing Universally Accessible DICOM-based Teaching Modules Using the Radiology Curriculum Management System Developed by the American College of Radiology**

Takashi S. Sato, MD, *University of Iowa Hospitals & Clinics, Iowa City, IA*; Brian Conway; Bruno A. Policeni, MD (shawn-sato@uiowa.edu)

PURPOSE: Radiology teaching cases are often limited to single static images, limiting manipulation. Radiology residency applications have decreased for several years, and it is important to engage future radiologists. We developed an easily shared educational content creation system that more accurately simulates the reading of a full exam and engages learners.

METHOD AND MATERIALS: We created a simple work flow for developing educational content. Initially, medical students, residents, and staff met to identify targeted areas for improvement. Medical students and residents then reviewed missed call cases for a certain period of time. Misses were categorized by type. Staff helped identify patterns in missed cases. Key cases were collected, and teaching points were written. A mix of positive and negative cases were collected for pre- and posttests. Cases were anonymized and uploaded with ACR TRIAD™ software and incorporated into the ACR Radiology Curriculum Management System (RCMS). Pretests, interventions, and posttests were quickly created with RCMS. Modules were easily accessed online via computer or tablet.

RESULTS: Modules for detecting pulmonary embolisms and a medical student introduction to cross-sectional imaging have been developed, and modules in ER CT brain and c-spine evaluation are in process.

While many DICOM viewers and custom solutions were investigated, none offered the ability to easily share across multiple institutions and had as robust support and development as the ACR RCMS.

CONCLUSION: In a time when teaching practices have changed dramatically, it is vital for radiology education to evolve and engage future radiologists. While the concept of teaching files is not new, the ability to quickly create and share easily accessible quality content is novel. Previous teaching files were often limited by technology, inability to share, and lack of support and development. In the past, good teaching files were institution-specific, forcing others to "reinvent the wheel." This future in collaborative content creation is essential to bring radiology education into the 21st century. Our system for educational content development is easily reproducible and shareable and involves multiple levels of radiology trainees to engage future radiologists.

(SS02-06) 2:50 PM**Novel Method for Rapidly Measuring the Thickness of Human Cerebral Cortex on MR Images**

Michael Hakky, MD, *Lahey Hospital and Medical Center, Burlington, MA*; Lyubomir Zagorchev, PhD; Florian Weiler; Christoph Wald, MD, PhD*; Sebastian Flacke, MD, PhD (michael.hakky@lahey.org)

PURPOSE: Imaging methods that rapidly and accurately measure human cerebral cortical thickness are important in large population-based studies of neurodegenerative diseases such as Alzheimer dementia. Automated cortical thickness measurements have the potential to identify subtle changes in brain regions to allow for sensitive detection and monitoring of neurodegenerative diseases, as well as in evaluating potential therapies. Our objective was to validate the accuracy and efficiency of a novel method in determining regional cerebral cortical thickness.

METHOD AND MATERIALS: Sagittal SPGR MR images at 3 T were obtained on 10 healthy control subjects scanned on two separate occasions. A reader identified the midsagittal slice as well as a true axial midbrain slice. The reader then set anchor points for the software to automatically demarcate the left and right cerebrum as well as cerebellum. The software then automatically registered the entire cerebral cortex and calculated cerebral cortical thickness. A total of 42 brain regions were segmented with an atlas-based algorithm, and cortical thickness data were obtained. Average processing times were recorded. The same data were analyzed with the FreeSurfer image analysis suite.

RESULTS: The software method required an average of 5 minutes of user interaction and 5 minutes of calculation per scan. The difference in cortical thickness measurements between successive scans in the same subject was determined. The average difference across all brain regions was 4.8%, with mean deviation of 1.2% and standard deviation of 1.6%. The statistical analysis was performed on the same data set utilizing the Destrieux atlas with FreeSurfer; the average difference was 3.5%, with mean deviation of 1.1% and standard deviation of 1.5%.

CONCLUSION: We have described an automated software method to measure the thickness of cerebral cortex in healthy adults using MRI at 3 T with potentially increased speed and accuracy. Our measurements performed comparably to well-established methods while offering substantial time savings. This method has the potential to allow assessment of a large number of subjects in a short period of time and offer a sensitive measure of cortical thickness.

(SS02-07) 3:00 PM**How Well Do Patients Understand Their Own Imaging Examinations? A Prospective Survey-based Assessment**

Eric Flagg, MD, *New York University School of Medicine, New York, NY*; Andrew B. Rosenkrantz, MD

PURPOSE: Radiologic tests are ordered by different physicians from those who perform and interpret these tests, creating a gap in communication that may lead to a lack of understanding by patients of the examinations that they undergo. In this study, we evaluated patients' knowledge regarding radiologic imaging examinations.



METHOD AND MATERIALS: Adult patients were provided a voluntary survey prior to undergoing an outpatient imaging examination at our institution. Surveys comprised a range of questions relating to patients' knowledge of various aspects of the scheduled examination, as well as assessing patients' perspectives regarding how such knowledge had been acquired and communicated. Responses were assessed using standard summary statistics.

RESULTS: 146 surveys were completed by patients awaiting CT ($n = 45$), MRI ($n = 18$), ultrasound ($n = 39$), and nuclear medicine ($n = 44$) examinations. 97% and 98% of patients correctly identified the exam modality and body part being imaged, respectively. However, a substantial fraction of patients were either unsure or incorrect as to whether their exam entailed radiation (CT, 57%; MRI, 67%; US, 38%; NM, 55%). In addition, 58%, 32%, and 0% of patients receiving oral, IV, and vaginal contrast indicated that such contrast would be administered. 15% (CT), 38% (MRI), 23% (US), and 54% (NM) indicated that the exam had been adequately explained in advance. Nonetheless, 81% (CT), 61% (MRI), 82% (US), and 61% (NM) reported a complete/near-complete understanding of the exam. 19% and 32% indicated consulting the Internet or friends/family, respectively, to learn about the exam. 19% indicated having unanswered questions about the exam; the most common questions related to the overall process, details of the contrast administration, radiation exposure, and when results would be received. 53% were interested/very interested in having the opportunity to discuss the exam with a radiologist in advance.

CONCLUSION: We've identified key areas of incomplete knowledge by patients regarding radiologic examinations. The trends can be applied in initiatives to improve patients' understanding of their imaging examinations, thereby enhancing patient empowerment and contributing to patient-centered care.

(SS02-08) 3:10 PM Contrasting Electronic Health Records from Two Different Hospital Systems: Radiologists' Perspective

Elliot S. Rinzler, MD, *Eastern Virginia Medical School, Norfolk, VA*;
Sarah Shaves, MD (rinzlees@evms.edu)

PURPOSE: We assessed electronic health record (EHR) use by radiologists and developed recommendations for improvements by comparing EHRs from two different health care systems with and without picture archiving and communication system (PACS) integration.

METHOD AND MATERIALS: Faculty and resident radiologists at a community residency program were sent an anonymous survey evaluating their EHRs. The survey queried utilization of the EHR and reasons for and impediments to using the EHR.

RESULTS: Daily EHR users had a near inverse trend in access by system: Users in the system with PACS integration were significantly more likely to access the EHR. The primary access reason was "Unclear study indication." The statement "EHR data ... Improves report quality" received the most agreement, followed by "Improves patient safety." The EHR changed report impressions for 78% of respondents. Radiologists felt the nonintegrated EHR system provided more useful clinical information than the integrated system with automatic log-in. However, they overall preferred the integrated system despite the perception that it was more difficult to navigate and contained less pertinent data.

CONCLUSION: Our radiologists utilize the EHR daily to clarify patient history and exam indication and are convinced the EHR improves report quality and patient safety. Automatic PACS integration significantly increased this utilization. For our radiologists, rapid access to limited data was more valuable than slower access to a more robust EHR. Given the increasing volume of imaging exams performed, it is no surprise that the ease of access offered by a PACS with integrated EHR is preferable to a nonintegrated system. Our ideal EHR software suite would be a combination of the automatic integration with the more-robust data. Ultimately, these sorts of improvements in our EHR systems will be necessary to meet national goals and provide the best possible patient care.

(SS02-09) 3:20 PM

Multi-institutional Resident Case Log Analysis: Effect of the New Core Exam Format on 4th-Year Resident Productivity

Thomas Loehfelm, MD, PhD*, *Emory University, Atlanta, GA*; Po-Hao (Howard) Chen; Andrew Lemmon, MD; Aaron Kamer, MD; Tessa S. Cook, MD, PhD; Marc D. Kohli, MD* (twloehfelm@gmail.com)

PURPOSE: The Association of Program Directors in Radiology (APDR) used the new ABR Core Exam to address "board frenzy," [BF] which is the disruptive period ... when the most well-trained residents ... become less available," by recommending no time off before the Core Exam (JACR, Nov 2012). We measured BF and the effectiveness of the APDR in eliminating it.

METHOD AND MATERIALS: We analyzed resident case logs from 7/1/10 to 6/30/14 for three academic training institutions; logs contained the accession number, resident ID, study description, and time stamp. Resident identifiers and accession numbers were replaced with nonsense text to ensure anonymity. Level of training is indicated by R1-R4. No protected health information is stored. Pace is the number of studies dictated per day over time periods ranging from several weeks to an academic year.

RESULTS: R4s read 50% more in AY13-14 (Fig 1). Pace ranged from 172-385/day during the oral boards period and 274-475/day under the Core Exam period. The 6 months preceding oral boards, during which productivity decreased to 45%, corresponds to BF as described by the APDR. R3 pace during AY13-14 was 452/day, ranging from 677/day during the 3 months when R4s were preparing for the Core Exam to 461/day in the middle of the year, 248/day for the 80 days preceding the June Core Exam, and 553/day thereafter (Fig 2). R3 pace under oral boards averaged 427/day, without discrete phases. 14,000 (28%) of the extra 50,000 studies dictated by R4s in AY13-14 came at the expense of R1-R3 volume (Fig 3).

CONCLUSION: R4s were reincorporated to the workforce, leaving fewer studies for R1-R3. Future work should analyze which studies shifted to R4s and whether this compromises R1-R3 education. BF had a longer duration (6 vs 3 months) and larger magnitude (45% vs 56% productivity) under the oral board system but affected R4s, who are less productive than R2-R3s even when not in a frenzy. If BF were eliminated, R4s would have read an extra 40,000 studies per year during the oral board years, and R3s an additional 17,000 during Core Exam years. Therefore, despite decreasing 50% in duration and 11% in magnitude, the absolute effect is only decreased 43%, since BF now affects a more productive cohort.

Thursday, April 16, 2015
2:00-3:30 PM

SS03: Education of Residents

AMA PRA Category 1 Credits™: 1.50

Location: Mardi Gras Ballroom D

Moderators: Katherine A. Klein, MD
Sravanthi Reddy, MD



(SS03-01) 2:00 PM

Multi-institutional Resident Case Log Analysis: Evaluating Performance against ACGME Minimum Requirements

Thomas Loehfelm, MD, PhD*, *Emory University, Atlanta, GA*; Po-Hao (Howard) Chen; Aaron Kamer, MD; Andrew Lemmon, MD; Marc D. Kohli, MD*; Tessa S. Cook, MD, PhD (twloehfelm@gmail.com)

PURPOSE: ACGME requires that radiology residencies track resident performance and specifies minimum numbers of studies that each resident should interpret. We evaluated performance against these case log minimums to understand differences within and between residencies.

* Faculty financial disclosures are located in the Faculty Index.



METHOD AND MATERIALS: We analyzed case logs from the cohort of residents who completed residency on 6/30/14 at three academic training institutions (AT11–AT13). Each record contains the accession number, resident ID, study description, and time stamp. Case log categories and minimum requirements were obtained from ACGME publications. Studies were assigned to categories either by CPT code or study description mapping. The cumulative number of cases dictated for each of the ACGME categories was tabulated and compared across training institutions. Our system requires that residents dictate the report to be credited. The numbers reported to ACGME may include studies from manual logs and so may differ from those presented here.

RESULTS: 23/42 (55%) residents completed at least the minimum number for each ACGME category (Fig 1). Forty-two residents dictated a total of 687,065 studies (avg, 16,359) (Fig 2). Thirty-nine (93%) completed all 4 years at the same institution, and of these, the range of case log volume for a single resident is 9277–25,894 (2.8x). Within each institution, the range was 1.6x–1.8x.

CONCLUSION: Residency experience varies considerably from one resident to another within and between institutions. Case log volume varied by 2.8x from the resident who read the most to the one who read the least, and even residents from the same institution vary by 1.6x–1.8x. The ACGME case log minimum requirements are reasonable standards that can be attained by most residents at our institutions. The average resident from the class of 2014 dictated at least 2x the minimum number of studies for most ACGME categories (Fig 3), and many times more than the minimum number for more-advanced imaging modalities such as body MRI and PET, which may reflect a case mix bias at academic institutions. In future studies, we hope to determine whether experience in residency, as measured by case logs, predicts performance on standardized exams and in general practice.

(SS03-02) 2:10 PM

Comparison of High-fidelity Simulation versus Didactic Instruction as a Reinforcement Intervention in a Comprehensive Curriculum for Radiology Trainees in Learning Contrast Reaction Management: Does It Matter How We Refresh?

Melissa Picard, MD, *Medical University of South Carolina, Charleston, SC*; Jeanne G. Hill, MD; Nancy S. Curry, MD; Lashonda W. Soma, MD; Heather Collins

PURPOSE: Simulation-based training has been shown to be a useful adjunct to standard didactic lecture in teaching residents appropriate management of adverse contrast reactions. In addition, it has been suggested that there is a need for a biannual refresher; however, the type of refresher education has not been assessed.

METHOD AND MATERIALS: This was a prospective study involving 31 radiology residents across all years in a university program. All residents underwent standard didactic lecture followed by high-fidelity simulation-based training. At approximately 6 months, residents were randomized into a didactic versus simulation group for a refresher. At approximately 9 months, all residents returned to the simulation center for performance testing. Knowledge and confidence assessments were obtained from all participants before and after each phase. Performance testing was obtained at each simulation session and scored based on predefined critical actions.

RESULTS: There was significant improvement in knowledge ($P < .001$) and confidence ($P < .001$) after baseline education of combined didactic and simulation in both groups and overall. There was no statistically significant difference between the simulation and didactic groups in knowledge and confidence at any phase of the study. There was no significant difference in tested performance between the groups either at the initial simulation training experience or during the final performance testing session.

CONCLUSION: This study suggests that a curriculum consisting of annual didactic and simulation-based training combined with a didactic refresher at 6 months could be considered as an effective method of

educating radiology residents in the management of adverse contrast reactions, particularly given the relative decreased time and cost commitments required with didactic sessions compared to simulation.

(SS03-03) 2:20 PM

Current Resident Perceptions of the Fellowship Application Process

Keir D. Marshall, MD, *Yale University, New Haven, CT*; Syed A. Bokhari, MD; Alan Goldstein, MD; Mohammad M. Samim, MD, MRCS

PURPOSE: The purpose was to query the opinions of residents regarding their preconceived notions and actual experiences in the fellowship application process. The survey attempts to define positive and negative aspects of the process, as well as provide an update on resident opinions in light of recent changes and trends in the radiology landscape. The survey was created to serve as a follow-up to the resident responses in a 2012 survey from Mulcahy et al.

METHOD AND MATERIALS: A nationally distributed anonymous survey was created. Survey topics include but are not limited to the following: (1) resident level, location, program size; (2) perceived availability of positions; (3) resident preference on a match process versus other forms of standardization; (4) pressure to commit to a position; (5) timing of the application process; (6) level of administrative support for the application process; and (7) factors which determine resident choice in subspecialty.

RESULTS: Preliminary results reveal that residents generally feel the application timing is too early in residency. Residents do not feel prepared to make an informed decision at/near the halfway point of residency. Factors that most influence the decision to pursue a particular fellowship include genuine interest in the subject, physical location, and strength of in-house experience during residency. Less influential factors include the potential for future monetary gain and potential for future advances in the subspecialty. Residents do not feel well informed or prepared for the fellowship application process, citing difficulty in assessing and comparing available options, as well as trouble finding interview dates and application deadlines. There appears to be no significant difference in resident preference regarding a formal versus informal match system.

CONCLUSION: Many issues persist in the application process. Several of these are easier to tackle with appropriate administrative or faculty support, while others would likely require an organized national effort to overcome.

(SS03-04) 2:30 PM

Radiology Trainees' Experiences with Professionalism and Leadership Skills Development during Residency Training

Kate Hanneman, MD, *Stanford University, Stanford, CA*; Michael C. Veronesi, MD, PhD; Pamela M. Deaver Ketwaroo, MD; George J. Watts, MD; Lyndsay Oancea; Richard B. Gunderman, MD, PhD; et al (*kate.hanneman@gmail.com*)

PURPOSE: The purpose was to examine radiology trainees' experiences with leadership and professionalism skills development during residency training.

METHOD AND MATERIALS: This was a self-administered electronic pilot survey of 256 radiology residents at six academic radiology residency programs within the United States and Canada. Analyses were performed using χ^2 and Fisher exact tests.

RESULTS: One hundred thirty-two residents responded (52%). Most respondents agreed that both leadership and professionalism skills were important to their future careers (94% for both). 33.3% indicated that leadership skills are taught in their residency program, with significant variability across institutions (7%–88%; $P < .001$). 61% indicated that professionalism skills are taught in their residency program, also with significant variability across institutions (38%–92%; $P = .001$). Overall, 42% of respondents had experienced a leadership- or



professionalism-related issue while in training. Compared to residents who had not received leadership and/or professionalism training, those who reported having such training were significantly less likely to report experiencing a leadership- or professionalism-related issue (58% vs 30%, $P = .001$). 64% of respondents indicated they would be interested in participating in a leadership and professionalism skills development program during their residency.

CONCLUSION: The majority of radiology residents surveyed here identified leadership and professionalism skills as important, but many have not received training for these skills in residency, and considerable variability exists among the six surveyed programs. These pilot results point to potentially critical gaps in radiology training.

(SS03-05) 2:40 PM

Radiology Residency Match Update: Do Factors Related to Recent ABR Core Exam Changes Affect Candidates' Decisions?

Amelia Whorowski, MD, *Thomas Jefferson University, Philadelphia, PA*; Suzanne S. Long, MD; Sandeep Deshmukh, MD; Andrea Frangos; Levon N. Nazarian, MD (*Amelia.Whorowski@jefferson.edu*)

PURPOSE: The purpose of this study was to determine how factors related to recent ABR Core Exam restructuring influenced radiology applicants' match decisions.

METHOD AND MATERIALS: We surveyed 626 applicants of our institution's radiology residency after the 2014 NRMP match. The survey was administered by *SurveyMonkey.com*. This study was waived by our institutional review board. Responses were anonymous. Questions included gender, age, type of program the applicant matched into, and whether the applicant received an advanced degree other than MD/DO. Applicants were asked to rate 21 factors on a 5-point scale. Eight of the factors pertained to the new ABR Core Exam. The remaining 13 were cited as important in the literature. The respondents also listed the top three factors in order of importance.

RESULTS: Thirty-nine e-mail addresses were invalid. The response rate was 26.1% (153/587). Most respondents were male (108/153; 70.6%) and the average age was 28 years. Most applicants matched into a university program (120; 78.4%), and 25 (16.3%) received a second advanced degree. The three most influential factors were current resident satisfaction (average score, 4.74/5.00), quality of the faculty (4.63), and quality of educational curriculum and clinical training (4.60). Of factors related to the Core Exam, the highest rated were Core Exam pass rate (4.21), program resources/time off for external review courses (3.92), and amount of time offered in the 4th year for a "mini-fellowship" (3.87). When asked to list the top three factors, geographic location was most frequently numbers 1 and 2 (53/153 [34.6%] and 29 [20%], respectively). Resident satisfaction was most frequently number 3 (30; 19.6%). Of the factors related to the new Core Exam, Core Exam pass rate and time off from clinical duties to study for the Core Exam appeared most often in the top three (16 and 6 times, respectively).

CONCLUSION: Factors influencing candidates' choice of radiology program are similar to those reported previously, despite the addition of questions related to ABR Core Exam restructuring. While there is variation in how programs have addressed the Core Exam changes, these issues are less important to candidates than more-traditional factors.

(SS03-06) 2:50 PM

Patterns of Error in Cervical Spine CT Scans Read by On-Call Radiology Residents

Robert Ingram, BS, *University of Iowa Hospitals & Clinics, Iowa City, IA*; Bruno A. Policeni, MD; Casey Swenson, MD

PURPOSE: Noncontrast cervical spine CT exams are commonly interpreted by on-call radiology residents. This study aims to determine the overall rate of on-call resident interpretation error on cervical spine CT and observe for patterns of recurrent resident error that may be predictable or correctable.

METHOD AND MATERIALS: A retrospective review of all noncontrast cervical spine CT exams completed during the on-call hours over a 35-month period was performed. All exams with documented disagreement between the resident preliminary report and the staff final report were flagged for review. Missed findings were categorized by location. The number of errors in each location was then determined.

RESULTS: A total of 3435 on-call noncontrast cervical spine CT exams were performed during the study period. Documented disagreement between the resident preliminary and staff final interpretation was present in 161 studies (with a total of 165 missed findings), for an overall disagreement rate of 4.7%. Of the 165 missed findings, abnormalities not affecting the vertebrae or occipital condyles account for the largest proportion of disagreements ($n = 103$; 62.4%); of these, lung ($n = 24$) and thyroid ($n = 20$) findings account for a large number, along with nonvertebral fractures ($n = 17$). The most commonly missed location-specific vertebral abnormalities include vertebral body fractures ($n = 21$; 12.7%), transverse process fractures ($n = 18$; 10.9%), and occipital condyle fractures ($n = 7$; 4.2%).

CONCLUSION: The overall disagreement rate between resident preliminary and staff final interpretations on noncontrast cervical spine CT at our institution is 4.7% during the study period. The anatomic distribution of missed abnormalities stresses the importance of searching beyond the cervical spine on these exams using bone, soft-tissue, and lung windows. Increasing awareness of this issue and training residents to further evaluate certain structures (ie, occipital condyle, transverse process) in specific planes may lead to a decreased overall resident error rate. This study does not evaluate the clinical significance of the missed findings.

(SS03-07) 3:00 PM

ACR Diagnostic In-Training Examination Performance and ABR Core Exam Preparation Factors as Predictors of Subsequent Performance on the ABR Core Exam

David Dilorenzo, MD, *University Hospitals Case Medical Center, Cleveland, OH*; Jeffrey Goletz, MD; Raj M. Paspulati, MD (*david.dilorenzo@uhhospitals.org*)

PURPOSE: The purpose was to determine an association between performance on the ACR Diagnostic In-Training Examination (DXIT™) and subsequent performance on the ABR Core Exam (CE). Other factors considered were the impact that attendance at one or more dedicated CE review courses and the introduction of CE-directed changes in residency program education had on CE performance.

METHOD AND MATERIALS: Fourth-year radiology residents nationwide who took the CE in June 2014 completed a voluntary anonymous survey, covering CE preparation and performance, DXIT™ performance, and CE-directed changes made to conference format and/or subject material in their respective residency programs.

RESULTS: The correlation between overall percentile score on DXIT™ taken during the 3rd year of residency and the overall three-digit score on the CE taken at the end of the 3rd year was 0.31 ($n = 78$, $P < .01$). The group that scored between the 1st and 25th percentiles on the DXIT™ ($n = 22$, mean score = 481) scored significantly lower on the CE than the group that scored between the 76th and 99th percentiles ($n = 23$, mean score = 545) ($P < .01$). No significant difference in CE performance was found between those who attended two dedicated CE review courses ($n = 24$, mean score = 514) and those who attended none ($n = 22$, mean score = 503). Similarly, no significant difference in CE performance was found between those who attended only one CE review course ($n = 25$, mean score = 524) and those who attended none ($n = 22$, mean score = 503). The group whose residency programs made CE-directed changes to conference format and/or subject material ($n = 30$, mean score = 531) scored significantly higher on the CE than the group whose programs did not ($n = 47$, mean score = 498) ($P < .05$).

CONCLUSION: There is weak positive correlation between DXIT™ performance and subsequent CE performance. However, those scoring in the lowest quartile on DXIT™ scored significantly lower on the



CE than those scoring in the highest quartile on DXIT™. CE review course attendance provided no significant difference in CE performance, and residents performed better on the CE when CE-directed changes in conference format and/or subject were made in their residency programs.

(SS03-08) 3:10 PM "RadCredits": A Resident Equivalent of the MOC

Leah E. Braswell, MD, *Arkansas Children's Hospital, Little Rock, AR*; Jennifer McCarty, MD; Linda A. Deloney, EdD; Kedar Jambhekar, MD (LEBraswell@uams.edu)

PURPOSE: Residencies are burdened with detailed and extensive requirements. Traditional conference attendance has always been a primary measure of educational participation, but it is well known that logistic hurdles exist in documenting accurate attendance. In addition, residents are adult learners with a variety of learning styles and needs. Like the ABR MOC, the ACGME requires documentation of educational activities. Creating opportunities for residents to be more actively involved in their education may increase engagement. Hence, a points system was designed to allow residents to accumulate credits ("RadCredits") using a variety of educational methods and scholarly achievements, one of which included traditional conferences.

METHOD AND MATERIALS: A RadCredits proposal was developed with resident input and submitted to the Program Education Committee (PEC) for review and approval. Details concerning credit attainment, documentation, minimum requirements, and impact on resident promotion were delineated in the proposal. The policy was approved and implemented at the outset of the 2014–2015 academic year.

RESULTS: Residents tabulated totals manually or by using a spreadsheet template. Totals and supporting documentation were uploaded to shared folders of a file sharing account (Dropbox; San Francisco, CA). All data concerning participation and credit attainment were subject to audit by the program. Resident compliance and satisfaction with the new reporting system will be reported. All residents participated in the first quarter ($n = 28$). Of those, 27 were in compliance, and one was deficient. A total of 2357 RadCredits were reported, with 74.2% of those from conference attendance. Residents participated in an average of 2.6 nonconference categories (online modules, interdisciplinary conferences, etc).

CONCLUSION: The institution of the RadCredits system has been straightforward and beneficial. Resident achievement is initially high, and overall satisfaction is encouraging. Although the project is in its infancy, there is a renewed focus on residents' individual learning styles, autonomy in educational choices, honesty in self-reporting, and simulation of future lifelong learning.

(SS03-09) 3:20 PM The E-mail Storm: Quantifying the Time Chief Residents Dedicate to Digital Communication

Osamu F. Kaneko, MD, *Stanford University Medical Center, Stanford, CA*; Jason D. Oppenheimer, MD; Alexis L. Crawley, MD; Tust Techasith, MD (jasonop@stanford.edu)

PURPOSE: E-mail has become the de facto mode of communication for chief residents to carry out their administrative responsibilities. The task of reading and responding to a steady flow of e-mails from faculty, administrators, and residents has anecdotally been the most time-consuming aspect of the position but has never before been quantified. We aim to calculate the time demand of digital communication of a chief resident and to compare it to that of a regular resident.

METHOD AND MATERIALS: A dedicated chief e-mail account was created using Gmail (Google, Mountain View, CA) to simplify the stream of communication of two chief radiology residents at a single institution during the 2013–2014 year. All incoming and outgoing work-related e-mails were diverted to this account. The chief account and four resident e-mail accounts were converted to IMAP, analyzed, and compared using Mozilla Thunderbird (Mozilla, Mountain View, CA) and

SAS (Cary, NC). Estimates of time consumption were generated with EmailLabs (Uptilt, Redwood City, CA), Nielsen Group, and McKinsey Institute reports. Gmail Meter (New York, NY) was used to generate advanced e-mail analytics and statistics over a 1-month period.

RESULTS: For the 2013–2014 year, the dedicated chief account received 15,061 e-mails, which was 8.5 times the average work-related e-mail in regular resident accounts. During this same period, the chief account sent 2124 work e-mails, which was 6.2 times that of their peers. Using conservative and liberal estimates for reading and writing e-mails, this amounts to between 3.8 and 10.3 total hours/week. Analyzing the daily chief account e-mail patterns showed that 80% of e-mails were received between 6 AM and 6 PM, 52% of messages were sent between 6 PM and midnight, 85% of activity occurred during the workweek, and 76% of messages had a response rate of under 24 hours.

CONCLUSION: We have quantified the administrative e-mails that a chief resident must read and send through the use of a work-specific account. Compared to their peers, chief residents receive and send 8.5 and 6.2 times as many e-mails, respectively. Using both conservative and liberal estimates, this amounts to a significant time demand, between 3.8 and 10.3 hours/week.

Thursday, April 16, 2015 2:00–3:30 PM

SS04: Education of Medical Students; Miscellaneous AMA PRA Category 1 Credits™: 1.50

Location: Mardi Gras Ballroom E

Moderators: Pedro J. Diaz-Marchan, MD
Christopher M. Straus, MD*

ED LM SQ

(SS04-01) 2:00 PM Becoming a Better Intern: The Fundamentals of Radiology in Internal Medicine

Adam Schwertner, MD, BS, *University of Chicago, Chicago, IL*; Christopher M. Straus, MD* (adamswwertner@gmail.com)

PURPOSE: Medical imaging has become a vital part of patient care in internal medicine and across medicine. Educational programming is variable, leaving medical students with disparate imaging knowledge upon graduation, limiting both optimal use of resources and increasing the burden on residency programs to teach these skills and concepts. There is a void of easily accessible medical imaging content that targets graduating medical students, focusing on this key transition. To improve graduating medical student preparedness, an internal medicine-focused peer-reviewed radiology learning module was created.

METHOD AND MATERIALS: The learning module was designed by meeting with internal medicine residency program directors to determine which skills and knowledge would optimize performance. To validate efficacy, pre- and postmodule surveys were administered to 4th-year medical students, assessing student preparedness to interpret medical imaging, understand specialized vocabulary common in radiologic reports, optimize image ordering, and consult with radiologists in patient care.

RESULTS: Pre- and postmodule surveys were completed by 61 and 54 medical students, respectively. Using a Likert scale (1 is very unprepared, and 4 is very prepared), the students' average preparedness to interpret images on the presurvey was 2.38, compared to 3.06 on the postsurvey (P value, .002). Similar results were identified regarding image ordering (average 2.24 on the pre- and 3.19 on the postsurvey [P value, .00007]), preparedness to understand specialized imaging vocabulary (2.66 on the pre- vs 3.56 on the postsurvey [P = .00007]), and student confidence working with radiologists in patient care (2.53 on the pre- vs 3.56 on the postsurvey [P = .00001]). The average time to complete the module was 86 minutes; 56% of students

* Faculty financial disclosures are located in the Faculty Index.



would prefer the module in the 3rd year of medical school, and 94% would take modules for other specialties.

CONCLUSION: Students described marked improved preparedness to perform tasks related to medical imaging, including optimal exam ordering and ability to read and use radiology reports and consult physicians. Standardized learning objectives and easily accessible material improve medical imaging skills of residents.

AUR Joseph E. and Nancy O. Whitley Award

(SS04-02) 2:10 PM

Radiology Report Turnaround Time: Effect on Resident Education

Eric B. England, MD, *University of Cincinnati, Cincinnati, OH*; Jannette Collins, MD, MEd, FCCP*; Richard D. White, MD; F. J. Seagull; John Deledda, MD (*eric.england@uchealth.com*)

PURPOSE: The purpose was to compare resident workload from emergency department (ED) studies before and after the implementation of a required 1-hour report turnaround time (RTAT) and to assess resident and faculty perception of the effect of RTAT on resident education.

METHOD AND MATERIALS: Resident study volumes 3 years before and 1 year after the implementation of a required 1-hour turnaround time (TAT) were compared. Resident workload was assessed for type of exam (eg, body, MSK, chest, neuro) and time of reading (daytime or overnight). Residents and faculty from two academic radiology departments with a required RTAT were invited to participate in an online survey regarding the perceived effect of the requirement on resident education. A *P* value less than .05 was considered statistically significant.

RESULTS: The volume of resident-dictated ED, MSK, chest, and neuro studies decreased significantly from an average 3 years before the 1-hour TAT of 89%, 88%, and 82%, respectively, to 66%, 68%, and 51% after implementation of the requirement (*P* < .05). The volume of resident-dictated ED body studies decreased from an average of 87% to 80% (*P* < .1). Forty-three (70%) of 61 residents and 63 (55%) of 114 faculty responded to the surveys. Overall, residents felt their learning opportunities from ED studies during the daytime (range, 1–5; mean, 3.42; CI: 3.14–3.60) and overnight (range, 1–5; mean, 4.02; CI: 3.76–4.28) were good. However, residents who were present both before and after the implementation of a required TAT felt their education had been negatively affected (range, 1–3; mean, 1.21; CI: 1.01–1.41). Faculty felt that the required TAT negatively affected their ability to teach (range, 1–5; mean, 2.32; CI: 2.07–2.51) and impaired the quality of resident education (range, 1–3; mean, 1.42; CI: 1.26–1.58).

CONCLUSION: The implementation of a required 1-hour TAT resulted in decreased resident exposure to ED studies. Residents who trained before and after the requirement was implemented felt that the decreased exposure negatively affected their education, but residents without this comparison did not agree. Faculty felt that the required TAT negatively affected their ability to teach, as well as the quality of resident education.

(SS04-03) 2:20 PM

An Effective and Economical Program to Enhance Residents' US Proficiency

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PURPOSE: Our annual residency program reviews identified proficiency in ultrasound as a perceived deficiency among radiology residents. Clinical services were perceived to be too busy to provide the desired level of ultrasound education. Our goal was to design a yearlong program to provide enhanced training to 2nd-year radiology residents.

METHOD AND MATERIALS: A total of thirty 2nd-year radiology residents participated in the program over 2 years. A complete detailed syllabus for the course was prepared; and a textbook, Web-based learning resources, and hands-on scanning experiences were provided. The course was taught primarily by a member of our radiologic technology faculty. Learners met 2 hours per week for a total of 43 weeks, during which they were excused from clinical duties. Learners completed pretests and posttests and a survey concerning the experience. For individual learners, results were analyzed using the Fisher test; and for all the residents in each year, a paired two-tailed *t* test was used. Costs of offering the course were also calculated and compared to those of having a faculty radiologist as instructor.

RESULTS: Of the residents in the 2012–13 class, 11 of 15 showed significant improvement (*P* ≤ .05). For the class as a whole, there was a significant improvement in average scores, from 59 to 79 (*P* ≤ .01). For the students in the 2013–14 class, eight of 15 showed significant improvement (*P* ≤ .05), and the class as a whole improved significantly from an average of 58 to 79 (*P* ≤ .01). 60% of participants strongly agreed and 33% agreed that the course had significantly improved their ultrasound proficiency. 67% strongly agreed or agreed that the course had significantly improved their performance on the ultrasound portion of the American Board of Radiology examination. While fixed costs for the course would have been the same whether a radiologist or technologist taught it, the cost for instruction was 81% lower with a technologist as the primary instructor.

CONCLUSION: This course provides a detailed model that other radiology residency programs may wish to adopt or adapt, to effectively and economically enhance their residents' ultrasound proficiency.

(SS04-04) 2:30 PM

Targeting Educational Deficits: Lessons Learned from Team Performance during Simulated Contrast Reactions

Bethany L. Niell, MD, PhD, *Massachusetts General Hospital, Boston, MA*; Shawn S. Bonk, MHM; Joanne C. Forde, RT(R)(CT); Alexandra G. Penzias, MEd, RN; Gloria M. Salazar, MD (*bniell@partners.org*)

PURPOSE: Our radiology department implemented simulation exercises for contrast and emergency management, with an emphasis on team training. Annual departmental simulation exercises require teams of physicians, nurses, and technologists to manage simulated contrast reactions. After the 2nd year of our simulation program, we evaluated how frequently teams completed the key actions necessary to appropriately manage adverse reactions in the simulated environment.

METHOD AND MATERIALS: Following IRB review, attending physicians, fellows, residents, nurses, and CT and MRI technologists involved in contrast administration were invited to participate. Of those invited, 152 physicians, 27 nurses, and 133 technologists worked in 114 interprofessional teams to manage two cases of simulated adverse contrast reactions (hypotension with bradycardia and laryngeal edema). Immediately following each simulation case, a trained observer documented objective measures of team performance using a standardized survey instrument.

RESULTS: Objective measures of team performance were completed for 100% (114/114) of teams, including 56 cases of hypotension with bradycardia and 58 cases of laryngeal edema. A team leader was explicitly assigned by 36% of teams. Of the 98% of teams that called for help, 41% required prompting. For laryngeal edema, 100% of teams administered intramuscular epinephrine, 29 (29/58 = 50%) teams correctly injected into the lateral thigh or arm, and 20 (20/58 = 34%) teams performed all necessary steps to correctly utilize the autoinjector. For simulated cases of severe hypotension with bradycardia, atropine was not administered in seven cases (12.5%). In cases of laryngeal edema, oxygen was not administered in two cases (3.4%), and an albuterol nebulizer was utilized despite the lack of bronchospasm in 40 cases (69%).

CONCLUSION: Team performance during simulation training for adverse contrast reaction management highlights the need for educational curriculum development to target deficits in the clinical management of radiologic emergencies, including team training skills.

**(SS04-05) 2:40 PM****Making Movies on a Shoestring Budget: A Cost-effective Method for Creating Radiology Resident Educational Video Modules**

Kulia K. Matsuo, MD, MBA, *Indianapolis University, Indianapolis, IN*; Bharat Kakarala, MD; Bilal Tahir, MD; Darel E. Heitkamp, MD

PURPOSE: As economic pressures in many radiology departments continue to impact resident educational funding, the creative use of inexpensive technology makes it possible to provide cost-effective teaching content. We developed a method of generating low-cost videos to supplement resident fluoroscopic education and then analyzed resident perception of the product.

METHOD AND MATERIALS: Using the esophagram as a pilot study, a script was created utilizing published ACR guidelines. Two radiology residents, a staff radiologist (also videographer), and a technologist participated in creating the video using an iPad (resident's property) to capture the video. After loading the video onto a laptop (resident's property), video editing was performed while adding informational slides and narrations. Twenty-three radiology residents who viewed the video answered nine Likert-scale questions (1–5; 5 = most favorable) pertaining to video utility and quality.

RESULTS: The total time to create the video was 6 hours, including 45 minutes to create the script, 30 minutes to record the video, 4.5 hours to edit, and 15 minutes to format/upload. When asked if the video was helpful and whether it boosted confidence in performing the actual fluoroscopy procedure, surveyed residents responded with scores of 4.61 and 4.52, respectively. With regard to video image and sound quality, residents responded with ratings of 4.52 and 4.61, respectively. When asked if the video made sense, residents assigned a rating of 4.43. Residents expressed a preference for the video learning format over PowerPoint presentations (4.65) and textbooks (4.61). Residents supported creating similar videos illustrating other procedures (4.74) and recommending these videos to colleagues (4.48).

CONCLUSION: In these times of financial prudence, a high-yield resident educational video was created in 6 hours without additional departmental funds. Given the positive resident response, similar videos can be made to develop a low-cost library of content. This provides an extremely cost-effective, technology-driven solution to close educational gaps found in radiology training programs today.

(SS04-06) 2:50 PM**Integration of Radiology Education into a Required 3rd-Year Surgical Clerkship Using a Modified "Flipped Classroom" Approach**

Andres R. Ayoob, MD, *University of Kentucky, Lexington, KY*; Sally A. Jones, BA; Joseph Iacono, MD (*andres.ayoob@uky.edu*)

PURPOSE: The purpose was to integrate formal radiology instruction into a required 3rd-year surgical clerkship using a modified "flipped classroom" model.

METHOD AND MATERIALS: Five 1-hour PowerPoint presentations were recorded by three attending faculty from the department of radiology. Lecture material was based on the Alliance of Medical Student Educators in Radiology curriculum as it pertained to common surgical topics. Presentations were made available to all students on the surgical clerkship Web site. Students were required to view the lectures prior to a live 1-hour session that took place shortly after the midpoint of the clerkship. This consisted of a question-and-answer period, followed by a case-based review designed to test clinical application of material presented in the taped lectures. The cases were presented using an audience response system to encourage interaction and to identify knowledge deficiencies that need to be addressed. Following the live presentation, students were tested, and anonymous evaluations were completed. The evaluation consisted of 17 questions using a 5-point scale. The test consisted of 15 multiple-choice questions and counted toward the overall clerkship grade.

RESULTS: 98% of students (203/208) who participated in the clerkship from 7/2012 to 6/2014 attended the live session and completed an evaluation form. Overall, this model was rated as a valuable clinical experience (4.52). The lectures were felt to be useful for future clinical practice (4.54). The overall lecture quality rated above average to excellent (4.27), although 44% of students reported that there was too little time to review the lectures. The question-and-answer session was felt to be necessary (4.36; 5 = very necessary), and practice cases using an audience response system were reported to be a useful way to re-view material (4.65; 5 = very useful). It was felt to be fair to test on this material, provided there was a question-and-answer session (3.92; 5 = very fair). The mean test score was 92% ± 10%.

CONCLUSION: A modified "flipped classroom" model can be used to successfully integrate radiology education into a required 3rd-year clerkship, with high student satisfaction.

(SS04-07) 3:00 PM**Automated Social Media-driven Push Notifications for Radiology Correlation and Education during Gross Anatomy: A Pilot Experience**

Christopher R. Bailey, BA; Liwei Jiang, BA, *Johns Hopkins University School of Medicine, Baltimore, MD*; Krishna Juluru, MD; Donna Magid, MD, MEd (*cbaile19@jhmi.edu*)

PURPOSE: Anatomy traditionally is the first course taught to medical students. The integration of radiology into the anatomy course provides an excellent clinical corollary to solidify anatomic relationships, introduce clinical relevance, and foster early interest in imaging. We sought to incorporate easily accessible, readily mastered daily samples of relevant material closely correlated with the anatomy course's day-by-day plan.

METHOD AND MATERIALS: A set of image-centered clinical cases that reinforce high-yield anatomic concepts was generated on the Medical Imaging Resource Center (MIRC[®]) software (RSNA). A Facebook (Facebook, Inc, Menlo Park, CA) page was created and promoted to 1st-year medical, biomedical engineering, and medical illustration students enrolled in anatomy. Students were asked to voluntarily "like" the Facebook page, which would allow them to receive notifications of new items. To deliver questions daily, we employed Buffer (*bufferapp.com*), a tool that permits the scheduled release of content ("posts") onto Facebook pages. Metrics provided on Facebook, including total "likes," page views, and link clicks, were used to assess participation.

RESULTS: The class size of anatomy is 139. At its launch on August 19, 2014, the Facebook page was "liked" by 122 people and seen by 410; evidently, Facebook users outside of the target demographic also viewed the page. The first post was seen by 163, of whom 85 (52%) clicked the question link. To date, the page has been "liked" by 147 and seen by 545. Number of people who viewed each post ranged from 74 to 181 (mean, 134; SD, 30), with 20%–59% (mean, 45%; SD, 12%) of post viewers clicking on the link. The anatomy course will conclude the 1st week of October, after which a complete data set will be analyzed.

CONCLUSION: Facebook combined with Buffer provides an efficient, low-cost, and automated technique to deliver educational material to students. Although still in progress, this novel approach has been well received by students, who cite both greater understanding of anatomy and radiology and interest in the field. Given the ubiquity of Facebook and ease of the method, this approach is widely applicable to other educational scenarios.

**A³CR² Research Award****(SS04-08) 3:10 PM****Teaching Medical Students Optimal Consulting Skills: The Challenge of Generating Better Referring Physicians**Nicholas Masse, MD, MS, *University of Chicago, Chicago, IL*; Martin Greenwald; Brent Greenberg, MD; Christopher M. Straus, MD*

PURPOSE: Referring physicians routinely initiate most radiology-based exams. Clear efficient use of resources is paramount in the challenges ahead as we collectively face changing health care expectations. Use of the ACR Appropriateness Criteria® (AC) has improved allocation of imaging and patient care, but additional skills of patient preparation, reading reports, required labs, or even an effort to minimize patient anxiety are not addressed. Our purpose was to incorporate this broader scope and educational challenge into the required radiology clerkship and determine the students' acceptance.

METHOD AND MATERIALS: A new required graded exercise in the MS III radiology clerkship was introduced in 2014. Students were provided at random an unknown case from a dedicated file and the resulting anonymous images and requisition. Students were expected to complete multiple serial tasks: (1) Prepare a simple voice recognition-derived report demonstrating structured reporting and key vocabulary related to the case. (2) Relay pertinent additional clinical information they would have provided if they had ordered the study. (3) Discuss follow-up imaging as if they were the referring physician, with knowledge of specialized instructions and how best to prepare the patient upon ordering. Each step stresses important global knowledge and skills applicable to all future referring physicians. Students were provided written examples and received interactive discussion, including resident support, in the process of preparation.

RESULTS: Likert-scale surveys showed considerable overall improvement and awareness among enrolled students ($n = 76$), measuring their perceived use of time, radiology reporting, clearer expectations on exam ordering, and their ability to advise patients.

CONCLUSION: The experience decreases the gap and poor penetration of this knowledge among physicians in training. Online resources are only of assistance in specific cases, but this experience attempts to instill reasoning skills and deeper understanding, altering behavior of physicians who initiate imaging. A clear opportunity to influence greater global adoption is to increase expectations among medical students, given that this cohort embraces most future referrals.

(SS04-09) 3:20 PM**Should ACR Appropriateness Criteria® Be a Part of the Training Curriculum? Ten-Year Meta-analysis of Educational and Quality Improvement Efforts**Supriya Gupta, MD, MBBS, *Georgia Regents Medical Center Hospital, Augusta, GA*; James V. Rawson, MD; Christopher M. Straus, MD* (*sugupta@gru.edu*)

PURPOSE: ACR Appropriateness Criteria® (AC) are an evidence-based free Internet guideline to assist referring physicians and other providers in making most appropriate image-related decisions. Increased awareness and understanding of ACR AC have repeatedly proven to improve allocation of image-based resources and, ultimately, patient care, thereby reinforcing inclusion of ACR AC in training curricula. Our purpose was to assess both the scope and potential trends observed in the published literature related to use and understanding of ACR AC.

METHOD AND MATERIALS: Meta-analysis of peer-reviewed journal articles indexed in PubMed from 2004–2014 was performed using search terms "ACR Appropriateness Criteria" and "Education." The studies were categorized by level of trainees (medical student [MS], radiologist [RP], nonradiologist physician [NRP]), nature of initiative (education, research, quality improvement, cost-effectiveness), and tool used to conduct research (survey, workshop, didactic training, review of radiology orders).

RESULTS: Meta-analysis revealed most studies were conducted among NRPs (6); remaining studies were among MSs (3) and RPs (3). There was an increase in number of studies after 2011, indicating increased use of ACR AC. Almost 60% of radiology residents were not aware of ACR AC, and almost 96% were unaware of the contents. The analysis showed that 43%–96% of MSs had never heard about ACR AC. The awareness was higher among MSs in institutions where decision support was integrated into the ordering system. Among NRPs, almost 55%–65% were ordering exams based on ACR AC, but this varied depending on the specialty and level of training of the resident.

CONCLUSION: Among all levels of physicians, a wide gap and apparent poor penetration of knowledge about ACR AC remain. Although there are trends of increased use of ACR AC, these appear influenced by type of academic setting, implying increased use is linked to a curricular element. A clear opportunity to influence greater global adoption is to increase awareness among MSs, given that this cohort embraces all future referring physicians, perhaps with more-standardized medical school expectation and curriculum.

Thursday, April 16, 2015**2:00–3:30 PM****SS05: Interventional; Musculoskeletal; Neuroradiology
AMA PRA Category 1 Credits™: 1.50****Location: La Galeries 1–2****Moderators: Mark E. Mullins, MD, PhD
Marc H. Willis, DO****(SS05-01) 2:00 PM****Implementation of a Division-Wide Interventional Radiology Simulation Day**Noy Bassik, MD, PhD, *Weill Cornell New York-Presbyterian Hospital, New York, NY*; Bradley B. Pua, MD; Ronald S. Winokur, MD; Jessica Waltz; Richard H. Marshall, Jr, MD; Theresa Salerno; et al (*brp9018@med.cornell.edu*)

PURPOSE: Validity of medical simulation's effect on knowledge, technical performance, work-flow improvement, and team communication is widely accepted. Interventional radiology (IR) departments have unique challenges due to the interaction of physicians, nurses, and radiology technologists, where divergent perceptions of team roles may result in communication difficulties. The objective of this project was to create and assess a multidisciplinary case-based simulation in a working IR division.

METHOD AND MATERIALS: A multidisciplinary team met regularly to design a case-based simulation day. Scenarios were focused around two cases, placement of nephrostomy tube and endovascular stent placement, both with resultant patient decompensation. After an introductory lecture and a presimulation survey given to assess baseline team dynamic, teams performed each case while additional staff observed. A moderator managed each scenario, followed by a debriefing session. The afternoon consisted of hands-on simulation time for all staff. All participants then received a survey to evaluate the utility of the exercise. Pre- and postactivity surveys consisted of Likert scale questions addressing familiarity with department protocols and communication, followed by a comment field.

RESULTS: Forty-two staff members participated in simulation day, while the department continued to function for inpatient cases. Prior to simulation day, 33% of staff had not participated in a team-building exercise. When asked how well team members communicated, presimulation response average was 3.1 on a 5-point scale. Postactivity response was excellent, with 82% agreeing that "Simulation Day made you more comfortable with voicing your concerns within your health-care team" (rising from 3.7 to 4.3 on a 5-point scale). 96% stated that this activity should be performed at least annually. Several work-flow issues were also discovered, which led to division-wide changes.

* Faculty financial disclosures are located in the Faculty Index.



CONCLUSION: Successful implementation of a case-based simulation curriculum in a working IR division involved all staff and was met with positive responses. The simulation day resulted in improved staff confidence regarding communication and emergency situations and revealed opportunities for work-flow improvement.

(SS05-02) 2:10 PM

Disclosure of the Resident Role in the Interventional Radiology Suite: How Do Interventional Radiologists Balance Patient Care and Resident Education?

Rebecca Zener, MD, *Western University, London, ON*; Daniele Wiseman (*rebeccazener@gmail.com*)

PURPOSE: The purpose of this study is to investigate (1) how interventional radiologists determine the intraprocedural role of residents, (2) what interventional radiologists disclose to patients about the role of radiology residents in the IR suite, and (3) how interventional radiologists balance their responsibility between delivering excellent patient care and providing hands-on training to radiology residents.

METHOD AND MATERIALS: A qualitative study consisting of in-person interviews with seven academic interventional radiologists from three tertiary care centers was conducted. Interviews were transcribed and underwent modified thematic analysis, whereby overarching themes were extracted from the transcripts.

RESULTS: Five major themes emerged: (1) Interventional radiologists permit residents to perform increasingly complex procedures with graded responsibility. While observed technical ability is an important factor determining the extent of a resident's intraprocedural participation, possessing good judgment and knowing personal limitations are paramount. (2) Interventional radiologists do not explicitly inform patients in detail about residents' intraprocedural role, as trainee involvement is viewed as implicit at academic institutions. (3) While patients are advised of radiology resident participation in IR procedures, detailed disclosure of their intraprocedural role is viewed as potentially detrimental to both patient well-being and trainee education. (4) Interventional radiologists recognize the trust and confidence placed in them by patients. While it is rare that patients refuse resident participation in their care, interventional radiologists' duty to respect patient autonomy supersedes their obligation to resident education. (5) Ultimately, interventional radiologists hold responsibility for any intraprocedural trainee-related complication.

CONCLUSION: Interventional radiologists recognize the confidence placed in them, and they do not inform patients in detail about residents' role in IR procedures. Respecting patient autonomy is paramount, and while rare, obeying patients' wishes can potentially be at the expense of resident education.

(SS05-03) 2:20 PM

Improving Resident Satisfaction and Efficiency in the Vascular and Interventional Radiology Rotation via Publication of a VIR Resident Handbook

Patrick J. Gilbert, MD, *Medical University of South Carolina, Charleston, SC*; Adam D. Rogers, MD; Marcelo S. Guimaraes, MD; Christopher Hannegan, MD; Bayne Selby (*gilberp@musc.edu*)

PURPOSE: We aimed to improve the resident experience on our vascular and interventional radiology (VIR) rotation at the Medical University of South Carolina through creation and publication of an institution-specific handbook to help residents to successfully and efficiently navigate the tasks required during the VIR rotation.

METHOD AND MATERIALS: We have created a VIR handbook specific to our institution. The document contains much institution-specific information, from where to show up on the 1st day of the rotation to specific expectations based on the level of the resident. There is also a large amount of general information that would likely be applicable to any VIR resident rotation, including basic step-by-step outlines for how to perform certain procedures, how to deal with common complications, and how to protocol and interpret some of the diagnostic studies that are expected of the resident, among other information. Residents

were asked to answer surveys prior to VIR rotations and following their rotation in which the handbook was used. In addition to online access to the handbook, we were able to procure a small amount of funding from the department in order to publish the handbook for distribution, which allows for easy reference when the resident is not at a computer, and we were able to do so at a relatively low cost.

RESULTS: Based on prerotational resident surveys, many residents had significant anxiety and uncertainty about their VIR requirements and about how to perform expected tasks. Postrotational surveys demonstrated the handbook to be a strong resource for the residents, allowing them to more efficiently and confidently perform their VIR requirements.

CONCLUSION: Based on the experiences of the residents who have used the handbook on the rotation thus far, we believe the handbook to be a tremendous resource for the resident, both on and off the VIR service. Residents demonstrated increased comfort with many of the tasks about which they were previously unsure, resulting in improved resident experience and patient care.

(SS05-04) 2:30 PM

Arthrography versus Arthroscopy: A Retrospective Analysis of the Accuracy of Direct MR Arthrography Compared to Arthroscopy for the Diagnosis of Glenoid Labral Pathology in a Community Setting

Rachel S. Silverstein, BS, *The Commonwealth Medical College, Scranton, PA*; John S. Farrell, MD; Amanda Moyer, BS; Michael R. Tracy, MD; Douglas Zaruta, MS (*jfarrell@tcm.edu*)

PURPOSE: The purpose was to compare the interpretations of MR arthrograms (MRAs) in a cohort of patients with their subsequent arthroscopic findings. This study will improve reader accuracy and, in turn, enhance the utility of MRAs as a tool for surgical planning, as the spectrum of labral pathology requires a variety of operative techniques.

METHOD AND MATERIALS: A total of 170 patients underwent direct shoulder MRA by radiologists at an outpatient imaging center in northeastern Pennsylvania from 2007 to 2013. Thirty-five of these patients had subsequent shoulder arthroscopy by orthopedic surgeons in a private practice. There were 135 patients who either had no surgical follow-up or pursued treatment at a different facility. The findings from each of the 35 arthrograms were recorded from the imaging center MRI report. The arthroscopic findings for each patient were then obtained from the operative reports. The arthrographic and arthroscopic findings were deemed concordant if the location and description of the labral pathology in the arthrogram report matched that of the operative report. Intraarticular bodies, articular cartilage pathology, fractures, rotator cuff tears, and long head biceps tendon tears were classified as additional findings both on arthrography and arthroscopy.

RESULTS: The MRA interpretations for labral pathology were concordant with the operative findings in 88.6% (31) of 35 patients. In the 31 concordant arthrograms, there were additional imaging findings in 13 patients (42%) that were not described in the operative report. Conversely, 11 patients of the 31 (35%) had surgical findings that were not described in the MRA report. A review of these MRAs to determine if the additional findings on arthroscopy were, in retrospect, present but not described in the report is in progress.

CONCLUSION: This retrospective study demonstrates that the interpretations of direct MRAs in this community setting are accurate predictors of the operative findings, although ongoing review of the imaging and operative findings will further optimize reader accuracy and improve patient care.

(SS05-05) 2:40 PM**Accelerated SPACE: Fast Isotropic Knee MR Imaging**

Jorge A. Lee Diaz, MD, *University of Texas Medical Branch, Galveston, TX*; Frank L. Goerner, PhD; Thaddeus Sze, MD; Esther Raithe^{*}; Abraham Padua, RT^{*}; Pavit Bains; et al (jaleedia@utmb.edu)

PURPOSE: We examine the use of sparse sampling and iterative nonlinear reconstruction in MSK MRI to reduce the time of acquisition (TA) without a reduction in image quality. The technique is implemented in a 3D SPACE pulse sequence prototype. This enables fast imaging of the knee with isotropic resolution, eliminating the need to scan for multiple views.

METHOD AND MATERIALS: The utilized pulse sequence features sparse, incoherent undersampling and is equipped with a dedicated iterative nonlinear image reconstruction. A Poisson-disc sampling pattern was used. The sequence is a 3D turbo spin-echo sequence (SPACE; Siemens, Malvern, PA). This technique was performed on the knee to evaluate image quality and pathology and compare it to conventional acquisition techniques. Five patients were imaged. The images were assessed by an MSK radiologist with 13 years of experience using a scale of 1–3 to evaluate the quality of the image for different tissues, with 1 being “inferior,” 2 “similar,” and 3 “superior”; a similar scale was utilized to assess the conspicuity of the pathology. The images were scored for chondral tissue, bone edema/bone marrow, ligaments, and menisci. Additionally, the acquisition times were recorded and compared.

RESULTS: The TA (minutes: seconds) for the conventional protocol was 12:44 (T1 cor was 02:22, PD sag was 03:32, PD tra was 03:28, and T2 cor was 03:22). The TA (minutes: seconds) for the accelerated SPACE (PD) was 04:43. Image acquisition time was decreased by 63% with the accelerated SPACE protocol. The accelerated SPACE images were rated in all of the cases as “superior quality” and “more conspicuous pathology” for chondral tissue (Fig 1) and as “similar quality” but “less conspicuous pathology” for bone edema/red marrow. Even though the quality of the image was “superior” for ligaments and menisci, the evaluation of the pathology was variable.

CONCLUSION: Using sparse sampling and iterative nonlinear reconstruction in a 3D SPACE sequence in the evaluation of the knee results in a decrease in acquisition time by up to 63% over the conventional protocol. The quality of the contrast appears to be superior for the evaluation of the chondral tissue over 2D clinical protocols.

AUR Trainee Prize: 3rd Place**(SS05-06) 2:50 PM****Prediction of Acute Thoracic Spinal Cord Injury on MR Imaging: Comparison of a Novel Prognostic Axial Grading System to Traditional Sagittal Grading**

Marc C. Mabray, MD, *University of California San Francisco, San Francisco, CA*; William Whetstone, MD; Sanjay S. Dahll, MD; Adam R. Ferguson, PhD; Michael Beattie, PhD; Jacqueline Bresnahan, PhD; et al (marc.mabray@ucsf.edu)

PURPOSE: Previous studies evaluating the prognostic value of MRI signal changes in the spinal cord have focused on the longitudinal extent of signal abnormality in the sagittal plane. However, the architecture of the spinal cord and preclinical models support the transverse extent of injury as being a strong predictor of clinical outcome. We have developed a system for grading spinal cord injury in the axial plane, which we here applied to spinal cord injury in the thoracic spine.

METHOD AND MATERIALS: We performed a retrospective cohort study including 19 patients who presented with thoracic spinal cord injury between 2005 and 2011 and had an MRI following admission but before any surgical intervention. We applied a novel axial grading system to the axial T2 images, as well as the traditional sagittal grading system and a measurement of the longitudinal extent of injury on

sagittal T2 images. Neurologic outcomes as evaluated by the American Spinal Injury Association (ASIA) grade at discharge were individually correlated with axial MRI grade, sagittal MRI grade, and longitudinal extent. Multiple linear regression was also applied in a combined model.

RESULTS: Axial MRI grade ($r = -0.92$; $P < .01$), sagittal MRI grade ($r = -0.87$; $P < .01$), and longitudinal extent of signal abnormality ($r = -0.84$; $P < .01$) were all highly correlated with ASIA grade at discharge. Multiple linear regression identified the axial MRI grade as the only significant predictive variable ($r^2 = -0.95$; $P = .01$), with an overall model-adjusted $R^2 = 0.80$ and $P < .01$. Sagittal grade ($r^2 = -0.10$; ns) and longitudinal extent ($r^2 = -0.01$; ns) were not significant predictors in this combined multivariable model.

CONCLUSION: Grading of acute thoracic spinal cord injury on axial MRI can be used to predict clinical outcome. Traditional measures of spinal cord injury on sagittal MRI also correlate with clinical outcome; however, they were no longer significant predictors in a combined model with axial grading.

(SS05-07) 3:00 PM**Training of Interventional Neuroradiology Fellows at Academic Centers in the United States: Are Neuroradiologists Still Involved?**

Moungnyan Cox, BS, MD, *Thomas Jefferson University, Philadelphia, PA*; Jim Y. Chen, MD; David P. Friedman, MD; Santosh Selvarajan, MD (moungnyan.cox@gmail.com)

PURPOSE: Interventional neuroradiology (INR) initially developed as a discipline of diagnostic neuroradiology, with the vast majority of procedures performed and taught by neuroradiologists. Currently, training pathways exist for neuroradiologists, neurosurgeons, and neurologists to learn INR. The purpose of our study was to determine the proportion of participation by these subspecialties in the training of INR fellows and residents in the United States.

METHOD AND MATERIALS: The official Web sites of 85 accredited neuroradiology fellowships and 105 neurosurgery departments were reviewed to determine which programs offered INR exposure to fellows. Of these programs, 72 were involved in training fellows. The faculty rosters at INR programs with rotating or INR fellows were then reviewed to determine the subspecialty training of the INR attendings on staff.

RESULTS: There were a total of 220 active INR staff at the INR programs with fellows. Of these, 107/220 (49%) staff were neuroradiologists, 91/220 (41%) were neurosurgeons, and 22/220 (10%) were neurologists. Of the 72 INR departments, 14/72 had only neuroradiologists on staff, 6/72 had only neurosurgeons, and 1/72 had only neurologists. The remaining 51 departments were comprised of specialists of more than one specialty.

CONCLUSION: Although neuroradiologists continue to have a strong presence at INR training programs in the United States, a majority of staff at these training programs are now neurosurgeons and neurologists. Moreover, only 20% of programs are staffed solely by neuroradiologists, and 10% of programs have no neuroradiologists at all. This represents a significant decline over the past decade in the participation of neuroradiologists in these procedures and, by extension, in the training of the next generation of potential INR specialists.

(SS05-08) 3:10 PM**Subjective and Objective Evaluation of Image Quality in Biplane Cerebral Digital Subtraction Angiography Following Significant Acquisition Dose Reduction in the Clinical Setting**

Amir R. Honarmand, MD, *Feinberg School of Medicine, Northwestern University, Chicago, IL*; Furqan H. Syed; Ali Shaibani; Pouya Entezari; Michael C. Hurley; Sameer A. Ansari, MD, PhD (amir.honarmand@northwestern.edu)

PURPOSE: The purpose was to study the feasibility of minimizing the radiation exposure dose in cerebral digital subtraction angiography



(DSA) while preserving the image quality for diagnostic purposes in the clinical setting.

METHOD AND MATERIALS: Following IRB approval, DSA images were obtained using a predefined manufacturer standard program with detector dose of 3.6 $\mu\text{Gy}/\text{frame}$ and reduced detector dose of 1.2 $\mu\text{Gy}/\text{frame}$ for each patient (with subsequent reduction in typical tube voltage, tube current, and focal spot size). Vertebral arteries and their contralateral equivalent arteries were injected to obtain standard-dose (SD) and low-dose (LD) AP/lateral DSA images, respectively. Qualitative assessment was performed by two readers on a de-identified PACS workstation using a 5-point scale in arterial, capillary, and venous phases. Subsequently, circle of Willis vessels were categorized into conducting, primary, secondary, and side-branch vessels; and diameter measurements were performed by two blinded observers using an appropriate proportionality equation for correction, due to lack of inherent image scale in DSA images. Intraclass correlation coefficients (ICCs), paired-sample *t* test, and Wilcoxon signed rank test were used for statistical analysis.

RESULTS: Twelve image series were obtained from six patients (6 M; 66.9 \pm 10.04 years). Mean reference air kerma and kerma-area product were significantly reduced by 60% or 2.5-fold (67.12 vs 26.64 mGy and 1019.35 vs 410.95 $\mu\text{Gy}/\text{m}^2$, respectively; $P < .0001$). No significant difference was observed between image quality scores while assessing arterial (observer 1 [O1]: $P = .9$; observer 2 [O2]: $P = .4$), capillary (O1: $P = .6$; O2: $P = .3$), and venous (O1: $P = .28$; O2: $P = .6$) phases of SD and LD images. Interobserver agreement was excellent or good, with no significant difference in vessel diameter measurements performed by the observers while comparing SD and LD images: SD: ICC = 0.98, 0.95, 0.82, and 0.90; LD: ICC = 0.96, 0.91, 0.70, and 0.97; O1: $P = .9$, .3, .6, and .7; O2: $P = .6$, .1, .7, and .5, for conducting, primary, secondary, and side-branch vessels, respectively.

CONCLUSION: Radiation exposure dose can be significantly reduced without compromising the image quality for diagnostic purposes in cerebral DSA studies.

AUR Trainee Prize: 2nd Place

(SS05-09) 3:20 PM

Assessment of Blood-Brain Barrier Permeability in Global Cerebral Edema after Subarachnoid Hemorrhage

Jana Ivanidze, MD, PhD, *Weill Cornell Medical Center, New York, NY*; Omar N. Kallas; Danial Mir; Ashley Giambrone, PhD; Alan Segal, MD; Ajay Gupta, MD*; et al (jai9018@nyp.org)

PURPOSE: Global cerebral edema (GCE) is an important predictor of mortality in aneurysmal subarachnoid hemorrhage (SAH). Early detection of GCE remains challenging and mainly relies on subtle noncontrast CT findings. Impaired blood-brain barrier permeability (BBBP) is thought to play a role in the development of GCE. CT perfusion (CTP) allows measurement of BBBP factors, such as KEP, K-trans, and PS. However, there currently is limited understanding regarding the utility of these BBBP measurements in the clinical setting. We assessed whether alterations in KEP, K-trans, and PS correlate with GCE in SAH. KEP is inversely related to BBBP and is independent of cerebral blood flow. We therefore hypothesized that in the setting of GCE, KEP is the most accurate parameter to assess BBBP in GCE, when increased extracellular volume and impaired flow occur.

METHOD AND MATERIALS: IRB approval was obtained. Twenty-four SAH patients underwent CTP in the early phase after aneurysmal rupture. Patients were stratified into three outcome groups as GCE, non-GCE, and indeterminate based on their admission noncontrast CT using established criteria via blinded consensus reading from two neuroradiologists. Indeterminate patients were excluded from the analysis. CTP data were postprocessed into BBBP quantitative maps of PS, K-trans, and KEP, including several additional parameters, using medical imaging software (Sphere; Olea Medical, La Ciotat, France). Unpaired *t* tests were performed.

RESULTS: Twenty-two patients (11 GCE; 11 non-GCE) were included in the statistical analysis. KEP and K-trans were significantly decreased in GCE compared to non-GCE. PS was increased in GCE compared to non-GCE, however not statistically significantly. Of the additional parameters, F was significantly decreased and VE was significantly increased in GCE compared to non-GCE.

CONCLUSION: Our findings support the hypothesis that altered BBBP function occurs early after SAH in the presence of GCE. We further demonstrate that given its independence of blood flow, KEP may be a promising indicator of GCE in patients with SAH, while the flow-limited parameters K-trans and PS are less reliable. These findings further contribute to our understanding of the pathophysiologic mechanisms underlying GCE in SAH.

Thursday, April 16, 2015

2:00–3:30 PM

SS06: RAHSR Session

AMA PRA Category 1 Credits™: 1.50

Location: Balcony L

Moderators: Heidi R. Umphrey, MD*
Saurabh Jha, MBBS*



RAHSR Harvey L. Nieman Award

(SS06-01) 2:00 PM

Predictors of Diagnostic Neuroimaging Delays in Adult Ontario Patients Presenting with Symptoms Suggestive of Acute Stroke

Kirsteen R. Burton, MSc, MBA, MD, PhD, *University of Toronto, Toronto, ON*; Moira Kapral; Jiming Fang; Alan Moody; Murray Krahn; Andreas Laupacis (kirsteen.burton@utoronto.ca)

PURPOSE: The purpose of this study was to evaluate factors that are associated with receipt of neuroimaging (computed tomography or magnetic resonance imaging) within 25 minutes, as well as 24 hours, of arrival in the emergency department among patients with suspected acute stroke. Four groups of factors were evaluated (patient demographics, past medical history, clinical presentation, and institution), and their effects were estimated from a large representative sample of patients from Ontario, Canada.

METHOD AND MATERIALS: The Ontario Stroke Registry collects data on a population-based sample of patients with suspected stroke seen at all acute care hospitals in the province of Ontario, Canada. We used data from patients seen between April 1, 2010 and March 31, 2011 and used hierarchical, multivariable Cox proportional hazards models to evaluate the association between patient and institution factors and the likelihood of receiving timely neuroimaging.

RESULTS: From a cohort of 5229 patients who presented to an emergency department (ED) with stroke-like symptoms, neuroimaging was performed within 24 hours of presentation in 91.8% of patients. Of those 3984 patients who presented to an ED within 4 hours of symptom onset, neuroimaging was performed within 25 minutes in 27.3% of these patients. After multivariable adjustment, the following variables were associated with a lesser likelihood of neuroimaging completion within 25 minutes of presentation: greater time from symptom onset to presentation; lower National Institutes of Health Stroke Scale score; female gender; past history of stroke; history of transient ischemic attack or intracranial hemorrhage; arrival to hospital from home; presentation to a hospital that was not a designated stroke centre; and a rurally located hospital.

CONCLUSION: In Ontario, Canada, a high proportion of patients with stroke-like symptoms who present within the 4-hour thrombolytic treatment window experience delayed neuroimaging. Neuroimaging delays are influenced by an array of patient demographic, presentation, medical history, and hospital factors.

* Faculty financial disclosures are located in the Faculty Index.

**(SS06-02) 2:10 PM****Major Contributors to Operating Cost Variation for Common Interventional Radiology Procedures**

Resmi Charalel, MD, *New York-Presbyterian Hospital/Weill Cornell Medical Center, New York, NY*; Ronald S. Winokur, MD; Jonathan Jo; Andrew Amorosso, RT; Bradley B. Pua, MD (*rac9069@nyp.org*)

PURPOSE: A recent report has identified equipment as the single largest contributor to transarterial chemoembolization operating costs. Here, we identify major contributors to operating cost variation for common interventional radiology procedures. We hope that such information may help identify new strategies for improved cost efficiency and overall value (successful outcome/cost).

METHOD AND MATERIALS: All total equipment and procedure suite costs for consecutive successful primary percutaneous nephrostomy tube (PCN) (25 cases), chest wall port (117 cases), and inferior vena cava (IVC) filter (41 cases) placements were analyzed over a 3-month period, as part of division quality improvement efforts. Actual procedure suite costs were estimated with a conservative cost of \$600/hour. Cost variation was analyzed per procedure and per provider to identify major contributing factors.

RESULTS: For PCN, chest wall port, and IVC filter placements, the average patient time in procedure suite was 131 minutes, 112 minutes, and 127 minutes, respectively. The average total cost per procedure per provider varied as much as 100% (\$1126–\$2251) for PCN placements, 41% (\$1374–\$1934) for chest wall ports, and 22% (\$2185–\$2681) for IVC filters. The equipment cost varied as much as 88% (\$249–\$466), 20% (\$491–\$591), and 27% (\$1065–\$1358), respectively, among different providers. However, the largest contributing factor to cost variation was total procedure suite time, which accounted for 79% (\$1373/\$1732), 67% (\$1127/\$1672), or 53% (\$1306/\$2482) of the total cost, respectively. Thus, despite large variations in equipment cost, total costs ultimately correlated more closely with total procedure suite time.

CONCLUSION: Despite vast differences in equipment cost among different operators for these common procedures within the same department, the largest contributor to overall cost remains patient time in procedure suite, despite utilizing a conservative low estimate for actual cost to operate a procedure suite. These findings suggest that utilization of equipment which allows for expedient procedure resolution, regardless of cost, may be paradoxically more cost-effective overall for select procedures.

(SS06-03) 2:20 PM**National Specialty Trends in Breast Imaging in Medicare Beneficiaries over 2 Decades**

Gelareh Sadigh, MD, *Emory University, Atlanta, GA*; Jennifer Hemingway; Danny Hughes, PhD; Mary S. Newell, MD; Richard Duszak, Jr, MD (*gsadigh@emory.edu*)

PURPOSE: The purpose was to evaluate national specialty trends in breast imaging over the last 2 decades.

METHOD AND MATERIALS: Aggregated claims data for screening mammography, diagnostic mammography, breast ultrasonography, and breast MRI were extracted from Medicare Physician/Supplier Procedure Summary Master Files from 1991 through 2012. Procedure volumes by specialty group (radiologists vs others) were studied.

RESULTS: Between 1991 and 2012, the frequency of breast imaging in Medicare beneficiaries changed from 117,757 to 316,331 (+169%) for screening mammography, 3,766,501 to 1,603,465 (–57%) for diagnostic mammography, and 111,118 to 907,651 (+717%) for ultrasonography. MRI-specific code data are available only since 1995 and have increased from 1,046 to 73,880 (+6,963%). An abrupt 7% decrease in the frequency of screening mammography and MRI occurred between 2009 and 2010, coincident with changing U.S. Preventive Services Task Force recommendations. For all four imaging modalities, radiologists remain by far the dominant provider group. Over time, however, the percentage of the imaging performed by radiologists has increased,

compared to other specialties, in all modalities except ultrasonography. Radiologists' contributions have increased from 86% to 95% for screening mammography, from 90% to 96% for diagnostic mammography, and from 95% to 98% for MRI. For ultrasonography, the national service contribution of radiologists has remained stable at 91%.

CONCLUSION: Over the past 2 decades, the frequency of breast imaging in Medicare Part B beneficiaries has increased considerably, with the exception of diagnostic mammography. Radiologists are by far the dominant provider of these services, and the specialty's relative contribution to overall services has increased over time.

(SS06-04) 2:30 PM**Performance of Academic versus Private Radiologists in Practice Quality Improvement as Part of the Maintenance of Certification Program: How Are We Doing?**

Gelareh Sadigh, MD, *Emory University, Atlanta, GA*; Kimberly E. Applegate, MD, MS*; Pina C. Sanelli, MD, MPH; Arl Van Moore, Jr, MD, FACR (*gsadigh@emory.edu*)

PURPOSE: Practice quality improvement (PQI) project was recently incorporated into the maintenance of certification (MOC) program. The purpose of this study was to assess participation, experience, and possible barriers of multi-institutional academic practice radiologists (APs) and private practice radiologists (PPs) in performing PQI.

METHOD AND MATERIALS: We previously piloted a survey of radiologists at two academic practices. After revision of survey questions, an electronic survey was sent anonymously to practicing radiologists—via the SCARD list serve (academic) and via the largest private practice consortium of approximately 1200 radiologists. The number and types of PQI projects, radiologist experience, and barriers for participating in PQI were investigated among APs and PPs.

RESULTS: A total of 225 APs and 297 PPs responded (combined response rate, 20%). 58% of APs and 65% of PPs were more than 10 years in clinical practice after completion of training (no MOC requirement). 83% of APs reported participating in PQI (61% completed 1–3 projects since training, and 39% completed more). 81% of PPs reported participating in PQI (78% completed 1–3 projects, and 22% completed more). Most projects were performed in group/division settings, compared to other settings (63% in APs vs 82% in PPs). The most common topics among APs were "Patient Safety" (54%) and "Report Timeliness" (36%), while among PPs, "Accuracy of Interpretation" (64%) and "Patient Safety" (46%) were most common. 65% of APs and 52% of PPs believed PQI improved patient safety. 68% of APs and 56% of PPs reported PQI improved quality of care. 39% of APs and 35% of PPs reported PQI improved patient and referring physician satisfaction. The most commonly reported barriers among APs were limited time (83%), lack of resources (46%), and lack of interest (39%); while among PPs, limited time (67%), lack of interest (34%), and limited understanding and knowledge (26%) were the most common barriers.

CONCLUSION: APs and PPs have similar attitudes and barriers to PQI. A large majority of APs and PPs have participated in PQI. More than 50% of radiologists believed PQI resulted in improved patient safety and quality of care. Having limited time was the main barrier to involvement in projects.

(SS06-05) 2:40 PM**Impact of Long Workdays on Satisfaction of Search**

Elizabeth A. Krupinski, PhD*, *University of Arizona, Tucson, AZ*; Kevin M. Schartz, PhD; Kevin S. Berbaum, PhD; Robert Caldwell; Alexandra Schaeffer, BA (*krupinski@radiology.arizona.edu*)

PURPOSE: To explain one type of false-negative (FN) error, it has been hypothesized that with the discovery of one abnormality, observers may be inclined to discontinue scrutiny without complete inspection—a lesion is "missed" after detecting another lesion. We hypothesized that work-induced fatigue will exacerbate the known magnitude of the satisfaction of search (SOS) effect for detecting diverse subtle test abnormalities.

* Faculty financial disclosures are located in the Faculty Index.



METHOD AND MATERIALS: After a long day of work, 10 radiologists and 10 radiology residents viewed 64 chest radiographs, half with native abnormalities (eg, pneumothorax) only (non-SOS), and all with added subtle pulmonary nodules (distractor) in the other (SOS) condition. Results were compared to a similar group who had viewed the cases before a long day of work. Demographic information was obtained, time spent per case was measured, and ROC analyses were performed on the detection of the native lesions and the nodules.

RESULTS: Six females and 14 males participated in the current reading-after-long-hours sessions. On average, they had been working for 7.79 hours (sd = 4.97) and had read 44.90 cases (sd = 44.26). Average ROC points indicate that the tired readers actually performed slightly better than the nontired readers, with faculty generally outperforming the residents overall and being less affected by fatigue after a long day of work. For residents, the SOS effect seems to be due to a shift in criteria—they are less willing to report anything (TP or FP).

CONCLUSION: Faculty and residents in the study after long hours of working performed better than those in the reading-before-work study. Faculty outperformed residents and had less of an SOS effect. The results suggest that fatigue is an important factor impacting today's radiologists but is more complex than simply resulting in missed calls.

(SS06-06) 2:50 PM

Comparative Effectiveness of CT versus Plain Radiographs in the Initial Diagnosis of Small Bowel Obstruction

Resmi Charalel, MD, *New York-Presbyterian Hospital/Weill Cornell Medical Center, New York, NY*; Jonathan Jo; Marc J. Gollub, MD; Heather Yeo; Jeffrey Milsom; Rama Rao; et al (rac9069@nyp.org)

PURPOSE: Despite the substantially improved diagnostic accuracy of CT abdomen/pelvis with intravenous and oral contrast (CT) compared to abdominal X-ray (XR) series, XR remains a first-line imaging examination for small bowel obstruction (SBO) in many hospitals. Here we model the comparative effectiveness of performing initial CT instead of XR in SBO patients.

METHOD AND MATERIALS: A decision analysis model (Figure) was developed comparing outcome health states for SBO patients who received CT versus XR as the initial diagnostic imaging exam. The clinical pathways were based on published clinical algorithm literature and multidisciplinary consensus among colorectal surgeons, an abdominal radiologist, and an emergency physician. Input probabilities were derived from published literature. Outcome health states were estimated based upon prior quality of life studies with similar outcome health states. Expected health benefits were calculated for each imaging strategy. One-way sensitivity analyses were performed on all variables. Additional multivariable sensitivity analyses were performed when appropriate.

RESULTS: The initial CT strategy was superior to the initial XR strategy, with improved health outcomes attributed to the earlier diagnosis of a surgical etiology of SBO, for which nonsurgical management with bowel rest would not be sufficient. CT remained the superior imaging strategy for all one-way sensitivity analyses except when the probability of death and complication after surgical treatment within the first 24 hours rose above 9.0% and 57.5%, respectively.

CONCLUSION: Given current postsurgical outcome data, the performance of initial CT over XR for SBO management results in improved health outcomes even if follow-up CT is performed within the first 24 hours. Furthermore, in this group of patients, the CT strategy results in less radiation and fewer imaging studies, which may provide added benefits to both health outcomes and costs. As a result, our study provides supportive evidence to perform broader analyses including all abdominal pain patients with suspected small bowel obstruction.

(SS06-07) 3:00 PM

Event Documentation and Transfer of Care Following Severe Contrast Reactions

Stephen A. Balfour, MD, *Temple University, Philadelphia, PA*; Justin McCloskey; Pratik Patel, DO; Xi Xue; Beverly L. Hershey, MD (Stephen.Balfour@tuhs.temple.edu)

PURPOSE: The proper management of acute contrast reactions is central to the role of radiologists, and yet in a recent study, only 41% of radiologists recalled the correct dose and route of epinephrine administration in the treatment of anaphylactic contrast reactions. Clinical simulation-based training is increasingly being used by residency programs to teach contrast reaction management; Sarwani and colleagues demonstrated that management of contrast-induced reactions by radiology residents improved after two simulation sessions. However, there is no literature evaluating proper documentation or transfer of care in the event of severe contrast reactions as a postsimulation primary end point. Following a clinical simulation of a contrast reaction, we evaluated resident documentation of the event and transfer of care to a receiving medical team.

METHOD AND MATERIALS: Following a high-fidelity mannequin simulation of contrast-induced anaphylactic shock, residents ($n = 18$) were asked to document the event in a progress note and transfer care to a receiving medical team. The criteria for analyzing the notes were derived from the ACR Practice Parameter for Communication of Diagnostic Imaging Findings and from the *ACR Manual on Contrast Media*.

RESULTS: Resident notes communicated the appropriate evaluation and management provided (criteria were met 61%–100% of the time). However, consistent deficiencies were found in documenting prior reaction to contrast (27%) and transfer of care criteria (22%–44%). The criteria used in evaluation of resident notes and the rates of documentation are shown in the Figure.

CONCLUSION: While standards for documentation of ACLS codes and other emergencies have been devised, no such standards exist for documentation of management of contrast reactions. Our results suggest the need for developing a standardized documentation system of severe contrast-induced reactions. In future clinical simulations, education regarding transfer of care should be emphasized, and providing residents with standardized criteria may result in improved documentation and transfer of care to a medical team.

(SS06-08) 3:10 PM

Effect of Radiology Data Mining Software on Departmental Scholarly Activity

Austin C. Bourgeois, MD; Alexander S. Pasciak, PhD*; Neema Patel, MD, *Mayo Clinic, Jacksonville, FL*; R. Eric Heidel, PhD; Yong C. Bradley; Mumtaz Syed, MD, PhD (austincb@gmail.com)

PURPOSE: Resident and clinical faculty involvement in research differs among institutions as a result of widely variable access to resources, incentives, and differences in institutional culture. Despite mandatory requirements to participate in research and quality improvement, establishing these endeavors as a departmental priority is often challenging. We review the scholarly activity of a radiology department over nearly 6 years, to characterize possible effects of data mining software (DMS) on productivity and interdepartmental collaboration.

METHOD AND MATERIALS: A single-institution retrospective review of 69 consecutive months of departmental faculty and resident files was conducted. National and international abstract presentations and scientific publications were included before and after data mining software (Illuminate; Softek Solutions, Prairie Village, KS) was installed throughout the department in month 35. Residents, clinical faculty, and research faculty were analyzed on aggregate and independent bases with regard to total scientific manuscript production, abstract presentation, and rate of collaboration with other departments at the author's institution. An "impact score" comprised of the number of departmental authors on each scientific manuscript multiplied by the respective journal impact factors was calculated and compared.

* Faculty financial disclosures are located in the Faculty Index.



RESULTS: Residents were 4.43 times (95% CI: 2.23–8.81) and clinical faculty were 3.9 times (95% CI: 1.3–11.7) more likely to author an abstract following DMS implementation. DMS was associated with increased clinical faculty and resident scientific manuscripts ($P = .001$). Residents alone were 3.7 times (95% CI: 1.2–11.6) more likely to author a scientific manuscript with DMS. However, DMS was associated with no change in total departmental “impact score” or increased interdepartmental collaboration in both abstract presentation ($P = .53$) and manuscript publication ($P = .77$).

CONCLUSION: A number of factors affect the scholarly activity production in academic medical centers. However, these data suggest that the implementation of DMS is associated with a significant increase in radiology research activity.

AUR Memorial Award

(SS06-09) 3:20PM

Simulation-based Educational Curriculum for Fluoroscopically Guided Lumbar Puncture Improves Operator Confidence and Reduces Patient Dose

Austin R. Faulkner, MD, *University of Tennessee Medical Center, Knoxville, TN*; Austin C. Bourgeois, MD; Yong C. Bradley, MD; Kathleen Hudson, MD; R. Eric Heidel, PhD; Alexander S. Pasciak, PhD*

PURPOSE: Fluoroscopy-guided lumbar puncture (FGLP) is a commonly performed procedure with increased success rates relative to bedside technique. However, FGLP also exposes both patient and staff to ionizing radiation. The purpose of this study was to determine if the use of a simulation-based FGLP training program utilizing an original inexpensive lumbar spine phantom could improve operator confidence and efficiency while also reducing patient dose.

METHOD AND MATERIALS: A didactic and simulation-based FGLP curriculum was designed, including a 1-hour lecture and hands-on

training with a lumbar spine phantom prototype developed at our institution. Six incoming PGY-2 radiology residents completed a short survey prior to taking the course, and each resident practiced 20 simulated FGLPs utilizing the phantom prior to their first clinical procedure. Data from the 114 LPs performed by the six trained residents (prospective cohort) were compared with data from 514 LPs performed by 17 residents who did not receive simulation-based training (retrospective cohort). Fluoroscopy time, FGLP success rate, and indication were compared.

RESULTS: There was a statistically significant reduction in average fluoroscopy time for the 114 procedures performed by the prospective study cohort compared with the 514 procedures performed by the retrospective cohort. This held true for all procedures in aggregate, lumbar punctures for myelography, and all procedures performed for a diagnostic indication. Aggregate fluoroscopy time for the prospective group (0.87 ± 0.68 min) was significantly lower when compared to the retrospective group (1.09 ± 0.65 min) and resulted in a 25% reduction in average fluoroscopy time ($P = .002$). There was no statistically significant difference in the number of failed FGLPs between the two groups.

CONCLUSION: Our simulation-based FGLP curriculum resulted in improved operator confidence and reduced fluoroscopy time. These changes suggest that resident procedure efficiency was improved while patient dose was reduced. The FGLP training program was implemented by radiology residents and required a minimal investment of time and resources. The LP spine phantom used during training was inexpensive, durable, and effective. In addition, the phantom is compatible with multiple modalities, including fluoroscopy, CT, and US, and could be easily adapted to other applications such as facet injections or joint arthrograms.