AUR 2015 Research Poster Abstracts

Research posters are located in the Acadia Ballroom. Each poster will be presented by its author during one of the *AMA PRA Category 1 Credit*™ poster discussion sessions scheduled for 7:00–8:15 AM, Wednesday (Session 201) and Thursday (Session 301). The day and time for each poster presentation follows the presentation number. 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.

Abdominal Radiology

(R-04) Thursday • 7:00 AM
Determining the Predictive Value of Risk Factors in the Development of Retroperitoneal Hemorrhage

Ahmed Fadl, MA, MD, *Winthrop-University Hospital, Mineola, NY*; Amanjit Baadh, MD; Nicholas A. Georgiou, MD; Man Hon, MD; Douglas S. Katz, MD; Jason C. Hoffmann, MD★ (*jhoffmann@winthrop.org*)

PURPOSE: Retroperitoneal bleed (RPB) is an uncommon and potentially life-threatening condition often requiring a high index of suspicion to diagnose correctly. Concern for RPB is often raised, given physical examination findings and pertinent laboratory values. Noncontrast computed tomography (CT) is a fast and accurate means to emergently assess these patients. We retrospectively evaluated specific risk factors in a series of patients and determined their predictive values in developing a retroperitoneal hemorrhage when correlating with CT findings.

METHOD AND MATERIALS: A single institutional retrospective analysis of 1000 consecutive patients who underwent a noncontrast CT of the abdomen and pelvis to evaluate specifically for retroperitoneal bleed was conducted. Patients were selected from a database of CT imaging requests during a 4-year period (June 2008–June 2011). Vital signs, recent invasive procedures, coagulation panel, hematologic status, and anticoagulant use were documented. Corresponding CT imaging at the time of evaluation was analyzed by two board-certified radiologists for the presence of a retroperitoneal bleed. Findings were subsequently compared between the RPB versus non-RPB cohort.

RESULTS: Of the 1000 patients meeting inclusion criteria, 29 were found to have CT-confirmed retroperitoneal bleeds. A randomly selected equal-size cohort with CT-confirmed studies negative for RPB was gathered for comparison. Analysis demonstrated that the CT-confirmed RPB patients had a statistically significant low mean arterial pressure (MAP), with average MAP of 76 mm Hg versus 86 mm Hg in control group (P = .0008). Recent invasive procedure was also found to have significance, with 24 of 29 in the RPB group having recent invasive procedures, compared to three of 29 in the control group (P = .0068). Drop in hemoglobin/hematocrit, coagulation panel, and anticoagulant use were not found to have statistical significance.

CONCLUSION: Although uncommon, RPB warrants a high index of suspicion and prompt evaluation due to associated morbidity and mortality. Our initial data suggest that low mean arterial pressure and a recent invasive procedure have predictive value in determining which patients should be emergently imaged.

AMSER Henry Goldberg Medical Student Award

(R-05) Wednesday • 7:00 AM
The Attenuation Distribution across the Long Axis: Preliminary Findings for Assessing Response to Cancer Treatment

Nikita Lakomkin, *Vanderbilt University, Nashville, TN*; Hakmook Kang; Michael S. Hutson; Bennett Landman; Richard G. Abramson, MD★ (*nikita.lakomkin@vanderbilt.edu*)

PURPOSE: Novel methods of image feature analysis may serve as useful adjuncts to standard tumor size–based cancer treatment response assessment, but broad clinical translation will require approaches that are time and resource efficient. The attenuation distribution across the long axis (ADLA) is a simple and straightforward measure of intralesional heterogeneity that can be obtained while measuring the long-axis diameter of a target lesion. The purpose of this preliminary study was to evaluate the potential for ADLA measurements to predict treatment response in a clinical trial.

METHOD AND MATERIALS: IRB approval was obtained for a retrospective review of imaging and clinical data from a phase 2 trial of linifanib, an orally activated multitargeted tyrosine kinase inhibitor, in patients with metastatic colorectal cancer. Fifteen patients with at least one liver metastasis measuring at least 10 mm on baseline CT were included. For each patient at every imaging time point while on trial, the ADLA for up to two target liver lesions was obtained as the standard of deviation of the postcontrast CT attenuation values in the portal venous phase across a linear function spanning the long-axis diameter. Weighted-average ADLAs were calculated at each time point using tumor long-axis diameters as the weighting factor. A response to treatment was defined as a weighted-average ADLA decrease of at least 40% from baseline. Best overall response for each patient was computed using both the ADLA method and RECIST 1.1. Using Kaplan-Meier survival analysis, the log-rank test was employed to evaluate the ability of each method to discriminate patients with longer survival.

RESULTS: The ADLA method was able to separate patients with longer survival times (P = .04; see Figure). RECIST 1.1 was not able to discriminate patients with longer survival (P > .05).

CONCLUSION: The ADLA measurement merits further study as an easily extractable quantitative CT parameter that may be useful as an adjunct to standard tumor size–based response assessment methods.

(R-06) Thursday • 7:00 AM
Evaluation of a Lesion Mapping, Removal, and Reinsertion Tool for Radiation Dose Reduction in Abdominal CT: A Validation Study

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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

★ Faculty financial disclosures are located in the Faculty Index.

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 performed 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.

(R-07) Wednesday • 7:00 AM
Can Intrahepatic Cholangiocarcinomas Mimic Hepatocellular Carcinomas on Multiphasic CT?

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PURPOSE: Liver transplant guidelines for diagnosis of hepatocellular carcinoma (HCC) do not mandate pathologic confirmation; instead, "classic" imaging features alone are deemed satisfactory. Intrahepatic cholangiocarcinoma (ICC) is a relative contraindication for transplantation due to a high rate of recurrence and poor prognosis. The objective of this study is to evaluate imaging features of ICC to aid detection and differentiation of confounding cases from HCC, and potentially avoid inappropriate therapy and liver transplantation.

METHOD AND MATERIALS: After IRB approval, 39 lesions in 36 patients with multiphasic CT and biopsy-proven ICC were retrospectively reviewed. Imaging parameters include tumor size, presence of cirrhosis, tumor capsule, vascular invasion, enhancement, and tumor markers. Two fellowship-trained radiologists assigned an enhancement grade to each tumor. Grading was classified as 1–5 based on Hounsfield unit enhancement on multiphasic CT. Grade 1 is typical HCC enhancement, grade 5 is typical ICC enhancement, and grades 2–4 denote varying degrees of enhancement. OPTN/LI-RADS classification was also assigned.

RESULTS: Sixteen tumors (42%) had capsular retraction, 24 (62%) had peripheral enhancement, and two (5%) had vascular invasion. Analysis based on our grading system showed three tumors (7.7%) with grade 1 enhancement, 10 (25.6%) with grade 2–4 enhancement, and 26 (66.7%) with grade 5 enhancement. Kruskal-Wallis test comparing AFP/CA19-9 between the groups; Wilcoxin rank-sum test comparing tumor markers with presence of tumor capsule, vascular invasion, and cirrhosis; and nonparametric Pearson correlation coefficient comparing tumor markers to tumor size were not statistically significant ($P > .05$).

CONCLUSION: Typical ICC pattern of arterial phase hypoenhancement with progressive delayed enhancement (grade 5) is present in most cases (66.7%). We show that 23.1% of ICCs demonstrate nonclassic enhancement characteristics (grades 1–3) on multiphasic CT, of which 7.7% demonstrate enhancement mimicking typical HCC (grade 1). Since biopsy is not mandated for transplant listing, failure to recognize varying patterns of ICC enhancement can have serious ramifications for the patient and jeopardize institution transplant licensure.

Cardiopulmonary Radiology

(R-11) Wednesday • 7:00 AM
CT Pulmonary Angiography for Diagnosis of Acute Pulmonary Embolism in the Emergency Department in Women between 18 and 40 Years of Age

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PURPOSE: The purpose of our study was twofold: (1) to evaluate thromboembolic risk factors for pulmonary embolism (PE) detected by using CT pulmonary angiography (CTPA) in young women presenting to the emergency department (ED), and (2) to determine whether such information may guide more-appropriate use of CTPA in this patient population.

METHOD AND MATERIALS: We retrospectively searched digital archives for female patients between the ages of 18 and 40 who presented to the ED and subsequently underwent CT to evaluate for PE. A total of 460 female patients were found between January 2010 and July 2013 who met our inclusion criteria. Then the electronic medical records (EMRs) were reviewed for laboratory data, vital signs, and clinical notes to discover established risk factors for PE.

RESULTS: Of the 460 young women with CT exams for evaluation of PE, 36 (7.8%) were positive for PE, which is similar to the rate reported in the literature (~9.6%–19.2%). Of these patients with PE, all had at least one of the recognized risk factors, and many had multiple risk factors. However, 51 patients without risk factors had CT scans, all of which were negative for PE.

CONCLUSION: Risk factor assessment should be a primary tool for guiding when to perform CTPA in young women in the ED who are clinically suspected of having PE. By using risk factor assessment, CTPA can be targeted appropriately, with the potential to substantially reduce radiation exposure. The PERC and Wells score for risk stratification of patients with potential PE have been widely accepted but may not be consistently followed, particularly in the ED. The results of our investigation of 460 young women confirm the potential benefits of applying such consistent risk stratification methods as a basis for performing CTPA. If the presence of risk factors had been used consistently in our population as a basis for requesting CTPA, the number of negative scans could have been reduced by 12%, and no PE would have been missed. It is very unlikely for CTPA to be positive for PE in young women with no thromboembolic risk factors. Consistent use of risk factor assessment has the potential to guide more-appropriate use of CTPA in young women presenting to the ED.

Education of Residents, Medical Students, Other

(R-13) Wednesday • 7:00 AM
Multidisciplinary Panel Approach to Address Issues Related to Professionalism between the Radiology and Emergency Medicine Departments

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PURPOSE: To use a multidisciplinary approach to promote a culture of professional behavior between the Radiology and Emergency Medicine (EM) Departments at Baylor College of Medicine.

METHOD AND MATERIALS: A core group of two attendings and one resident from the EM Department and one attending and two residents from the Radiology Department collaborated to create a 20-question survey which was presented to the residents and faculty of both programs. The purpose of the survey was to evaluate the perception of

professional behavior between the two groups, anonymously disclose situations where unprofessional behavior has previously occurred, and identify areas for improvement. The survey also included questions regarding the perceptions each department has of the other. The results of the survey were analyzed by the core group and by a multidisciplinary panel format and presented at a grand round open to all departments at Baylor College of Medicine. Recommendations made by the core group and those who attended the multidisciplinary-panel grand round were implemented for a period of 2 months. A second survey was then sent to the residents and faculty of both departments to determine whether improvement in professional behavior between the members of both departments had taken place. The results of the second survey were then discussed at a second multidisciplinary-panel grand round.

RESULTS: The results of both surveys and of the multidisciplinary grand rounds will be discussed at the 2015 AUR meeting.

CONCLUSION: The use of a multidisciplinary panel approach between the Radiology and Emergency Medicine Departments is an effective method to address issues and promote a culture of professional behavior between the EM and Radiology Departments and ultimately improve patient care. This approach may be used by other departments throughout the Texas Medical Center.

(R-14) Thursday • 7:00 AM
Predictors of Resident Performance on the American Board of Radiology Core Examination

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PURPOSE: Literature identifying predictors of performance on the new American Board of Radiology (ABR) Core Examination is lacking. The purpose of this study is to identify predictors of resident performance on the ABR Core Exam by correlating American College of Radiology (ACR) Diagnostic In-Training Examination (DXIT™) scores, USMLE scores, and RAPHEX exam scores with ABR Core Exam scores.

METHOD AND MATERIALS: During the 2-year 2013–2014 academic period, the ABR Core Exam, ACR DXIT™, USMLE, and RAPHEX exam scores from all 15 diagnostic radiology residents at the Cleveland Clinic were anonymized and analyzed. The Pearson correlation coefficient was used to assess the linear correlation between each predictor and Core Exam performance. A multiple-variable analysis to simultaneously estimate the effects of the potential predictors was precluded because of the small sample size ($n = 15$). A separate analysis of the association between RAPHEX scores and the ABR Core Exam physics score was assessed similarly.

RESULTS: USMLE Step 1 and 2 scores show promise as predictors of Core Exam performance—particularly Step 2, which had strong positive correlation with exam performance ($r = 0.725$; 95% CI: 0.34, 0.90). ACR DXIT™ scores from the R2 year also showed a strong positive correlation ($r = 0.712$; 95% CI: 0.26, 0.91). The same correlation strength was not observed for ACR DXIT™ R1 or R3 ($r = 0.275$ and 0.369, respectively). A larger sample might help clarify the predictive abilities of the ACR DXIT™ exam. No significant correlation between RAPHEX exam and Core Exam physics scores was observed ($r = -0.089$; 95% CI: −0.610, 0.486; $P = .773$).

CONCLUSION: USMLE Step 1 and 2 scores show promise as predictors of resident performance on the ABR Core Exam—particularly Step 2, which had strong positive correlation with exam performance.

(R-16) Thursday • 7:00 AM
Impact of Community and Emergency Radiology Divisions on the Resident Experience at an Academic Training Institution

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PURPOSE: Many institutions have implemented emergency and community radiology ("ER") divisions to provide final interpretations of exams from the emergency room both during and after regular business hours, to satisfy a need for 24/7 attending coverage. Our goal is to examine the change in resident experience during the past 5 years of this transition in our department.

METHOD AND MATERIALS: We analyzed resident case logs from 7/1/10–6/30/14 to determine the average number of studies residents dictate with attendings from each division. For clarity, divisions accounting for less than 1% of all resident dictations were excluded. A total of 1,079,123 studies dictated by 54–63 residents per academic year were included.

RESULTS: Residents read 37% more studies in AY2013–14 than AY2010–11, while the number of residents only increased 17% (Fig 1). The ER division accounted for the majority of this increase, while MSK and neuro also saw absolute volume increases above those expected from the increased number of residents alone. Chest and mammography saw absolute volume decreases, while body and pediatrics volumes increased but less than expected for the number of residents. The ER division is now responsible for more resident dictations than any other subspecialty. Residents read 23% of their studies between 7 PM–7 AM in AY2013–14, compared to 12% in AY2010–11, a 187% increase (Fig 2).

CONCLUSION: Residents read more studies now than before, due in part to increased after-hours workload. 42% of the additional studies are staffed by general radiologists from the ER division, which began in AY2010–11. An additional night-float rotation staffed by an ER attending began in AY2011–12 and led to an 88% increase in after-hours dictations. In the traditional academic radiology model, attendings function primarily within the division in which they are fellowship trained. In this new model, ER divisions are staffed by attendings who may be fellowship trained but practice as general radiologists. This organizational structure is understandable from a health care delivery standpoint and perhaps is necessary for customer service but might direct case volume away from subspecialists, and its impact on resident education should be explored further.

(R-18) Thursday • 7:00 AM
Perspiration, Performance, and Preparation: An Analysis of Resident Preparatory Methods and Habits in Successfully Passing the American Board of Radiology's New Core Examination

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PURPOSE: The purpose was to evaluate radiology resident performance, preparatory methods, and habits related to successful preparation for the new American Board of Radiology (ABR) Core Examination.

METHOD AND MATERIALS: Thirty-one 4th-year radiology residents who passed the Core Exam were anonymously surveyed using Likert-type scale, rank ordering, and free-response question formats. The survey evaluated overall and subcategory-specific exam performance, study patterns and habits, departmental board review attendance, organ- and subcategory-specific study resource recommendations, and residents' perceived impact of specific activities on exam performance.

RESULTS: 84% of surveyed residents scored above the national average overall score (surveyed average physics subscore was 216 points

above passing). The most valued factors (eight choices) in passing the exam were self-study time after work and during rotation downtime (4.8 and 4.7, respectively; scale 1–5; $P < .01$ vs six other choices). This was followed by audience response system/multiple-choice question–based conferences (4.1), didactic conferences (4.0), hot-seat conferences (3.9), daily clinical rotations (3.3), call/night float (3.1), and group study (2.8). Regarding conferences, attendance (1 = 0%–25%; 2 = 26%–50%; 3 = 51%–75%; 4 = 76%–100%) was highest for physics/quality/safety conferences (3.6; $P < .01$ vs case-based) and lowest for case-based conferences (3.1). At 9–12 months before the exam, residents studied an average of less than 15 hours/week. At 6–9, 3–6, and 0–3 months before the exam, the hours per week studied increased 1.3-, 2.1-, and 2.8-fold, respectively, compared to 9–12 months before exam. Among the nonphysics resource types (six choices), practice questions (RADprimer, 4.6; scale 1–5; $P < .01$ vs other choices) were most valued, while radiologic articles (2.4) were least valued. The most valued physics resource was the RSNA physics modules (4.6; scale 1–5; $P < .01$ vs bottom three resources).

CONCLUSION: Our study provides in-depth analysis of appropriate study patterns, resource utilization, and habits for Core Exam preparation and can be used to develop a study plan appropriate for passing and possibly achieving an above-average score on the ABR Core Exam.

R-19) Wednesday • 7:00 AM
Learning from Our Mistakes: Lessons from a Resident-centric Morbidity and Mortality Conference

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PURPOSE: The purpose was to determine the benefits of a resident-led morbidity and mortality (M&M) conference and to compare its effectiveness to faculty-run M&M.

METHOD AND MATERIALS: A monthly 1-hour noon conference slot was dedicated to the formation of an M&M conference where only radiology residents were allowed to attend and participate. Cases for the conference were contributed by residents anonymously into a PACS folder and reviewed in chronological order. The chief residents led the conference and case discussion; however, all residents were given the option of presenting their own cases. Pre- and posttest surveys with a 10-point Likert scale were administered prior to the first resident-led M&M conference and after 1 year, to assess and compare the resident-led M&M conference to the faculty-led M&M. Statistical analysis to compare the surveys was performed using statistical software (SAS, Cary, NC), and comparisons between the resident-led and faculty-led groups were made using the Mann-Whitney *U* statistical test.

RESULTS: There was an 81% pretest response rate and a 75% posttest response rate. More residents agreed that there was a forum to discuss mistakes among colleagues after the initiation of the resident-led M&M conference (mean pretest, 2.0, and mean posttest, 8.4; $P < .01$); however, the stigma perceived with discussing call cases was not significantly changed after 1 year ($P = .66$). On the posttest, residents agreed that the resident-led M&M was successful, helped them to learn from their own and others' mistakes, and prepared them for call responsibilities (respective means: 9.4, 9.5, 9.5, and 9.3). Moreover, the resident-led M&M was statistically more successful than identical faculty-led M&M metrics (respective means: 2.7, 3.3, 3.7, and 2.7; $P < .01$ for all metrics), and residents agreed that they felt more comfortable speaking up during resident-led M&M (mean, 9.5) than at the faculty-led M&M (mean, 3.1) ($P < .01$).

CONCLUSION: Resident-led M&M is a successful way for residents to help prepare each other for call and learn from their own and other residents' mistakes. Residents seem to prefer resident-led M&M to faculty-led M&M, in part because they feel more comfortable speaking up in an audience of their peers.

(R-21) Wednesday • 7:00 AM
A Standardized Curriculum of Screening Mammograms for Radiology Residents Increases Exposure to Screen-detected Cancers

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PURPOSE: A curriculum of screening mammograms enriched with a large number of cancers was created to increase resident exposure to screen-detected cancers. We describe this curriculum and analyze residents' performance by year in residency throughout this curriculum.

METHOD AND MATERIALS: This educational activity and its analysis were exempt from IRB review. At the beginning of each breast imaging rotation throughout residency, residents were given a "learning module" of 100 cases of digitized screening mammograms. Residents were asked to mark any area of interest and report an appropriate BI-RADS final assessment category and their quantitative level of suspicion. After they read each case, they were given instant feedback of the correct findings and outcomes of the case. At the end of each rotation, residents were given an additional "testing module" of 100 cases of FFDM screening mammograms for which they were required to report the same data as the learning module but without the instant feedback. Resident performance on this testing module was quantified in terms of sensitivity, specificity, and area under the ROC curve. Statistical analysis for trend was based on Spearman rank-order correlation, Kendall τ, and Student t test.

RESULTS: A total of 38 residents completed the curriculum, and 21 completed it more than once throughout their residency rotations, for a total of 66 takes of the testing module. The overall performance of all residents was sensitivity of 70.53%, specificity of 88.73%, and AUC of 0.9064. When grouped by year in residency, there was an apparent increase in sensitivity (1st year = 67% ± 11%; 2nd year = 69% ± 10%; 3rd year = 71% ± 12%; 4th year = 73% ± 12%), which was not statistically significant ($P = .07$). For residents who underwent the study more than once, 16 of 21 improved sensitivity from the first to the second take of the testing module ($P = .02$, t test for paired data).

CONCLUSION: This curriculum for residents rotating through breast imaging increases their exposure to screen-detected breast cancer and could document their improvement in sensitivity (although currently short of being statistically significant) as they proceed through residency.

(R-22) Thursday • 7:00 AM
A 360° Evaluation of the Program Director and Program Coordinator

Kedar Jambhekar, MD, *University of Arkansas for Medical Sciences, Little Rock, AR*; Leah E. Braswell, MD; Anna Moses, MEd; Linda A. Deloney, EdD *(DeloneyLindaA@uams.edu)*

PURPOSE: No one likes performance reviews, but professionals need feedback to improve job performance and advance their careers. The 360° assessment, widely used in business for personal and professional development, came to graduate medical education (GME) with the general competencies. The Accreditation Council for Graduate Medical Education (ACGME) requires an annual 360° as a measure of resident competence, but no 360° evaluation of program leadership has been suggested. We aimed to develop a 360° for our program director (PD) and program coordinator (PC), to determine the feasibility of the process and whether feedback would impact subsequent job performance. We believe this is the first study to report a 360° for program leaders.

METHOD AND MATERIALS: After a literature review, items were selected, and rating groups were defined. Surveys were administered by our GME office using software (New Innovations, Uniontown, OH) to ensure data were collected anonymously. Evaluations were sent on June 6 and remained available until July 15, 2014, after which composite reports were provided to the PD and PC as formative feedback.

RESULTS: The PD instrument had 15 items with a 5-point Likert-type scale and open-ended comment boxes. Rating groups included radiology residents and interns, radiology faculty, DIO, and General Counsel (91 invitations); 46 responses were received (51%). The PC instrument had 15 different items with a similar scale and open-ended items. Raters included radiology residents and interns, CCC members, PEC members, department administrative staff, and GME office contacts (62 invitations); 47 responses were received (76%). No feasibility issues were experienced. Three raters felt they were not qualified to evaluate. Two raters who felt their responses would not be anonymous completed a paper evaluation, and data were entered by GME office personnel. Feedback provided by the raters resulted in improvements of skills and attitudes as the PD and PC became aware of areas where they were perceived as being somewhat "off course."

CONCLUSION: The 360° assessments were easy to administer and obtained high response rates. Feedback was balanced, as it came from multiple points of view, and was hard to disregard due to its broad range. The PD and PC modeled willingness to accept feedback.

(R-23) Wednesday • 7:00 AM
Radiology Education Fund: A Philanthropic Approach to Support Resident Education

Kedar Jambhekar, MD, *University of Arkansas for Medical Sciences, Little Rock, AR*; Linda A. Deloney, EdD; Leah E. Braswell, MD; James E. McDonald, MD *(DeloneyLindaA@uams.edu)*

PURPOSE: As economic challenges across health care are increasing, radiology programs are struggling to fund high-quality resident education. Institutional support covers only a fraction of the costs, most of which is used for resident stipends. Supplemental activities, such as the AIRP review courses and professional meeting attendance, increasingly require support from the clinical revenue stream. We found few reports of using philanthropy to support a department's educational program. As a potentially viable source of financial support, we undertook a formal effort to create a radiology education fund.

METHOD AND MATERIALS: With guidance from the College of Medicine's Executive Director of Development & Alumni, we developed and implemented a five-part strategy: (1) clearly define the purpose of the fund; (2) set a target goal; (3) identify potential donors, and categorize them as major, leadership, or regular donors; (4) ask for specific amounts; and (5) thank contributors, and report back on the impact of their investments.

RESULTS: The purpose of the fund is to expand educational and networking opportunities for residents and teaching faculty, offset the cost of education resources, support invited speakers and resident recruitment, and reward extraordinary educational achievements. Other activities that enhance GME in the department may be funded at the discretion of the program director. The fund was established with proceeds from the PD's 2014 Residency Educator award given by the College of Medicine. At the end of the first quarter, we had achieved 72% of our goal from 10 contributors (6 faculty, 3 adjunct faculty, and 1 private practice physician). In addition, pledges have been made that will allow us to surpass our goal by the end of the next quarter. We are continuing to contact potential donors.

CONCLUSION: Alumni and faculty will invest in resident education by making gifts that boost the program's competitive reputation and directly impact the residents. Establishment of formal philanthropic efforts and understanding the fundraising process, especially donor motivation, can benefit resident education and may be essential for the continued success and survival of high-quality academic radiology training.

(R-24) Thursday • 7:00 AM
Management of Contrast Extravasation: Current Awareness at a Tertiary Care Center and Quality Improvement Initiatives

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PURPOSE: Intravenous contrast extravasation (ICE) has a similar frequency to acute contrast reactions: around 0.1%–0.9%. We created a standardized template in the electronic medical record (EMR) to facilitate evaluation, management, and reporting of ICE events. Because residents are often the first physician to respond to ICE events, we held an educational session to assess current resident knowledge and provide teaching modeled on published resources.

METHOD AND MATERIALS: The template incorporates required reporting elements from national guidelines and the department-defined severity grading by volume (Fig 1). A 12-question paper-based survey was administered to assess baseline resident knowledge. The evaluation, management, and reporting of ICE events was then discussed during a walk-through of the department template during resident conference.

RESULTS: Thirty-five residents participated, with at least six residents from each residency class. Participants reported a total of 49 ICE events (average, 1.6 events per resident), with senior residents reporting the most events. The mean reported comfort in evaluating and managing ICE events was 3.3 (3 = neither uncomfortable or comfortable) on a 5-point scale. The most common method of documenting ICE was a free-form note in the EMR (57%), followed by a note in the radiology report (29%). Residents reported documenting the following recommended items: contrast type (29%), volume (26%), site (34%), exam findings (74%), treatment (54%), and disposition (26%). No resident reported documenting all items. Three residents correctly identified all three department severity thresholds for volume, while 20 residents correctly identified at least one volume threshold. Baseline resident knowledge of risk factors and management is discussed. The percentage of ICE event reports documenting all recommended elements following implementation of the standardized template is reported at 3, 6, and 9 months.

CONCLUSION: Nearly all residents will participate in the evaluation and management of ICE during training, and a standardized reporting form should greatly increase the percentage of reports that document all elements recommended by national guidelines.

(R-26) Thursday • 7:00 AM
Revised Interactive Diagnostic Radiology Physics Curriculum for the New Radiology Boards: Initial Experience at a Mid-Size Academic Radiology Residency

Justin Tran, MD, *University of Nebraska Medical Center, Omaha, NE*; Neil J. Hansen, MD; Matthew J. DeVries, MD

PURPOSE: We present a newly implemented radiology physics curriculum for residents at a mid-size academic radiology residency, designed to improve clinical relevance, resident ability to apply physics principles to clinical situations, and maintain a high level of performance on the ABR Core Exam.

METHOD AND MATERIALS: A redesigned physics curriculum was implemented for the academic year of 2013–2014 in response to resident feedback for improvement. The course consists of 29 one-hour lectures, delivered twice per week from January to June 2014. Most of the sessions were presented by staff radiologists, with a minority led by medical physicists and radiation safety officers. The contents were designed to parallel the online RSNA/AAPM modules, with required completion of each module prior to the given lecture. Audience response system was implemented to emphasize resident interactivity and for tracking individual progress. Three voluntary surveys were taken. The first survey gathered feedback on the previous physics teaching

and suggestions for positive change. The second survey measured perceived quality of physic teaching and self-assessment of physics knowledge. The final survey collected the same data after completion of the curriculum.

RESULTS: Data collected before and after the new curriculum demonstrates a dramatic increase in perceived knowledge of physics and preparedness to apply principles to clinical imaging. The secondary endpoint was also achieved, with maintenance of 100% resident pass rate for the physics section, and overall total score, on the ABR Core Exam for 2014.

CONCLUSION: Our initial experience with a redesigned physics curriculum shows significantly increased resident satisfaction and perceived ability to apply principles to clinical radiology. Additionally, we have been able to achieve a performance standard of 100% pass rate on the ABR Core Exam. The curriculum will be monitored and revised based on future Core Exam performance, RAPHEX and in-service exam scores, and resident feedback.

(R-27) Wednesday • 7:00 AM
Using a Commercial Game Engine to Create a Virtual Environment for Learning about Cervical Spine Fractures

Geoffrey M. Siesel, MD, *University of Toledo Medical Center, Toledo, OH*; Terrence J. Lewis, MD; Jacob Zeiss, MD; Robert Coombs, MD; Roy Schneider, MS; Tonya Floyd-Bradstock, MA

PURPOSE: The purpose was to utilize a modern video game engine to create an interactive, first-person, immersive virtual environment to aid in medical student and resident education relating to cervical spine trauma.

METHOD AND MATERIALS: Unity game engine (Unity Technologies, San Francisco, CA) was utilized to create the virtual environment. Simple models were created within Unity, while cervical spine models were created using CT data sets to maximize realism. Processing of CT data was accomplished using Slicer3D and MeshLab. Textures are graphics applied to surfaces of objects, created with GIMP and stored as JPEGs. Shaders control color and illumination, directly applied within Unity. JPEG and Unity plug-ins allow for viewing of educational presentations within the environment. Audio files were applied within Unity or created with text-to-speech converter and later imported. First-person and stereoscopic cameras with perspective display and 90° field of view were used. Camera motion was controlled via mouse and keyboard. Graphics and audio engines within Unity allow for the display and manipulation of all relevant data, including visual effects to enhance realism. We used standard mouse and keyboard control of navigation and interaction.

RESULTS: Radiologists have experience with digital image rendering and manipulation. Rendering techniques developed within computer and gaming industries have been translated into medical imaging. Using these tools to create virtual 3D environments, one may freely interact with learning objects, including audio lectures, 2D presentations, or 3D models, to enhance understanding of pathology and imaging anatomy. Networking capabilities allow multiuser learning and interaction within a single environment.

CONCLUSION: Current trainees comprise a generation of learners who respond favorably to media-rich interactive educational resources. With nearly ubiquitous access to Internet and video games, current learners are able to adapt quickly to virtual environments. Virtual reality has the advantage of being able to simulate a multitude of learning environments within a single setting, and the degree of realism achieved via modern engines allow for creation of an immersive environment optimized for maximal concentration and content mastery.

(R-28) Thursday • 7:00 AM
How to Establish a Web-based Teaching File for Your Department

Jason W. DeBerry, MD, BS, BA, *University of Virginia, Charlottesville, VA*; Kristen Hojnowski; Jimmy Han; Michael Hanley, MD *(jdeberry@virginia.edu)*

PURPOSE: Teaching files have always been at the core of radiology education and research. Over the years, the concept has evolved from a dusty film jacket under a professor's desk, to USB drives, to PACS or Web-based collections. Each of these methods has its own advantages with respect to access, portability, ease of use, and cost. We have found that Web-based wiki platforms perform best when considering the true goals of a teaching file. We would like to share a step-by-step instruction for how to establish a Web-based teaching file at your institution.

METHOD AND MATERIALS: There are five steps to establish a Web-based teaching file: (1) Pick a name. A memorable Web address is important, with registration costs being approximately $10/year. (2) Find a host. Many commercial Web hosts are available for approximately $150/year. Many universities will offer hosting internally, which is helpful if you want to use your department's or university's logo. Any Web address can be easily redirected to an internal or external host. (3) Establish the site. The wiki platform that runs *wikipedia.com* is free to use and is customizable. It is necessary to have someone who is familiar with the platform help set up the site's logo and appearance. We have found that many of our residents and medical students are adept at this type of programming. (4) Provide content. Residents are asked to submit a minimum of two cases during a rotation. The uploading of images and text requires only minimal training. (5) Determine accessibility. The Web site can be viewable to all, but we have restricted adding/editing cases to staff, fellows, and residents with oversight.

RESULTS: Creation of a Web-based teaching file can be done with only a small investment in time and money. The teaching value surpasses other formats, with respect to access, portability, and ease of use. Residents learn from adding cases, as well as from reviewing cases submitted by their colleagues. Having a cataloged image repository also has great value when preparing a presentation or a research paper.

CONCLUSION: Radiology education has taken many forms, but now a dynamic and easy-to-access wiki-based teaching file can be developed at your institution.

(R-29) Wednesday • 7:00 AM
Development of a Team-based High-fidelity Simulation Training Program for Both Contrast Reaction Management and Teamwork Based on TeamSTEPPS®

Carolyn L. Wang, MD, *University of Washington, Seattle, WA*; Sankar Chinnugounder, MD; Daniel Hippe★; Ryan O'Malley; Sadaf Zaidi, MD; William H. Bush, Jr, MD *(wangcl@uw.edu)*

PURPOSE: The purpose was to develop a team-based high-fidelity simulation curriculum for both contrast reaction management (CRM) and teamwork based on TeamSTEPPS® for radiologists, nurses, and technologists.

METHOD AND MATERIALS: Six nurses, six technologists, and six PGY-2 radiology residents were prospectively recruited for this IRB- and HIPAA-compliant study. Participants were arranged into teams of three (one resident, nurse, and technologist each). Each team separately underwent high-fidelity simulation-based training on both CRM and teamwork skills. The training consisted of five high-fidelity simulation clinical scenarios, each teaching both a single CRM and teamwork skill. Before and after the intervention, the participants completed a questionnaire about their individual comfort with various aspects of CRM and team communication skills. The responses were based on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Questionnaire responses were summarized as mean ± standard deviation.

Wilcoxon signed-rank test was used to test for a change in responses after undergoing the simulation-based training.

RESULTS: The participants were significantly more comfortable at managing contrast reactions (P = .01), administering medications to treat CRM (P = .005), and administering the proper dosages (P = .01) following the intervention. The participants were similarly comfortable before and after the intervention at working in a team during emergent situations (3.7 ± 1 vs 3.6 ± 0.9; P = .9) and raising safety concerns to the team (4.1 ± 1.1 vs 4.2 ± 0.6; P = .9). They tended to be more comfortable using team communication skills (3.1 ± 1.0 vs 3.6 ± 0.6; P = .077) and recognizing team communication skills (3.2 ± 0.7 vs 3.7 ± 0.6; P = .02) following the intervention.

CONCLUSION: Radiology residents, nurses, and technologists can be trained together as a team, which more accurately reflects real life, utilizing high-fidelity simulation on both CRM and teamwork. Following training, there was resultant improvement in their level of comfort at managing reactions and using team communication skills based on TeamSTEPPS®.

(R-33) Wednesday • 7:00 AM
Development and Evaluation of a Vertically Integrated Online Radiology Curriculum

Jennifer E. Lim-Dunham, MD, *Loyola University Medical Center, Maywood, IL*; David C. Ensminger; John A. McNulty, PhD; Amy Hoyt; Arcot Chandrasekhar *(jlim2@lumc.edu)*

PURPOSE: Principles of the cognitive apprenticeship model were used to design a radiology curriculum in which students practice radiologic skills using electronic, interactive case-based modules embedded within clinical 3rd-year clerkships. The purpose of this paper is to describe the development of a vertically integrated online radiology curriculum and evaluate its efficacy using a mixed-method approach.

METHOD AND MATERIALS: The curriculum was developed over a 2-year period. Student participation was voluntary in the 1st year and mandatory in the 2nd year. For quantitative curriculum evaluation, student metrics for voluntary versus mandatory groups were compared using independent sample t tests and Pearson correlation coefficients. For qualitative analysis, responses from a survey of students were organized into defined themes using consensus coding.

RESULTS: When there was voluntary participation, a strong correlation existed between the number of cases a student completed and that student's radiology exam grade (r = 0.248). Mandatory participation significantly elevated the mean radiology exam score compared to the voluntary group (P < .01). Of the five dominant themes that emerged from consensus coding, three described aspects of the curriculum that students found enhanced their learning, and the other two described valuable outcomes.

CONCLUSION: The vertically integrated online radiology curriculum can positively impact student performance and the learning process in the context of the cognitive apprenticeship model.

(R-34) Thursday • 7:00 AM
Essentialimaging.org: A Teaching Web Site for Medical Students and Residents that Correlates "Need to Know" Medical Conditions with Their Typical Appearances on Common Imaging Modalities

Vikram Sundaram, MD, *Mount Sinai Hospital, New York, NY*; Serge Sicular; Amish H. Doshi, MD; Richard H. Stern, MD *(vikram.sundaram@mssm.edu)*

PURPOSE: There is an increased need for accessible and simple-to-use informational tools on radiology images. A Web site allows for the combination of medical discussion and correlation with specific and commonly used imaging modalities, can be viewed at computer stations and on mobile devices, and can be a tool for students to gain confidence with making faster decisions about their patients' hospital courses.

METHOD AND MATERIALS: We focused on some of the more typical cases that a hospital team might face when diagnosing new medical problems in a patient. We also considered imaging used for evaluating the placement of medical devices. For modality, we focused on what a medical student or resident could efficiently interpret without extensive specific training in radiology, such as x-ray, head and body CT, and ultrasound. We gathered relevant images from radiology attendings in various sections of the radiology department. The Web site was formatted in a table layout, so the user can quickly find the medical condition of interest and read a summary describing how that condition would appear on the specific imaging modality. By moving the cursor over the text description, the actual image would appear, allowing the user to correlate the description with its appearance.

RESULTS: *Essentialimaging.org* is a Web site that can be accessed quickly and provides a condensed summary of common diagnoses of hospital patients and their corresponding findings on a variety of imaging modalities. It has been used successfully at Mount Sinai to instruct medical students and residents on how to visually interpret common pathology, thus allowing them to engage in well-informed clinical decision making with their attendings.

CONCLUSION: Our Web site is an easy-to-use educational tool for medical students and residents to access a condensed list of the most common medical conditions that would require imaging correlation. The user can find the condition in question, read a summarized description, and view an example chosen by a radiology attending from Mount Sinai. This tool allows a student to apply this knowledge to the appropriate patient, so they may confidently discuss with their attendings and decide on a likely hospital course.

(R-36) Thursday • 7:00 AM
Learning Neuroradiology for Medical Students: A Model for a "Flipped Classroom"

Nicholas Marinelli, MD, *University of Wisconsin-Madison, Madison, WI*; Tabassum A. Kennedy, MD *(tkennedy@uwhealth.org)*

PURPOSE: The purpose of this study was to evaluate the efficacy and student preference on the use of a "flipped classroom" model for learning neuroradiology in the context of a neurology clerkship. We have converted a lecture-based neuroradiology curriculum for medical students into a Web-based learning module that enables students to learn neuroradiology. Students are expected to go through the Web site based on a recommended schedule. Core concepts are reinforced during weekly case discussions where students present their clinical patients to a group of their peers and a neuroradiologist who facilitates the discussion.

METHOD AND MATERIALS: This is an IRB-approved prospective study. Third- and fourth-year medical students rotating on the neurology clerkship were included in the study over a 10-month period. Students who agreed to participate in the study gave informed consent, and responses were anonymized. Students were given a prequiz, a presurvey, weekly quizzes, and an end-of-rotation survey. Responses were tabulated and compared.

RESULTS: A total of 117 students were included in the study. The average score on the prequiz was 46%, and the average of summated weekly quiz scores was 91%. Only 4% of students felt very or extremely confident in identifying brain structures on imaging prior to the course, which increased to 68% after the course. Only 5% of students understood clinical indications for neuroradiology studies before the course, which increased to 70% after the course. At the completion of the course, 89% of students rated the Web-based curriculum as very good/excellent, 87% of students rated the case discussion sessions as a very good/excellent alternative to traditional didactic lectures, and 84% of students somewhat preferred/strongly preferred the combined Web-based curriculum with case conference format to a traditional lecture-based curriculum.

CONCLUSION: Radiology is an important component of medical education, and alternative educational strategies are becoming increasingly

important in this era of curriculum redevelopment. Integrating a radiology curriculum within the context of a clinical rotation is possible and may be preferred by medical students over a conventional lecture-based curriculum.

(R-37) Wednesday • 7:00 AM
Perspectives on a Proposed 3rd-Year Mandatory Curriculum to Teach Appropriate Imaging Utilization to Medical Students: Results of a National Survey

Robert J. Ward, MD, *Tufts Medical Center, Boston, MA*; Hansel J. Otero, MD; Joshua Kyle, MD; Margaret K. Chung, MD *(robert.ward@tufts.edu)*

PURPOSE: The purpose was to identify perceived barriers to the establishment of an appropriate imaging utilization education in medical school by surveying radiology clerkship directors.

METHOD AND MATERIALS: An IRB-approved cross-sectional study included a 13-question Web-based survey sent nationwide via e-mail to all radiology clerkship directors from the 134 allopathic medical schools in the United States. Descriptive statistics and correlations were calculated using χ^2 or Fisher exact test, as appropriate. Statistical significance was set at 5% error level ($P < .05$).

RESULTS: A total of 104 radiology clerkship directors from 100 different medical schools were sent surveys via e-mail. Five e-mail addresses were invalid, and four recipients responded that they were not the current clerkship directors. A 34% (32/95) response rate was achieved after two reminders. A radiology clerkship is mandatory in 8/32 schools. Lower priority compared to other clinical areas and lack of interest/support from the medical school were ranked as the first and second most important reasons for radiology not being a mandatory clerkship. In 21/32 programs, 10%–50% of the time allotted is devoted to teaching utilization, while image interpretation consumes 50% of the allotted time in 14/32 programs. Similarly, learning appropriate ordering and utilization was ranked second in the overall objectives of the radiology clerkship; identifying critical findings in common tests was ranked first, while advanced imaging interpretation, imaging economics, and medical physics were ranked lower. Lectures and open discussion are used by the vast majority of the programs to teach appropriate utilization. Radiology staff time constraints and short clerkship length were identified as the main barriers to implementation of an imaging utilization curriculum.

CONCLUSION: Based on the surveyed clerkship directors, most believe that appropriate imaging utilization is very important during the training of medical students. Limited faculty time and short clerkships were cited as the main barriers for implementing an imaging utilization curriculum.

(R-40) Thursday • 7:00 AM
Development of an Audience Response System That Allows Audience Members to Click on an Abnormality or Structure in an Image

David Rubinstein, MD, *University of Colorado at Denver Health Sciences Center, Aurora, CO*; Nicole Restauri, MD; Anthony C. Brown, MD; Jeffrey Meier, MD

PURPOSE: Teaching radiology is heavily dependent on the use of medical images during lectures. Use of audience response systems helps maintain audience attention and gives feedback to the presenter about what has been taught. Most available audience response systems allow presenters to ask multiple-choice questions or to ask questions with free text response. They do not include a method to display an image and have audience members identify abnormalities or anatomical structures. We developed an audience response system that does allow audience members to identify abnormalities or anatomical structures and is easy to use.

METHOD AND MATERIALS: Using PowerPoint, Visual Basic for Applications (VBA), Java, Java servlets, the Apache http server, and HTML5, an audience response system was created. A template slide

was created in PowerPoint for the presenter to use to create an audience response slide. Any image can be added to the slide for the audience to locate a structure or pathology. An image of the slide, with information of the size and location of the image, is sent using VBA and Java to the http server. Information about the location of the correct answer can also be supplied. The audience can then view this image on a Web page and click or tap on the image to indicate the structure or pathology. The locations of where the audience indicated is then passed by HTML5, a Java servlet, Java, and VBA back to the Power-Point presentation for display.

RESULTS: The presenters found the system easy to use. After copying and pasting the slide template into their presentation, they could edit the slide like any other PowerPoint slide. The audience, using intranet-connected mobile devices, found the response Web page intuitive and easy to use. It worked well with the iPads supplied to all our residents.

CONCLUSION: The audience response system provided an easy method for presenters to display an image and ask the audience to identify abnormalities or anatomy.

(R-41) Wednesday • 7:00 AM
Enhancing Communication: Implementation of a LI-RADS Practice Quality Improvement Program in a Multidisciplinary Setting

Benjamin B. Lange, MD, *University of Vermont Fletcher Allen Health Care, Burlington, VT*; Anjuli R. Cherukuri, MD; David P. Keating, MD; Kenneth Najarian, MD

PURPOSE: Imaging plays a critical role in the diagnosis and management of hepatocellular carcinoma. The Liver Imaging Reporting and Data System (LI-RADS) was developed to reduce interpretation variability and enhance communication with referring providers. However, the details and significance of LI-RADS are not well known to all radiologists or referring clinicians. This practice quality improvement (PQI) project aims to educate providers about the LI-RADS system and to implement its use in our tertiary care center.

METHOD AND MATERIALS: A PQI project was performed at our tertiary care center to encourage the use of the LI-RADS system. Dedicated LI-RADS training was provided for radiologists in didactic and console-side settings, as well as for referring providers at multi-disciplinary educational workshops. LI-RADS quick reference guides were created for both radiology and referring provider work areas. After the educational intervention, a new departmental policy was initiated, encouraging the use of LI-RADS terminology in relevant reports. Radiologists and referring clinicians completed surveys designed to evaluate familiarity with LI-RADS and to assess its perceived usefulness in radiology reports.

RESULTS: Familiarity with LI-RADS increased significantly after the implementation of the PQI project, rising from 25% before implementation to 67% after implementation. Similarly, comfort with radiology reports that use LI-RADS increased significantly from 16% to 61%. The proportion of radiologists and referring clinicians reporting prior training in LI-RADS also increased, rising from 28% to 82%, suggesting that our educational intervention reached the majority of the target audience. After adoption of the LI-RADS system, 95% of respondents agreed that the utilization of LI-RADS improves the clarity and usefulness of radiology reports.

CONCLUSION: In our institution, implementation of a LI-RADS PQI project has significantly increased provider familiarity and comfort with the LI-RADS system. Our results suggest that both radiologists and referring clinicians prefer the clarity and precision of LI-RADS terminology in liver imaging reports.

RESEARCH POSTERS

(R-43) Wednesday • 7:00 AM
Deconstructing Silos: A Blueprint for Improving Inter-disciplinary Communication and Collaboration between Radiologists and Nonradiology Clinicians

Keith D. Herr, MD, *University of Southern California, Los Angeles, CA*; Ajit Vyas, MD; Paul Jaffray, MD; Lee A. Myers, MD; Orest B. Boyko, MD, PhD★; John Brunner, MD; et al

PURPOSE: The purpose was to demonstrate how the implementation of a resident "exchange program" between emergency medicine and radiology residents at our institution has promoted a perception of improved communication between the Department of Emergency Medicine (DEM) and the Emergency Radiology Division (DER). This exchange program subsequently formed the basis for additional collaborative endeavors between the DEM and DER, contributing to an ongoing climate of interdisciplinary cooperation between specialties that have traditionally grappled with a mutual "silo" mentality. These supplemental efforts will also be described.

METHOD AND MATERIALS: Electronic surveys *(surveymonkey.com)* were sent to residents in the DEM and Department of Radiology prior to and following 10 months of participation in a resident exchange program. While on an elective rotation, R2 DEM residents spent a few hours shadowing residents and attending physicians in the DER reading room, and R1 radiology residents spent a few hours during their emergency radiology rotation shadowing physicians in the DEM. Subsequently, an emergency radiologist–led seminar on the history and mission of the DER was presented during a DEM grand rounds. Finally, a collaborative ultrasound training experience for medical students was developed involving members of both departments.

RESULTS: The follow-up survey demonstrated an improvement in the perception of communication between trainees in the DEM and Department of Radiology. The success of this program spurred the creation of two additional interdisciplinary projects involving the DEM and DER.

CONCLUSION: The practice of "silo" medicine has given rise to "institutional xenophobia," a phenomenon of mutual alienation common between radiologists and nonradiology clinicians. The viability of our profession depends on a renewed spirit of teamwork with our non-imaging colleagues as we enter an era of value-based radiology. Our experience with a resident exchange program and other joint efforts provides a model for a multimodal approach to promoting a culture of cross-discipline communication and collaboration as part of an evolving identity of radiologists as health care team players.

Musculoskeletal Radiology

(R-61) Wednesday • 7:00 AM
Three-dimensional Micro-CT Evaluation of Rheumatoid Arthritis Disease Progression

Andrew Antill, *LSU Health Shreveport, Shreveport, LA*; David H. Ballard, MS; Anne Holister; Emily Rogers; Shu Yang; Stephen Lokitz *(aantil@lsuhsc.edu)*

PURPOSE: Structural damage in rheumatoid arthritis (RA) includes cartilage degradation and bone erosion. This damage has traditionally been identified using conventional radiography to assess cortical bone, joint narrowing, and periarticular osteoporosis. This purpose of our study was to evaluate the utility of using three-dimensionally (3D) reconstructed micro-CT images to quantify the progression of disease in a mouse model of RA.

METHOD AND MATERIALS: Nine male mice at 12 weeks of age were used as the study sample (three control mice). The cartilage-induced arthritis (CIA) model method was used, in which chicken collagen type II was injected at 0, 4, 7, and 9 weeks. Images were acquired using the CT portion of a Gamma Medica Triumph scanner at each time period. Areas of focus included the proximal and distal humerus and the proximal femur. These areas of interest were investigated first by semiautomated region of interest (ROI) routines in Analyze 10.0.

Each ROI was then examined and corrected on a slice-by-slice basis by multiple investigators to produce better-quality renderings. These ROIs were then rendered by MeshLab into 3D objects and compared across time frames. Bone volume and density for the manual ROIs were measured in Analyze 10.0 and compared.

RESULTS: Visual examination of the 3D renderings shows decreased bone volume over time in the CIA model. Evaluation of the mean bone density and mean bone volume shows a statistically significant decrease in the CIA mice when compared to the control mice over the entire span of the study. The 3D renderings produced from the manually corrected ROIs showed visible improvement over the semiautomated ROI renderings.

CONCLUSION: These results support the hypothesis that 3D micro-CT imaging provides data of sufficient quality to evaluate the bone and joint erosion resulting from the CIA model of rheumatoid arthritis. Furthermore, this technique is noninvasive and more accurate than current diagnostic techniques. In the future, micro-CT could be used to evaluate treatment efficacy for RA in the preclinical environment, to evaluate the extent and progression of disease in a clinical setting, and as an indicator for treatment efficacy in human disease.

(R-79) Wednesday • 7:00 AM
CT Metal Artifact Reduction in Total Knee Arthroplasty: A Promising Technique

Jorge A. Lee Diaz, MD, *University of Texas Medical Branch, Galveston, TX*; Rami W. Eldaya; Frank L. Goerner, PhD; Pavit Bains; Matthew K. Fuld, PhD★; Glenn M. Garcia, MD *(jaleedia@utmb.edu)*

PURPOSE: Metal-induced artifacts impede CT evaluation of patients with metal implants. The purpose of this study is to assess a promising new technique for reduction of metal artifact associated with CT imaging of the knee after total knee arthroplasty.

METHOD AND MATERIALS: A new metal artifact reduction image reconstruction technique, iterative frequency splitting (IMAR [iterative metal artifact reduction]), was compared to the standard weighted filtered backprojection (WFBP) approach using data from a dual-source CT scanner (SOMATOM Definition Flash; Siemens, Forchheim, Germany). Water phantoms with two types of total knee implants, cobalt-chromium (CoCr) and oxidized zirconium (Zir), were also imaged. The Hounsfield units (HUs) were measured in the phantom for all the area that contained water. This was compared to the standard HU in water. The closer to 0, the better the artifact correction. Images were blinded and scored by an MSK radiologist with 13 years of experience. Scoring was done on a scale of 1–4 (4 being a normal evaluation without metallic artifact) for evaluation of the soft tissue near the implant, evaluation of the implant, and evaluation of the bone in the same area.

RESULTS: The conventional WFBP was rated 1 for evaluation of the soft tissue near the implant, 1 for the evaluation of the implant, and 1 for evaluation of the bone. IMAR was rated 2 for evaluation of the soft tissue near the implant, 3 for the evaluation of the implant, and 2 for evaluation of the bone.

CONCLUSION: IMAR is an effective technique to reduce metal artifact and is a promising technique in postoperative evaluation in patients after knee arthroplasty.

Neuroradiology

(R-87) Wednesday • 7:00 AM
Effect of Caffeine Administration on Deep Medullary Vein Prominence in Healthy Adults

Hannah Kim, MD, *Loma Linda University Medical Center, Loma Linda, CA*; J. Paul Jacobson, MD★; Daniel K. Kido, MD; Udo Oyoyo

PURPOSE: The purpose was to estimate the upper physiologic prominence of deep medullary veins (DMVs) on susceptibilty-weighted imaging (SWI) in healthy adults using a common neurostimulant, caffeine.

METHOD AND MATERIALS: With IRB approval, a prospective cohort of healthy volunteers (ages, 18–35) was recruited from residents and medical students at Loma Linda University Medical Center. Subjects had abstained from caffeine for more than 2 weeks. Based on a priori power calculations to achieve β = 0.8, thirty subjects were enrolled. Each participant underwent magnetic resonance imaging (SWI and FLAIR) at both 1.5 T and 3 T prior to caffeine. Next, each subject ingested 200 mg of caffeine and was rescanned 20 minutes later at both 1.5 T and 3 T in random order. Each set of SWI images was ranked for DMV prominence according to a previously published 7-point visual scale by two neuroradiologists blinded to patient, field strength, and caffeine status. A Wilcoxon signed rank test was used to assess statistical significance of the difference in DMV prominence before and after caffeine administration.

RESULTS: At both field strengths, prominence of DMVs increased on SWI after caffeine compared to before. At 1.5 T, mean DMV prominence was 2.63 (95% CI: 2.38, 2.88) before caffeine versus 3.20 (95% CI: 2.85, 3.54) after (P = .002). At 3 T, mean DMV prominence was 3.33 (95% CI: 3.03, 3.63) before caffeine versus 3.77 (95% CI: 3.51, 4.02) after (P = .005). Thus, the mean DMV prominence was 0.57 units greater after caffeine at 1.5 T and 0.44 units greater at 3 T on the 7-point ordinal visual scale.

CONCLUSION: Caffeine is a commonly used neurostimulant, mainly consumed in coffee or tea. An adenosine antagonist, caffeine vasoconstricts cerebral vessels and increases oxygen extraction, leading to increased deoxyhemoglobin concentration. On SWI, this darkens the cerebral veins. Our results confirm a statistically significant increase in the visual prominence of the cerebral DMVs after caffeine ingestion in a population of healthy caffeine-naive adults. Caffeine stimulation helps approximate the upper physiologic limit of DMV prominence on SWI, which should be useful in discriminating abnormally prominent veins, such as during acute cerebral ischemia.

(R-88) Thursday • 7:00 AM
Prominent Deep Medullary Veins on Susceptibility-weighted Imaging May Predict Worse 6-Month Neurologic Outcomes In Neonates with Cyanotic Congenital Heart Disease

Paggie Kim, *Loma Linda University Medical Center, Loma Linda, CA*; Ethan Glazener, BS; Udo Oyoyo; Daniel K. Kido, MD; J. Paul Jacobson, MD★ *(pagkim@llu.edu)*

PURPOSE: The purpose was to investigate the relationship between cerebral deep medullary venous (DMV) susceptibility, a marker of oxygen extraction on SWI, and 6-month neurologic outcome in neonates undergoing evaluation for cyanotic congenital heart disease (CHD).

METHOD AND MATERIALS: Neonates presenting with cyanotic CHD from 2007 to 2014 were retrospectively identified. All patients less than 30 days old with SWI prior to any surgical intervention were included, subject to the following exclusion criteria: prematurity (≤36 weeks), low birth weight (≤2 kg), low Apgar at 5 minutes (<5), or proven trisomy syndrome. DMVs were separately evaluated by two neuroradiologists blinded to outcome; prominence of vein scores (POVSs) were assigned using an ordinal 7-point scale. MR spectroscopy data at time of SWI were collected if available. Six-month neurologic outcomes were determined from the medical record using the Pediatric Cerebral Performance Category Scores (PCPCSs). Correlations were assessed (Spearman's ρ) between cerebral venous prominence and neurologic outcome at 6-month follow-up for those who survived the initial hospitalization.

RESULTS: Nineteen neonates with cyanotic CHD were enrolled, of whom 13 were discharged alive. Nine were male; the mean age was 12 days. The leading diagnosis (11) was hypoplastic left heart syndrome. Other diagnoses included truncus arteriosus, single ventricle, tetralogy of Fallot with absent pulmonary valve, and AV canal defect. Four patients had POVS of 1, four patients had POVS of 2, one patient had POVS of 3, five patients had POVS of 4, and five patients had POVS of 5. Higher POVSs were strongly correlated with elevated choline/creatine (cho/cr) ratio in the posterior occipital gray matter on MRS (r = 0.84; P = .03). Among the 13 survivors, higher POVS showed a moderate correlation (r = 0.50) with worse neurologic outcomes at 6 months on the PCPCS, trending toward statistical significance (P = .08).

CONCLUSION: In a small sample of neonates with cyanotic CHD, increased venous prominence of DMVs on SWI is strongly associated with elevated posterior occipital gray matter choline/creatine ratio. A moderate correlation between DMV prominence and worse 6-month neurologic outcomes is also suggested.