AUR 2013 Research Paper Abstracts

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

Thursday, April 11, 2013
2:00–3:30 PM

SS01: Learning Continuum
Location: Platinum Ballroom Salon D
Moderator: Douglas S. Katz, MD

AMSER Henry Goldberg Medical Student Award
(SS01-01) 2:00 PM
Tying Medical Imaging to Teaching Medical Reasoning
Andrew W. Phillips, BA, University of Chicago, Chicago, IL; Sandy G. Smith, PhD; Christopher M. Straus, MD (cstraus@uchicago.edu)

PURPOSE: Instructors have increasingly incorporated radiology into preclinical gross anatomy as they search for methods to correlate anatomy to clinical care. However, many programs include minimal or no imaging on anatomy exams, and literature is lacking in how students’ knowledge is assessed. Our research objective is to adapt Bloom’s taxonomy of cognitive processes, a well-validated taxonomy outside of medical education, to guide an improved assessment methodology and to link medical imaging to medical reasoning.

METHOD AND MATERIALS: Bloom’s taxonomy was adapted for course objectives of anatomical spatial understanding and standard imaging properties. Approximately 20 exam questions for each of the six body regions were created, with each question subsequently assigned to one of the six cognitive processes: (a) remember, (b) understanding, (c) apply, (d) analyze, (e) evaluate, and (f) create. Questions ranged from simple recall to complex reasoning. Data from 2008 anatomy course were analyzed by combining identical respective taxonomy categories and running reliability analyses utilizing Cronbach’s α.

RESULTS: A total of 108 questions (27, 25, 14, 31, 1, and 10 for processes I–VI, respectively) were administered. Moderate internal reliability was noted in the three categories of remember (α = 0.559), understanding (α = 0.510), and analyze (α = 0.559), and mild internal reliability for the categories of apply (α = 0.308) and create (α = 0.203). The evaluate category (n = 1) could not be assessed. Considerable improvement in the Cronbach’s α value could be achieved for most categories with deletion of the least-correlated item (α = 0.578, 0.525, 0.372, 0.576, and 0.232 for remember, understanding, apply, analyze, and create, respectively).

CONCLUSION: Bloom’s taxonomy of cognitive processes was successfully adapted and used in radiologic anatomy instruction. Results are consistent with a stable hierarchy of questions examining deeper understanding of material. This measurable level of learning captures cognitive skills tied to medical reasoning, image analysis, and patient care. This pilot study shows encouraging results and the potential to create a taxonomy specifically for medical imaging and reasoning.

(SS01-02) 2:10 PM
Formal Instruction in Radiology in Medical School: Comparison of 3rd-Year Students Who Completed Their Radiology Clerkship to Students Who Have Not Yet Fulfilled the Requirement
Awad Ahmed, BA, Temple University School of Medicine, Philadelphia, PA; Erin E. O’Connor, MD

PURPOSE: Radiology education during the clinical years in medical school varies throughout the United States, ranging from required clerkships in radiology to no exposure to diagnostic imaging. Some educators believe radiology can be learned as students advance through nonradiology clinical clerkships, eliminating the need for a structured clerkship, while others firmly believe that formal education in radiology is a necessity, particularly as annual spending on medical imaging increases. Previous studies have looked at the educational benefits that a radiology clerkship provides. Our study, however, investigates long-term retention of knowledge by evaluating students at the end of their 3rd year, rather than on the final day of the clerkship.

METHOD AND MATERIALS: A total of 189 students who had just completed their 3rd year of medical school were evaluated with a 20-question examination testing (a) knowledge of appropriate imaging workup in common clinical scenarios and (b) ability to interpret basic plain radiographs. Scores of students who had completed their radiology clerkship during their 3rd year were compared to those who had not yet taken radiology. Students were also stratified into two groups based on when they took the exam: short term (≤6 months) and long term (≥6 months). Exam scores were analyzed by an independent two-group t test.

RESULTS: Students who completed the radiology rotation performed better on the post-3rd-year examination than their counterparts: 64.3–68.2 versus 75.2–80.5 (95% CI). No differences in test scores between the short-term and long-term groups were found: 74.2–86.1 versus 73.2–79.2 (95% CI).

CONCLUSION: Integrating a radiology clerkship into the medical school curriculum improves students’ knowledge of appropriate imaging management and basic radiograph interpretation. The knowledge appears to be retained by the student beyond the confines of the clerkship and will translate to improved familiarity and comfort with radiology over a student’s medical career. These skills are essential for our future physicians as the role of medical imaging in patient care continues to rise.

(SS01-03) 2:20 PM
Easing the Transition from Intern to Radiology Resident: Implementation of a “Boot-Camp” Orientation for R1 Residents
Kedar Jambhekar, MD, University of Arkansas for Medical Sciences, Little Rock, AR; Victoria E. Major, MD; Marcus M. Brown, MD; Dana J. Coker, MD; Linda A. Deloney, EdD (KJambhekar@uams.edu)

PURPOSE: Transitions in medical education are challenging, but the shift from clinical intern to radiology resident is especially difficult. Stress during this transition has been attributed to the lack of thorough preparation. Curricula designed to equip residents with basic skills can increase confidence and decrease errors. Participation in a “boot-camp” orientation also supports team building and development of greater camaraderie among the new residents. Given that research on resident readiness has shown the usefulness of focused educational interventions, we hypothesized that a 2-week boot-camp...
METHOD AND MATERIALS: A 2-week “boot camp” was delivered to six 2012 R1 residents. Faculty provided a foundation of basic radiology knowledge, recommended level-appropriate resource materials, and encouraged team building among class members. Teaching methods were didactic lectures, computer-based modules, and simulation-based workshops for hands-on practice of common but challenging interventional scenarios (adult and pediatric cases). Administrative time was provided to complete paperwork, secure passwords and ID badges, and attend orientations to PACS, voice recognition software, and the VA and Children’s Hospitals. R1s completed human subject training and established research accounts, were introduced to PubMed and literature searches, and learned about ongoing research activities in the department. Sessions to clarify performance expectations and rules for training, including call, to explain evaluation processes, and to begin the resident portfolio were offered. All R1s were issued iPads for their personal use throughout the residency.

RESULTS: Residents completed daily evaluations and entrance/exit surveys. Data were recorded so that residents could not be identified. The data confirmed the effectiveness of the focused educational intervention and are guiding improvements for the 2013 boot camp.

CONCLUSION: A boot-camp orientation is a feasible and preferable method for transitioning interns into radiology residents. It creates a readiness for embarking on the new role and fosters team spirit and camaraderie among the residents.

(S501-04) 2:30 PM
Toward Consensus: Training in Procedural Skills for Diagnostic Radiology Residents—Part 1
Emily L. Ebert, BS, Emory University, Atlanta, GA; Bradley Rostad, MD; Adam Prater, MD; Jian Kang, PhD; Mark E. Mullins, MD, PhD; Christopher P. Ho, MD

PURPOSE: To the best of our knowledge, no published studies exist regarding standardization of radiologic procedure (RP) training for radiology residents. The aim of this first part in our two-part study was to determine opinions regarding RP training by surveying our current residents and faculty members.

METHOD AND MATERIALS: Our current diagnostic radiology (DR) residents and faculty members were surveyed about three interrelated topics: (a) whether or not there should be standardization of RP training for DR residents; (b) in which RPs DR residents should achieve competency, if any; and (c) number of times an RP needs to be performed to achieve that competency. The institutional review board approved this study, and all subjects provided informed consent.

RESULTS: Survey data were received from 60 study participants (65.5% faculty, 29.3% current residents). Sixty-five percent of respondents believed that RP training should be standardized for residents, whereas 26.7% were uncertain. Over 50% of respondents strongly agreed that competency should be achieved with most image-guided biopsy and drain placement procedures (CT, US, and fluoroscopic); general diagnostic fluoroscopy; and vascular access procedures. For most of these categories, the majority of responders believed that these procedures needed to be performed 6–20 times to achieve competency. More than 60% of responders either disagreed or strongly disagreed that competency should be achieved with most image-guided treatment procedures, including angioplasty/stent placements, embolizations, and radiofrequency ablations.

CONCLUSION: Results of our small, single-site pilot survey suggest that (a) RP training expectations should be standardized; (b) competency in RPs should be achieved in most image-guided biopsy and drain placement procedures, vascular access procedures, and general diagnostic fluoroscopy; and (c) select RPs need to be performed approximately 6–20 times under supervision to achieve competency. Our results may be of interest in developing guidelines regarding resident RP training and case logs. Part 2 of the study will compare these results to resident RP logs compiled from the last 10 years at our institution.

(S501-05) 2:40 PM
Implementing a Milestone-based Curriculum for Musculoskeletal Radiology
James J. Morrison, MD, Henry Ford Hospital, Detroit, MI; Eric M. Spickler, MD (jamesmor@rad.hfh.edu)

PURPOSE: Included in the new accreditation system is the impetus to create a milestone-based curriculum to ensure that radiology training programs appropriately assess levels of performance for each trainee throughout residency. Continuous monitoring of milestone achievements allows program directors to monitor the progression of residents through training, give constructive feedback, and promptly identify trainees who are struggling. The purpose of this project was to initiate and assess the viability and effectiveness of a milestone program in musculoskeletal radiology following the recommendations of the Residency Review Committee (RRC).

METHOD AND MATERIALS: The subspecialty of musculoskeletal radiology was chosen as a test bed for milestone implementation at our institution. The existing learning objectives were altered to match the draft milestones released by the RRC. Milestones were defined for each level of training: internship, junior resident (1st and 2nd radiology year), senior resident (3rd and 4th radiology year), and fellowship. The milestones were based upon the six core competencies of patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice.

RESULTS: Residents and faculty were surveyed regarding the usefulness of milestones in guiding learning goals and their effectiveness in assessing competency. While milestones were initially perceived as onerous, the feedback has been positive. In particular, residents preferred the well-defined learning objectives, patient care goals, and focused feedback provided on a more frequent basis.

CONCLUSION: As the medical specialty training and certification process moves toward increased transparency, the need to provide documentation of competency and qualification will only increase. A milestone-based curriculum such as the one we have developed is advantageous for both instructors and trainees to continuously monitor performance and achievement. The musculoskeletal curriculum that we have developed provides a solid framework for other training programs to replicate and expand upon.

(S501-06) 2:50 PM
Early Resident-to-Resident Physics Education in Diagnostic Radiology Residency
Akash P. Kansagra, MD, University of California, San Francisco, San Francisco, CA (akash.kansagra@ucsf.edu)

PURPOSE: The purpose was to address a perceived lack of relevant physics training at many institutions; and in anticipation of upcoming changes to the American Board of Radiology board certification process, we developed an abbreviated resident-taught physics curriculum offered to 1st-year radiology residents during their first 2 months of training. Here, we report our initial experience with this new educational approach.

METHOD AND MATERIALS: The course was offered in the 2011–2012 and 2012–2013 academic years to each PGY-2 resident, representing 26 total residents. The course consisted of five weekly hour-long lectures during the first 2 months of residency; each lecture was delivered by a PGY-3 or higher resident. Anonymous course evaluations were distributed after completion of the course and after all residents had completed at least one CT-based and one ultrasound-based rotation.

RESULTS: The survey response rate was 65% (17 of 26). 96% of residents (25 of 26) attended at least 80% of lectures. Participants judged resident-delivered lectures to be of higher quality (65%
agreement; 11 of 17) and more enjoyable (82% agreement) than typical faculty-delivered lectures. First-year residents reported an improved ability to understand topics in physics (94% agreement) and clinical radiology (76% agreement). Impact on daily clinical activities was less pronounced, with 53% reporting improved confidence with image interpretation and 47% reporting improved ability to prescribe and perform imaging studies. Overall, participants reported an enhanced level of interest in physics (82% agreement), and 82% agreed that the course was worth their time.

CONCLUSION: We describe the successful implementation of a resident-run physics course intended to introduce new radiology residents to the basic physics of radiologic imaging at an early stage of training. Because of the limited resources required to implement this course, we believe that similar educational programs may be put into place at other institutions with little difficulty and in time for the introduction of the new ABR core examination.

Piloting a New Body MR Imaging Resident Rotation: A Virtual Environment for Interactive Learning

Michael Chung, MD, St Luke’s-Roosevelt Hospital Center, New York, NY; Kenneth S. Cooke, MD; Munir Ghesani, MD; Michael Abiri, MD (michhung@cphnet.org)

PURPOSE: The purpose was to evaluate the efficacy of a new body MRI rotation by reviewing quantitative data and early opinions of attendings/residents.

METHOD AND MATERIALS: Two radiology residency programs within our network cover nine hospitals and imaging facilities in a large metropolitan area. Starting August 2012, the two programs’ body MRI rotations were combined. One attending, who alternates through the week, discusses cases at set readout times with 2–3 residents. Web-conferencing software is used in conjunction with Web-based PACS on a high-definition monitor, with the addition of webcams to allow for face-to-face discussion. A survey was sent out to residents and attendings who have participated. Questions addressed their opinions on the Web-conferencing technology and on how the new rotation compares to that in years past. In addition, dictation data were examined to quantify the effectiveness of the new rotation.

RESULTS: Dictation data show that residents are now dictating on average 6.3 body MRI cases/day, whereas in the previous academic year, a resident of equal PGY level was dictating on average 1.5 cases/day. Surveys showed that residents felt the increased volume and variety of cases were beneficial. Residents commented that set readout times allow for more independence in formulating their own opinions. An attending survey showed that the majority of them think they can engage residents and teach effectively through Web conferencing. The attendings were split on the necessity for webcams, but the majority found the technology overall easy and reliable to use. A majority of attendings saw potential for using this model in other rotations, specifically with body/chest CT. The most frequently cited issue was the degraded image quality from the Web-based PACS. Attendings were able to work around this issue by also referring to their dedicated PACS stations to convey teaching points.

CONCLUSION: Early impressions of the virtual rotation are positive, with a larger case volume and variety being the most favorable opinion. The technology, although easy to use, has its limitations, especially with the degraded image quality. Continued evaluation throughout the academic year will determine the program’s sustainability.

Case-based Education in Adverse Contrast Reaction Management for Practicing Radiology Faculty

Cristy N. Gustas, MD, Penn State Hershey Medical Center, Hershey, PA; Jonelle M. Petsavage, MD*; Christine M. Peterson, MD (cgustas@hmc.psu.edu)

PURPOSE: The purpose was to evaluate comfort level and knowledge regarding adverse contrast reaction management in practicing academic radiology faculty, design and implement a case-based training program, and measure subjective and objective outcomes.

METHOD AND MATERIALS: An anonymous 10-question survey was administered to radiologists in a single academic institution. The survey consisted of six questions concerning comfort level with managing contrast reactions and four questions assessing knowledge base. Two weeks later, a 45-minute educational session was held, with faculty attendees working through case-based contrast scenarios in small-group settings. The session concluded with a “hands-on” review of the materials in the contrast reaction box. One month after the session, an anonymous 10-question follow-up survey using a Likert scale was administered to evaluate the session’s effectiveness.

RESULTS: There was a 44.7% (17/38) faculty response rate to the initial survey. Over 50% expressed discomfort in managing a contrast reaction, and 88% were unfamiliar with the contrast box contents. Over half of the faculty responders had not managed a contrast reaction in 3 years, and only 10% of these reactions required epi- nephrine administration. Approximately 50% of respondents answered incorrectly on all four management application questions, demonstrating a clear knowledge deficit. Eighteen radiologists attended the educational program. Four case-based scenarios were presented and reviewed. All staff received hands-on training with the contents of the contrast box. There was a 55.5% (10/18) response to the follow-up survey. 90% felt more comfortable managing a reaction and confident regarding the contents of the contrast reaction box. 90% felt the session should be held annually. There was a statistically significant (P < .05) increase in mean number of correct responses to the knowledge questions. Open-ended comments highlighted the benefit of a case-based small-group format.

CONCLUSION: Regular educational review of adverse contrast reaction management for practicing radiology faculty is necessary to ensure an adequate level of comfort and knowledge. Radiologists felt the review should be conducted annually and favored a case-based small-group format.

Mammographic Parenchymal Patterns as an Imaging Marker of Endogenous Hormonal Exposure: A Preliminary Study in a High-Risk Population

Dania Daye, BS, University of Pennsylvania, Philadelphia, PA; Brad M. Keller, PhD; Emily F. Conant, MD*; Jinbo Chen, PhD; Mitchell D. Schnall, MD, PhD*; Andrew D. Maidment, PhD*; et al

PURPOSE: Parenchymal texture patterns have been previously associated with breast cancer risk, yet their underlying biological determinants remain poorly understood. Here, we investigate the potential of mammographic parenchymal texture as a phenotypic imaging marker of endogenous hormonal exposure.

METHOD AND MATERIALS: A retrospective cohort study was performed. Digital mammography (DM) images in the craniocaudal (CC) view from 297 women, 154 without breast cancer and 143 with unilateral breast cancer, were analyzed. Menopausal status was used as a surrogate of cumulative endogenous hormonal exposure. Parenchymal texture features were extracted, and mammographic percent density (MD%) was computed by using validated computerized

* Faculty financial disclosures are located in the Faculty Index.
methods. Univariate and multivariable logistic regression analysis was performed to assess the association between texture features and menopause status, after adjusting for MD% and hormonally related confounders. The receiver operating characteristic (ROC) area under the curve (AUC) of each model was estimated to evaluate the degree of association between the extracted mammographic features and menopause status.

RESULTS: Coarseness, gray-level correlation, and fractal dimension texture features have a significant independent association with menopause status in the cancer-affected population; skewness and fractal dimension exhibit a similar association in the cancer-free population \((P < .05)\). The ROC AUC of the logistic regression model including all texture features was 0.70 \((P < .05)\) for cancer-affected and 0.63 \((P < .05)\) for cancer-free women. Texture features retained significant association with menopause status \((P < .05)\) after adjusting for MD%, age at menarche, ethnicity, contraception use, hormone replacement therapy, parity, and age at first birth.

CONCLUSION: Mammographic texture patterns may reflect the effect of endogenous hormonal exposure on the breast tissue and may capture such effects beyond mammographic density. Texture features could ultimately be incorporated into breast cancer risk assessment models as markers of hormonal exposure.

Thursday, April 11, 2013
2:00–3:30 PM

SS02: Evaluation
Location: Platinum Ballroom Salon C
Moderators: Lily M. Belf, MD
Lori A. Deitte, MD

(SS02-01) 2:00 PM
Pediatric Fluoroscopic Objective Structured Clinical Examination: Radiology Resident Evaluation and Teaching Tool
Zack Beatty, University of Minnesota Medical School, Minneapolis, MN; Kelly Dietz, MD; Tara Holm, MD (beatt096@umn.edu)

PURPOSE: We designed and implemented an objective structured clinical examination (OSCE) to evaluate radiology residents in fluoroscopy skill, communication ability, and knowledge of equipment, for the dual purpose of assessment and education.

METHOD AND MATERIALS: A total of 9 PGY2, 10 PGY3, and 8 PGY4/5 residents participated in a 15-station exam. Performance was directly observed and was scored by using both checklists and global scales for each of three subsections. Reliability of the exam was assessed by using Cronbach’s \(\alpha\) coefficient. Validity was assessed with a postexam survey and comparison of resident performance using ANOVA.

RESULTS: Reliability by Cronbach’s \(\alpha\) was 0.925 for the overall exam, 0.907 for the global scales combined, and 0.859 for the checklists combined. PGY3 and PGY4/5 residents performed significantly better than PGY2 residents on all subsections of the exam and overall. There was no significant difference in performance between PGY3 and PGY4/5 residents on any subsection of the exam or overall. The majority of residents surveyed responded positively that the skills tested on the exam were reflective of real-world competencies and that the exam was a helpful educational tool.

CONCLUSION: Our exam was both a reliable and valid evaluation of radiology residents in fluoroscopy, communication, and use of equipment. Design and implementation required minimal resources. Above all, the exam proved to be a formative learning experience.

(SS02-02) 2:10 PM
The Emotional Wellness of Radiology Residents: Prevalence and Predictors of Burnout
Michael F. McNeely, MD, University of Washington, Seattle, WA; Francisco A. Perez, MD, PhD; Felix S. Chew, MD, MBA (mcneely@uwashington.edu)

PURPOSE: Burnout is a complex phenomenon characterized by emotional exhaustion, social detachment, and feelings of low personal achievement. In this study, we aim to establish the prevalence of burnout among radiology residents and to explore the factors influencing its development.

METHOD AND MATERIALS: Survey data were collected from 266 resident members of the Association of University Radiologists to assess financial status, attitudes toward money and compensation, and burnout symptomology. Descriptive and inferential statistics were used to analyze these data.

RESULTS: Most radiology residents reported high levels of personal achievement but routine symptoms of emotional exhaustion and depersonalization. Although increasing levels of household debt were correlated with symptoms of depersonalization and lower reported quality of life, we found that the subjective financial experience was a more reliable indicator of emotional well-being. Specifically, higher subjective self-assessments of financial strain were the best predictors of symptoms of depersonalization \((P < .0001)\), emotional exhaustion \((P < .0001)\), and lower self-reported quality of life \((P < .0001)\).

CONCLUSION: The unique nature of radiology training could mean that traditional assumptions regarding the development of trainee burnout do not necessarily apply. Finances may be an underappreciated influence on resident burnout, and subjective feelings of financial scarcity could outweigh the impact of objective indebtedness. Further study is needed to ensure that the emotional well-being of radiology trainees is optimally supported.

(SS02-03) 2:20 PM
End-of-Rotation Evaluations: Infrastructure to Assess Achievement of the Educational Milestones
Jessica B. Robbins, MD, University of Wisconsin, Madison, WI; Timothy Ziemlewicz, MD; Allison M. Grayev, MD*; Amy Romandine; David H. Kim, MD*

PURPOSE: As the Accreditation Council for Graduate Medical Education (ACGME) transitions to the Next Accreditation System (NAS), resident achievement of educational milestones takes front and center. We seek to demonstrate how our innovative end-of-rotation evaluation (EORE) tool allows us to assess resident competence and attainment of the milestones in the six core competencies (patient care, medical knowledge, professionalism, interpersonal and communication skills, systems-based practice, and practice-based learning and improvement).

METHOD AND MATERIALS: A three-part rotation-specific EORE is administered to every resident at the completion of each 4-week core radiology rotation. The resident prepares a sample dictation of an unknown case, completes a computer-based image-rich written examination, and is evaluated on the oral presentation of a selection of unknown cases. Results are immediately shared with the resident and tracked in the EORE database. Collated de-identified results are presented at monthly resident education committee meetings. Finally, biannual review of the resident’s EORE performance is undertaken by the Clinical Competency Committee (CCC).

* Faculty financial disclosures are located in the Faculty Index.
RESULTS: The comprehensive EORE program addresses milestones in all six of the core competencies. Residents utilize immediate feedback about their EORE performance to formulate or modify their individual learning plans. Through the data presented at the monthly education committee meetings, the subspecialty sections rapidly identify gaps in the curriculum and implement changes in the didactic curriculum through the creation of supplemental programs, for example, a new module on first trimester ultrasound. Biannual review of each resident's global EORE performance forms the core of the CCC's assessment and allows for objective documentation of progression through the milestones.

CONCLUSION: Our innovative EORE tool allows us to monitor and document resident achievement of the educational milestones, providing a valuable objective component used in conjunction with subjective faculty evaluations.

AUR Trainee Prize: 1st Place

(SS02-04) 2:30 PM
The Effect on Patient Radiation Dose of a Formal Fluoroscopy Privileging Program in First Fluoroscopy Rotations
Katherine C. Frederick-Dyer, MD, University of Tennessee Medical Center, Knoxville, TN; Ted Chang, MD; Steven P. Knight, MD; Alexander S. Pasciak, PhD*; Austin R. Faulkner, MD (kfredrick@utmck.edu)

PURPOSE: Fluoroscopy, although commonly utilized, imparts a relatively high radiation dose when compared to other imaging modalities. Reducing patient radiation exposure is a high priority in training programs. A recent study in our radiology department demonstrated that resident level of training significantly affects the patient dose from common fluoroscopy procedures, showing a decrease after the residents have undergone formal classroom training in radiation safety and fluoroscopy in their 2nd year. The purpose of this study is to determine if an accredited online fluoroscopy training course completed by 1st-year residents 1 week prior to their first fluoroscopy rotation will result in decreased patient dose compared to residents who received no specialized training prior to their first fluoroscopy rotation.

METHOD AND MATERIALS: Retrospective data to evaluate the impact that level of training (PGY2–PGY5, radiology) has on fluoroscopy time (FT), dose-area product (DAP), and patient dose have been recorded for the last 6 years. New radiology residents took an AMA-accredited online fluoroscopy training program in the week prior to the start of their first fluoroscopy rotation. Prospective data for new residents under this training program were compared to the first fluoroscopy rotation data from prior classes, stratified by procedure type.

RESULTS: Over 600 studies were included. Esophagrams and upper GI studies demonstrated statistically significant reductions in both FT and DAP. The average FT and DAP reduction for esophagrams was from 3.5 to 2.7 minutes and from 152 to 69 dGy-cm², respectively, and the reduction for upper GI studies was from 4.2 to 3.0 minutes and from 208 to 112 dGy-cm².

CONCLUSION: New radiology residents are often expected to independently perform common GI fluoroscopy exams before formal classroom instruction on radiation safety and dose reduction techniques. An online training program can be effectively used to provide the necessary instruction immediately before the start of the rotation, decreasing patient dose and increasing resident competency.

(SS02-05) 2:40 PM
Evaluation of an End-of-Rotation Resident Assessment Tool: Strong Correlation with ACR In-Service Results
Timothy Ziemlewicz, MD, University of Wisconsin, Madison, WI; Allison M. Grayev, MD*; Jessica B. Robbins, MD; Amy Romandine; David H. Kim, MD (tziemlewicz@uwhealth.org)

PURPOSE: In an attempt to both quantify outcomes and improve the educational program of the diagnostic radiology residency, the leadership team of the residency program designed a comprehensive end-of-rotation evaluation (EORE) tool to increase the objectivity of resident evaluation. This assessment has been in place for 1 year and has been positively received by the residents. This study aims to determine the correlation between this examination and the ACR in-service examination (DXIT™).

METHOD AND MATERIALS: The computer-based examination is administered through the Electronic Residency Management System and is meant to simulate the new certification examination, with image-rich questions in multiple formats, including multiple-choice, true-false, extended matching, and free-text questions. Residents complete a rotation-specific assessment at the conclusion of each rotation. Pearson product-moment correlations were calculated, comparing the percentage results of these tests with gross and percentile scores obtained on the corresponding section of the DXIT™ exam; neuroradiology, GI, and ultrasound sections were assessed in 13, 11, and 12 residents, respectively, as these specific EORE tests have been in place the longest.

RESULTS: Strong correlation is noted between the EORE assessment and DXIT™ examination, with r values of 0.44, 0.53, and 0.66 for the neuroradiology, GI, and US sections, respectively. There was greater correlation between EORE assessment and gross score on DXIT™ than EORE assessment and percentile score on DXIT™ for the neuroradiology, GI, and US sections (r = 0.44, 0.53, and 0.66 vs 0.37, 0.46, and 0.62, respectively). None of these correlations reached statistical significance.

CONCLUSION: An image-rich end-of-rotation assessment strongly correlates with the DXIT™ exam, providing an opportunity for earlier identification of resident difficulty as well as an excellent means of program evaluation.

(SS02-06) 2:50 PM
Curriculum Intervention: Utilizing Resident Assessment to Focus Education Resources
James Boyum, University of Wisconsin, Madison, WI; Jessica B. Robbins, MD; Elizabeth Sadowski, MD; Laura A. Sabo, MD; Timothy Ziemlewicz, MD (tziemlewicz@uwhealth.org)

PURPOSE: The advent of a comprehensive end-of-rotation evaluation at our institution has allowed for assessment of our education program. This assessment has identified several areas of weakness in our curriculum, one of them being the handling of ultrasound cases of first trimester pregnancy. A learning module was created to address this weakness, and we plan to assess the effectiveness of this module.

METHOD AND MATERIALS: A PowerPoint module was created that includes a decision tree based on clinical scenarios to guide residents to the appropriate differential diagnosis and communication with referring providers. This module includes imaging findings of normal and abnormal pregnancies, as well as sample dictations for each of the clinical scenarios. The end-of-rotation scores pertaining to first trimester ultrasound will be compared between residents on the ultrasound rotation both prior to and following introduction of this module. In addition, a survey using Likert scale responses will be utilized to evaluate the residents' perceptions of this new module in their education.

RESULTS: The average overall score for first trimester pregnancy cases currently is 3.5/5.0, with the average score of all ultrasound cases at approximately 4.0/5.0 for the 14 residents who have taken

* Faculty financial disclosures are located in the Faculty Index.
the exam. The average communication score for the first trimester pregnancy cases is 3.4/5.0. Following current implementation of this module, scores will be collected prospectively for comparison. In addition, survey results will be available at the time of presentation.

CONCLUSION: A comprehensive resident assessment program allows for identification of weaknesses in the curriculum and subsequent intervention. We will report on the early results of this intervention.

(SS02-07) 3:00 PM
Radiation Risks from CT: From Basic Radiation Biology, to Understanding Cancer Risks, to CT Dose Reduction—An Educational Training Module for Radiology Residents
Sri Hari Sundararajan, MD, Robert Wood Johnson University Hospital, New Brunswick, NJ; Sandip Basak, MD; Jeffrey Kempf, MD (JKempf@unirad.com)

PURPOSE: In recent years, there have been many papers published in the medical literature describing the increasing utilization of CT, as well as CT’s increasing source of radiation exposure to the population, with reported excess cancers and cancer mortality. The purpose of this study was to develop a comprehensive curriculum for radiology residents for understanding the potential increased cancer risks from CT, to help trainees better inform patients about these risks, and to learn methods of CT dose reduction.

METHOD AND MATERIALS: A dedicated curriculum for understanding radiation risks from CT was created from a review of the last 10 years of the scientific literature. Learning modules were developed with summative materials and data from frequently cited articles, bridging basic radiation physics to dose reduction techniques for state-of-the-art CT technology. A review of the principles of the specific rates of cancer incidence relative to radiation exposure and how they are extrapolated was included. A 17-question pretest and posttest were administered to 12 radiology residents ranging from 1st-year to 4th-year trainees.

RESULTS: Five modules were created: (a) a pretest and posttest/evaluation; (b) introduction to essential physics and radiation biology regarding radiation dose; (c) description of the biological effects of ionizing radiation and review of the BEIR VII report, including principal data from which predictions of increased cancer incidence are extrapolated; (d) a review/summary of the current methods to reduce radiation exposure from CT; and (e) a closer scrutiny of the BEIR committee’s report. Pretest scores for the 12 radiology residents ranged from 35% to 88%, with a mean of 56%; and posttest scores ranged from 59% to 100%, with mean of 76%. A P-value for pretest and posttest score statistically significant difference of 0.007 was calculated by using a two-tailed Student’s t-test.

CONCLUSION: This new educational module has significantly improved our radiology residents’ understanding of the radiation risks associated with CT. It has also helped improve their confidence in effectively communicating with patients regarding CT radiation risks, as well as their understanding of methods of CT dose reduction.

(SS02-08) 3:10 PM
Documenting Training of a Competent Radiologist: How to Incorporate the Milestone Project into Your Radiology Residency Training Program
Kristen L. Baugnon, MD, Emory University School of Medicine, Atlanta, GA; Ashley H. Aiken; William F. Auffermann, MD, PhD; Mark E. Mullins, MD, PhD (kmlloyd@emory.edu)

PURPOSE: The Accreditation Council for Graduate Medical Education (ACGME) Outcome Project requires that residency directors objectively document resident competence in six general dimensions of practice (the core competencies). The next phase is the Milestone Project, which provides specific benchmarks against which a resident’s performance can be measured and compared, and programs will soon be required to document residents’ progress semiannually. This paper organizes our program’s approach to address these upcoming mandates.

METHOD AND MATERIALS: In 2010, to restructure our education program to ensure adequate competency-based education and documentation of outcomes, we formed an 18-member core competency committee. The committee includes members from the residency leadership (program director) and also faculty from the different divisions. The committee has a chair and co-chair, and the other members are assigned to one of the six competencies. Members at large have been added to address certain needs, including a curriculum development director, and educational liaisons to our different hospital sites. We plan to add a resident to the committee in the future for even further transparency.

RESULTS: Each group is responsible for mapping our current activities to each competency and brainstorming ideas for both teaching the competency and documenting resident proficiency. For instance, we have incorporated an audience response system into lectures to document acquisition of medical knowledge during a lecture. Additionally, since the release of the first draft of the milestones, we have begun to map our competencies to the milestones, to develop further strategies for implementation.

CONCLUSION: Restructuring residency education to meet the demands of the ACGME outcomes initiative may seem a daunting task for the leadership of any residency program. However, tracking milestones will aid in decisions regarding promotion, aid resident assessment, guide curriculum development, and aid in standardization of resident education. Forming a core competency committee, dividing the responsibilities into each competency, and mapping current educational activities to the milestones will aid in preparation for the training program of the future.

(SS02-09) 3:20 PM
Immediate and Lasting Benefit of a Brant and Helms-Based Curriculum for 1st-Year Radiology Residents as Seen through In-Service Training Exam Scores and Satisfaction Surveys: Our Program’s 7-Year Experience
Anthony Krueger, MD, University of Nebraska Medical Center, Omaha, NE; Matthew DeVries, MD; Ashwin Hegde, MD (anthony.krueger@unmc.edu)

PURPOSE: First-year radiology residents can feel overwhelmed by the abundance of knowledge essential for their residency. To help alleviate this, our program created a 6-month Brant and Helms-based curriculum that was initially implemented as a peer-driven process.

METHOD AND MATERIALS: Brant and Helms’ Fundamentals of Diagnostic Radiology textbooks are given to 1st-year radiology residents by the radiology department. Running from July to December, the curriculum, which consists of an assigned reading schedule with weekly question-and-answer sessions, is prepared and administered by more-senior residents throughout the course. Annual in-service training exam scores over the 7-year period in which this curriculum has been in place were analyzed to determine effectiveness. Furthermore, satisfaction surveys were conducted to gauge the residents’ perceptions of the curriculum.

RESULTS: Our Brant and Helms-based curriculum for 1st-year radiology residents had an immediate, lasting, and significant increase on in-service training exam scores. After implementation of the curriculum, cumulative 1st-year class scores were consistently within the 90th percentile nationally for annual in-service exams. Moreover, the course was also popular with residents, as evidenced by satisfaction surveys.

CONCLUSION: Creation and implementation of a 6-month Brant and Helms-based curriculum for 1st-year residents had an immediate and lasting benefit, as seen through annual in-service exam scores and satisfaction surveys. These results serve to validate the lecture time and textbook cost provided by the department, as well as the residents’ time and effort teaching and learning a comprehensive radiology text within the first 6 months of training.

* Faculty financial disclosures are located in the Faculty Index.
RESULTS: According to the standard modified RECIST criteria for tumor response to therapy, 16 of 18 (88.9%) patients were classified as “stable disease” during the on-treatment phase. Tumor volume analysis using semiautomated segmentation verified that the mean tumor volume remained similar at the first follow-up scan compared with the final pretreatment scan. However, a comparison of specific growth rates before versus during therapy showed a marked difference: Median pretreatment SGR was 1.62, while median on-treatment SGR was –0.78 (P = .0005). Change in SGR from the pretreatment to the on-treatment period was roughly normal, with a mean of –3.03 (95% CI: –3.84, –1.62).

CONCLUSION: Consideration of the natural history growth rate of a tumor may provide valuable information in the assessment of therapeutic response. By placing on-treatment tumor volume growth rate in the context of the preexisting tumor growth characteristics, we may obtain complementary information regarding a patient’s response to therapy. Future studies, however, must evaluate whether this approach more accurately predicts patient survival.

**Thursday, April 11, 2013**
2:00–3:30 PM

**SS03: Cardiopulmonary; Emergency/On Call**

**Location:** Platinum Ballroom Salons A and B

**Moderator:** Marta E. Heilbrun, MD

(520-01) 2:00 PM

**High-Pitch Dual-Source CT Angiography with a Low Volume of Contrast Medium in Patients Considered for Transcatheter Aortic Valve Replacement**

Alex Lewis, MBA, MD, Medical University of South Carolina, Charleston, SC; Lucas Geyer; U. Joseph Schoepf, MD*; Philip Costello, MD (lewal@musc.edu)

**PURPOSE:** The purpose was to investigate the feasibility of a high-pitch dual-source CT protocol with a low volume of contrast medium (CM) in the planning of transcatheter aortic valve replacement (TAVR).

**METHOD AND MATERIALS:** Nineteen patients (9 male; 82 ± 9 years), considered for TAVR, underwent a retrospective ECG-gated CT of the aortic root followed by high-pitch CT angiography (CTA) of aortoiliac access route using two different CM protocols. In seven patients (group A), a standard volume of CM (70–140 mL) was injected; in 12 patients (group B), the volume of CM was decreased (40–60 mL). Aortic root and iliofemoral dimensions were measured. Mean arterial attenuation, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), and figure-of-merit (FOM) were calculated.

**RESULTS:** Aortic root and iliofemoral dimensions could be analyzed in all cases. While the contrast volume in group B was significantly decreased (89.8 ± 25.7 mL vs 55.8 ± 7.8 mL; P < .001), the mean attenuation at the level of the aortic root (337.2 ± 122.6 HU vs 314.6 ± 146.9), aorta (297.9 ± 164.9 vs 215.2 ± 81.4), and iliofemoral access route (314.2 ± 203.1 vs 260.9 ± 101.2) was nonsignificantly lower in group B. The SNR, CNR, and FOM were nonsignificantly higher in group A.

**CONCLUSION:** Retrospective ECG-gated CT of the aortic root combined with a high-pitch dual-source CT aortoiliac access route allows for significant reduction of CM volume while maintaining diagnostic image quality.

(SS03-02) 2:10 PM

**Natural History Tumor Growth as a Contributory Factor in Assessing Response to Chemotherapy in Malignant Pleural Mesothelioma**

Ashoke Khanwalkar, BA, University of Chicago Pritzker School of Medicine, Chicago, IL; Samuel G. Armato III, PhD*; Anna Nowak, MD; Zacariah Labby, PhD; Masha Kocherginsky, PhD; Christopher M. Straus, MD

**PURPOSE:** This research compares the tumor volume growth rate during the pretreatment natural history period with the on-therapy period in malignant pleural mesothelioma and quantifies change in tumor volume growth rate. We hypothesize that consideration of the natural growth trajectory of a tumor may provide clinically relevant information, even in the absence of significant tumor volume regression, when the alternative would have been a continued increase in tumor size at the natural growth rate.

**METHOD AND MATERIALS:** A CT-based semiautomated tumor segmentation algorithm produced disease contours that were confirmed by an experienced radiologist. These contours were used to calculate tumor volumes for 18 mesothelioma patients at multiple pretreatment and on-therapy scan dates. A specific growth rate (SGR) was calculated for each patient’s pretreatment and on-therapy phases by using these tumor volumes. Aggregate pretreatment SGR was compared with on-therapy SGR by using a Wilcoxon paired rank sum test.

**RESULTS:** Median pretreatment SGR was 1.62, while median on-treatment SGR was –0.78 (P = .0005). Change in SGR from the pretreatment to the on-therapy period was roughly normal, with a mean of –3.03 (95% CI: –3.84, –1.62).

**CONCLUSION:** Consideration of the natural history growth rate of a tumor may provide valuable information in the assessment of therapeutic response. By placing on-treatment tumor volume growth rate in the context of the preexisting tumor growth characteristics, we may obtain complementary information regarding a patient’s response to therapy. Future studies, however, must evaluate whether this approach more accurately predicts patient survival.

(SS03-03) 2:20 PM

**How Does Peripheral Vascular Calcification Affect CT Runoff Diagnostic Confidence?**

Pegah Entezari*, Northwestern University, Chicago, IL; Rahul Rustogi; Darshit Thakrar; Hamid Chalian, MD; Amir R. Honarmand, MD; Jeremy Collins, MD; et al

**PURPOSE:** The purpose was to evaluate the effect of lower extremity vessel calcification on the performance and diagnostic confidence of CT angiography (CTA).

**METHOD AND MATERIALS:** A total of 260 segments in 20 patients with symptomatic peripheral vascular disease were evaluated. All patients had both CTA and digital subtraction angiography (DSA) in less than 1 week. Vessel calcification, stenosis, and diagnostic confidence (0: nondiagnostic; 1: poor; 2: fair; 3: good; and 4: excellent confidence) were assessed for all segments. Correlation between CTA stenosis and DSA stenosis and also correlation between CTA calcification and diagnostic confidence were assessed. Chi-square was used for analysis, with an α of 0.05.

**RESULTS:** Stenosis evaluation at CTA was highly correlated with the calcification level (28/37 highly calcified segments were >70% stenotic). Diagnostic confidence was greater in low-calcified segments compared to highly calcified ones (average diagnostic confidence score of 3.5 in 150 low-calcified and 16 high-calcified segments). Higher correlation was detected between CTA and DSA stenosis grading in segments with lower grades of stenosis, following the prevalence of vascular calcification (82% correlation in <70% stenosis vs 68% correlation in segments with ≥70% stenosis).

**CONCLUSION:** Readers had higher confidence for grading stenosis in low-calcified arteries. Accuracy for stenosis was impaired in highly calcified segments. High prevalence of severe calcification in severely stenotic segments limits CTA performance in lower extremity atherosclerosis. Application of techniques to enhance image quality in severely calcified lower extremity vessels should be pursued to improve diagnostic accuracy.

(SS03-04) 2:30 PM

**Thoracic Aorta CT Angiography: A Comparison between Filtered Backprojection and Automated kVp Selection in Combination with Sinogram-affirmed Iterative Reconstruction**

Pegah Entezari*, Northwestern University, Chicago, IL; Marcos Butelio; Fernanda Gonzalez, MD; Jeremy Collins, MD; James Carr; Vahid Yaghmai, MD (p-entezari@northwestern.edu)

**PURPOSE:** The purpose was to evaluate the image quality and radiation dose of thoracic aorta CT angiography in automated kVp selection combined raw data based sinogram-affirmed iterative reconstruction (SAFIRE) technique.

* Faculty financial disclosures are located in the Faculty Index.
METHOD AND MATERIALS: In this HIPAA-compliant study, 21 patients who had undergone ECG-gated thoracic aorta CTA with current modulation, filtered backprojection reconstruction technique (group A) were compared to 21 BMI-matched patients with ECG-gated thoracic aorta CTA scans with automated kVp selection and SAFIRE (group B). Mean attenuation levels in ascending and descending aorta, as well as mean CTDIvol, DLP, CNR, and SNR, were compared in two groups. Student’s t test was used for analysis.

RESULTS: BMI was comparable in two groups (P > .05). Both groups were also matched based on kVp. Mean attenuation level was higher in group B compared to group A in both ascending aorta (476.4 ± 150.2 vs 407.2 ± 116.3, respectively) and descending aorta (476.6 ± 119.3 vs 399.9 ± 116.1, respectively). Group B had significantly (P < .05) lower CTDIvol (6.16 ± 2.8 mGy vs 11.32 ± 4.7 mGy) and DLP (157.9 ± 96.9 mGycm vs 242.4 ± 104.3 mGycm) in comparison with group A. Both CNR and SNR were significantly higher in group B compared to group A (CNR: 23 ± 14.7 vs 15.2 ± 4.9; SNR: 27.9 ± 17.3 vs 19.1 ± 5.2, respectively, P < .05).

CONCLUSION: Despite the significant decrease in radiation dose, the image quality was improved by automated kVp selection and SAFIRE in thoracic aorta CTA images.

AUR Trainee Prize: 3rd Place
(SS03-05) 2:40 PM Validation of a Semiautomated Approach for Assessment of the Thoracic Aortic Dimensions
Pegah Entezari*, Northwestern University, Chicago, IL; Amir R. Noramand, MD; Aya Kino, MD; Sameer A. Ansari, MD, PhD; Jeremy Collins, MD; Vahid Yaghmai, MD; et al (p-entezari@northwestern.edu)

PURPOSE: The purpose was to assess the reproducibility of semiautomated segmentation software for thoracic aorta diameter measurement in images obtained with ECG-gated CT angiography.

METHOD AND MATERIALS: Multiplanar reformatted images of 49 cases with thoracic aorta aneurysm were studied. The maximum transaxial diameter of external wall to external wall was measured at four anatomic levels of the thoracic aorta: sinus, sinotubular junction (STJ), mid ascending aorta (MAA) at the level of right pulmonary artery, and proximal aortic arch (PROX) immediately proximal to innominate artery. One reader performed the measurements with both the semiautomated and manual methods. The measurements were repeated by a second reader independently. Inter-method, intraobserver, and interobserver reliability was evaluated according to the intraclass correlation coefficient (ICC).

RESULTS: ICC for diameter measurements was >0.9 for all intraobserver, interobserver, and intermethod reliabilities. Mean diameter in the semiautomated and manual methods was sinus, 41.9 mm and 42 mm; STJ, 38 mm and 37.5 mm; MAA, 43.4 mm and 42.5 mm; and PROX, 38.4 mm and 37.3 mm, respectively.

CONCLUSION: The semiautomated tool showed a high level of reproducibility, compared with the manual method, in measurement of the ascending aorta.

(SS03-06) 2:50 PM Assessing Inpatient Imaging Utilization in a Trauma Hospital to Describe Variability in Use and Characterize Radiology Efficiency
Brian W. Bresnahan, PhD*, University of Washington Harborview Medical Center, Seattle, WA; Bruce Lehnert; Daniel Hippie; Wendy Cohen

PURPOSE: The purpose was to describe inpatient imaging use in a busy level 1 trauma hospital as part of a quality improvement initiative focusing on portable x-rays in intensive care units (ICUs) and imaging use for subarachnoid hemorrhage (SAH) patients.

METHOD AND MATERIALS: We conducted descriptive analyses on two types of imaging use in inpatients to assess radiology efficiency: portable radiographs, and CT and other imaging for SAH patients. Continuous variables were summarized as mean ± SD or median (interquartile range [IQR]). Spearman’s rank correlation coefficient was used to assess associations between length of stay and cost variables. Two-tailed tests were used, with P < .05 denoting statistically significant. SAH patients were categorized by complications and comorbidities status.

RESULTS: We used two distinct samples from inpatient imaging to assess portable x-rays and SAH patients: We assessed 16,396 portable ICU exams from March 2011 through February 2012. Most portable x-rays were done in the medical cardiac ICU (24.2%), the neuroscience ICU (28.8%), and the trauma surgery ICU (46.6%). The ages of patients diagnosed with portable x-ray ranged from 10 to 98 years, with a median (IQR) of 55 (41, 66) years. For SAH patients, our preliminary July 2011 to July 2012 sample included 126 patients with diagnosis-related group (DRG) 20 or 21. All SAH patients underwent CT, and most underwent angiography (98.4%), with approximately 95% receiving radiographs. Smaller portions of SAH patients received magnetic resonance or nuclear imaging. Length of stay for SAH was found to strongly correlate with total direct costs (r = 0.83, P < .001), although radiology direct costs were only modestly correlated (r = 0.34, P < .001).

CONCLUSION: Preliminary descriptive results indicate that variability exists in portable radiographs for inpatients. In addition, SAH patients with major complications and comorbidities had significantly longer lengths of stay and greater radiology use than those without major complications.

(SS03-07) 3:00 PM Secure Instant Messaging: Improvement in Intra-departmental Communication for the On-Call Radiology Resident
Jason H. Lee, MD, Robert Wood Johnson University Hospital, New Brunswick, NJ; Sandip Basak, MD; Judith K. Amorosa, MD (jasonhuanglee@gmail.com)

PURPOSE: At our institution, communication between the on-call radiology resident and other physicians is handled via direct phone calls or overhead pages from our file room. A proposal was made to institute a secure instant messaging (sIM) service within the file room to allow for improved communication.

METHOD AND MATERIALS: An sIM service (Ipswitch Instant Messaging; Ipswitch, Lexington, MA) was installed and was confirmed to be HIPAA compliant. Anonymous surveys were taken of all 22 radiology residents both before and after the implementation of sIM.

RESULTS: Prior to the institution of sIM, 85% of the radiology residents felt that usage of the overhead paging system was not an efficient form of communication. The residents unanimously agreed that a more efficient communication system between the file room personnel and the resident on call was warranted. After the institution of sIM, 58% of the radiology residents stated that the file room personnel were using sIM as their primary form of communication. However, 90% of the radiology residents agreed that when sIM was used as the primary form of communication, the efficiency of their work flow improved.

CONCLUSION: Interpersonal and communication skills are one of the core competencies that programs are required to address, as defined by the ACGME. Given the ever-increasing demands placed upon radiology residents to provide timely and accurate interpretations of studies after hours while maintaining communication with other physicians, providing the house staff with an efficient work environment is imperative. Other departmental studies have shown that traditional paging systems, like our original scheme, have switched to alphanumeric paging systems, citing improved efficiency and overall patient care. The implementation of sIM has the potential to achieve those same results.

* Faculty financial disclosures are located in the Faculty Index.
Clinician Satisfaction with On-Call Radiology Resident Services
Matthew R. Hammer, MD, University of Michigan Health System, Ann Arbor, MI; Katherine A. Klein, MD; Edward Karls, MBA; Shane A. Wells, MD; Sachin Patel, MD; Janet E. Bailey, MD; et al (hammerm@med.umich.edu)

PURPOSE: Referring clinician satisfaction with radiology services is an important indicator of a department's success, analogous to patient satisfaction as a quality indicator for all fields of medicine. Our radiology department provides 24-hour coverage, which includes independently functioning radiology residents covering nights and weekends. We created surveys to measure our referring colleagues' satisfaction with the resident service and to develop strategies for improvement that could be assessed over time.

METHOD AND MATERIALS: 573 referring physicians were surveyed by utilizing online survey software (Qualtrics). By using various question formats including a seven-point Likert-like scale, clinician demographics were assessed, as well as domains, including quality of communication, radiology department logistics, perceived preliminary report discordant rates, and overall satisfaction. Data from the initial survey were analyzed and areas of needed improvement identified. Interventions were instituted to provide education, correct misperceptions, and increase satisfaction. A follow-up survey was issued 12 months later to assess the effectiveness of the interventions.

RESULTS: The initial survey response rate was 31.6% (181/573), and follow-up survey response rate was 32.0% (183/572), with similar demographic profiles. The number of clinicians indicating they usually (or more often) viewed the preliminary report increased from 91% to 96% following an improvement in online viewing availability, with 91% finding the new format at least usually helpful. Clinicians gained confidence (usually or more often) in the preliminary reports after publicizing the low discordance rate with the final interpretations (76%–91%). The overall satisfaction with the radiology on-call service increased from 75% to 87%.

CONCLUSION: Clinician satisfaction with radiology services is an important measure of quality in diagnostic radiology. Our experience shows that survey tools can be used to determine satisfaction in multiple areas, including with the on-call radiology resident service. Directed interventions can result in positive trends in satisfaction and ultimately improve patient care.

Emergency Imaging Discrepancy Rates at a Level 1 Trauma Center: Identifying the Most Common On-Call "Misses" among Residents at Each Level of Training
Jennifer Tomich, MD, East Virginia Medical School, Norfolk, VA; Sarah Shaves, MD; Michele Retrouvey, MD (tomichj@evms.edu)

PURPOSE: The focus of our research is to identify and analyze the most frequently reported on-call discrepancies at our institution by modality and level of resident training. Our intent is to improve awareness of common missed findings in order to further reduce the rate of on-call radiology resident errors.

METHOD AND MATERIALS: Our study included 648 significant discrepancies from 193,722 studies ordered through the emergency department over a 7-year period. The overall discrepancy rates were calculated for each resident level of training and modality type. Significance was determined by using χ² testing with α = 0.05. The most common types of discrepancies were then identified.

RESULTS: Our study demonstrated an overall low rate of reported discrepancies for all levels of training (0.0023%–0.0042%), with a small but statistically significant decrease in rate for the senior level residents. There was a significantly higher rate of discrepancies reported for computed tomography (CT) and plain radiographic studies (0.49% and 0.25%, respectively). Common categories of discrepancies included fractures on plain radiographs and CT, masses and hemorrhage on CT, and lung nodules and pulmonary infiltrates on radiographs. These discrepancies were similar for all residents regardless of their level of training. Specific frequent discrepancies included lung nodules; fractures of the hands, feet, and ribs; and the presence and characterization of peritoneal fluid.

CONCLUSION: While senior residents had slightly lower discrepancy rates, the most commonly reported missed findings were similar for all residents regardless of level of training. Residents should be aware of the frequency of these errors as a reminder to look for subtle findings that may be easily overlooked.

Thursday, April 11, 2013 2:00–3:30 PM

Women's Imaging; Abdomen
Location: Platinum Ballroom Salons F and G
Moderators: Jessica B. Robbins, MD Martha B. Mainiero, MD

Axillary Lymph Nodes to Predict Breast Cancer Metastatic Involvement
Jane Conlin, MD, University of Washington, Seattle Cancer Care Alliance, Seattle, WA; Habib Rahbar, MD; Sana Parsian; Wendy B. DeMartini, MD; Constance D. Lehman, MD, PhD; Savannah C. Partridge, PhD (jaconlin@uw.edu)

PURPOSE: Axillary lymph node (ALN) status in patients newly diagnosed with breast cancer provides essential prognostic information. An imaging approach utilizing quantitative MR imaging values for axillary staging has substantial clinical value to avoid the cost and morbidity of surgical staging. The purpose of our study was to compare the dynamic contrast-enhanced (DCE) and diffusion-weighted (DW) MR imaging characteristics of benign versus metastatic ALNs that exhibited suspicious morphology on clinical breast MR imaging for newly diagnosed breast cancer.

METHOD AND MATERIALS: After IRB approval, we retrospectively identified patients who underwent ultrasound-guided core needle biopsy from 3/2006 to 1/2010 of ALNs with suspicious morphology that were identified on MR imaging for newly diagnosed breast cancer. All patients underwent subsequent surgical staging via sentinel or full ALN dissection. Presence of malignancy at core biopsy or surgical staging was considered a metastatic outcome. Breast MR exams were performed at 1.5 T with DCE and DWI (b = 0, 600 s/mm²). For each case, quantitative DCE characteristics (size, manual volume, peak initial enhancement, percentage washout, angio volume) and DW MR apparent diffusion coefficient (ADC) values were assessed for the suspicious ALN and a representative contralateral normal-appearing ALN. MR characteristics were compared for benign versus metastatic and contralateral ALNs.

RESULTS: A total of 41 MR suspicious ALNs (21 malignant, 20 benign) in 41 women (mean age, 49 ± 13.2 years) were included. Overall, in all, intrasubject comparisons showed significant differences in size, manual volume, angio volume, and ADC values of suspicious versus contralateral normal ALNs (P < .05). However, there were no significant differences in DCE or DW MR characteristics of benign versus metastatic suspicious ALNs (P > .05).

CONCLUSION: Morphologically suspicious ALNs show significant quantitative DCE and DW MR differences compared to contralateral ALNs. However, among suspicious ALNs, no differences were found between benign and metastatic ALNs, suggesting that quantitative DCE and DW MR characteristics cannot improve the accuracy for identifying metastatic ALNs at this time.

* Faculty financial disclosures are located in the Faculty Index.
RESULTS: A total of 79 division directors received the survey, with 18 completed surveys yielding a response rate of 23%. The average callback rate for a division was 12% (SD, 2.7). The average highest callback rate for an individual was 18% (SD, 5.1). The average lowest callback rate for an individual was 7.5% (SD, 2.7). The majority (56%) of radiologists had 5–10 years of experience reading screening mammograms. All practices train residents and/or fellows. The vast majority (94%) of institutions single-read screening mammograms. Some measures taken by institutions to decrease their callback rates included weekly peer review, tomosynthesis, regular feedback to faculty with high recall rates, quarterly reports, double reading with a breast imaging fellow, and consulting another breast imager before issuing a final read for all category 0 studies.

CONCLUSION: The average recall rate of academic institutions is slightly higher than recommended, at 12%. In the future, it is likely that reimbursement will be tied to recall rates. Studies evaluating how to effectively decrease recall rates need to be conducted.

**RESEARCH PAPERS**

**Variation in Breast MR Imaging BI-RADS® Assessment by Clinical Indication in U.S. Community Settings**

Michele C. Rochelle, MD,* University of Washington, Seattle, WA; Christoph I. Lee, MD; Laura Ichikawa, MS; Bonnie N. Joe, MD, PhD; Brian Sprague, PhD; Karen Wernli, PhD; et al

**PURPOSE:** As breast MRI use grows in community settings, benchmark parameters are needed for auditing and quality assurance. We aim to describe distributions of breast MRI assessments by clinical indication in a nationally representative sample.

**METHOD AND MATERIALS:** We analyzed data from the Breast Cancer Surveillance Consortium (BCSC) network of breast imaging registries. Each registry obtained IRB approval for this HIPAA-compliant analysis. We included all breast MRIs conducted in 2005–2009 among women aged 18–79 years. For each MRI, we recorded data including clinical indication and BI-RADS® assessment. For analysis purposes, we characterized assessments as either positive (needing further evaluation; BI-RADS® 0, 3, 4, and 5) or negative (no further evaluation needed; BI-RADS® 1, 2, and 6). We categorized indications as (a) screening (asymptomatic), (b) diagnostic (eg, specific breast problem), (c) extent of disease (eg, recent cancer diagnosis), and (d) other (eg, short-interval follow-up). We reported frequencies of positive and negative BI-RADS® by indication and performed the Pearson χ² test for significant differences (P < .05).

**RESULTS:** A total of 7367 breast MRIs were performed across BCSC breast registries during the study period. Among screening MRIs, 78.1% (2090/2677) had a negative assessment, while 21.9% (587/2677) had a positive assessment. In contrast, among diagnostic MRIs, 78.1% (2090/2677) had a negative assessment, while 21.9% (587/2677) had a positive assessment. Among MRIs performed for extent of disease, 82.4% (1083/1315) had a negative assessment, while 17.6% (232/1315) had a positive assessment. Among MRIs done for other indications, 72.6% (729/1004) of BI-RADS® were negative, while 27.4% (275/1004) were positive. The differences in positive and negative BI-RADS® by clinical indications are significantly different (P < .0001).

**CONCLUSION:** Breast MRI BI-RADS® assessments vary based on clinical indication. As facilities develop breast MRI quality assurance programs, positive and negative assessments should be audited separately based on whether studies are performed for screening, diagnostic evaluation, extent of disease, or other indications.

**Mammography Recall Rates in an Academic Setting**

Madeleine Lewis, MD,* Medical University of South Carolina, Charleston, SC; Abid Irshad, MD; Susan J. Ackerman, MD; Rebecca Leddy, MD (lewism@musc.edu)

**PURPOSE:** Recall rate is defined as the percentage of screening studies for which further workup is recommended by the radiologist. Different groups have recommended different target recall rates. European guidelines recommend a target recall rate of 5%. The American College of Radiology and the U.S. Agency for Healthcare Policy and Research both recommend an overall recall rate of less than 10%. There is considerable variation in the recall rates for different mammographers, practices, and countries. The goal of the survey is to determine the recall rates for radiologists practicing in an academic setting.

**METHOD AND MATERIALS:** An electronic survey was distributed to breast imaging section heads at academic institutions in the United States. The list of section heads was derived from the Society for the Advancement of Women's Imaging and the Society of Breast Imaging directories. The surveys were completely anonymous and not linked to the responder's institution.

**RESULTS:** We analyzed performance data of 771 course participants on 104 breast MR cases. MR indications were 54% screening (56/104) and 46% diagnostic (48/104). On average, participants provided correct BI-RADS® for 78% of screening cases and 74% of diagnostic cases. Participants more accurately assessed screening compared to diagnostic MR cases (P = .0005), and masses compared to nonmass enhancement (P = .002).

**CONCLUSION:** Practicing radiologists accurately assess the correct BI-RADS® in three-quarters of cases used in the ACR "Breast MR with Guided Biopsy" course. Performance was more accurate on screening, compared to diagnostic MR, and when evaluating masses, as opposed to areas of nonmass enhancement. Future case-based breast MR education efforts should emphasize strategies for interpretation of diagnostic breast MR cases and evaluation of nonmass enhancement.

* Faculty financial disclosures are located in the Faculty Index.
Is Extensive Intraductal Component Predictable on Imaging? Impact of Extensive Intraductal Component on Definitive Surgical Treatment of Invasive Breast Carcinoma

Jill Gluskin, MD, Albert Einstein Medical Center, Philadelphia, PA; Dorothy A. Sippo, MD; Mrugank Shukla; Mar’ina Reynolds; Eva C. Gombos, MD (jgluskin@partners.org)

PURPOSE: Extensive intraductal component (EIC) is associated with a higher incidence of positive lumpectomy margins and thus an increased number of surgeries. Currently, EIC is determined pathologically after surgical excision. Our purpose is to determine if diagnostic imaging can predict EIC prior to surgery. We also reviewed the impact of EIC on the number of surgeries required to achieve clear margins.

METHOD AND MATERIALS: In this IRB-approved and HIPAA-compliant study, retrospective review of medical records of 529 patients with newly diagnosed invasive breast carcinoma between 11/2004 and 1/2009 was performed. Imaging findings suspicious for EIC were reviewed, including presence of extensive mammographic calcifications and nonmasslike enhancement on MRI. We compared the sensitivity of mammography and MRI at detecting EIC using McNemar’s test. We recorded the number of excisions needed to reach definitive surgical treatment in all 529 patients and analyzed the significance of EIC on whether one or more excisions were required using Fisher’s exact test. Statistical analysis was performed with SAS software (SAS version 9.2; SAS Institute, Cary, NC).

RESULTS: EIC was found on pathology in 115 of the 529 cases (21.7%). All 115 patients with EIC-positive tumors had a mammogram, and 20 patients had MRI. Of those 115 with EIC-positive tumors, 54 (47.0%) showed suspicious imaging findings: 43 were identified on mammogram and 14 on MRI. Three patients had evidence of EIC on both mammogram and MRI. For the 20 patients who were imaged with both mammography and MRI, mammography had a sensitivity for EIC detection of 15% (95% confidence interval [CI]: 3%, 38%) compared with MRI, which had a sensitivity of 65% (95% CI: 41%, 85%) (P = .0016). Of the cases with EIC, 34.8% (40 of 115; 95% CI: 26.1%, 44.2%) required only one surgery to reach definitive surgical treatment, compared to 71.7% (297 of 414; 95% CI: 67.1%, 76.0%) for the patients without EIC (P < .0001).

CONCLUSION: Imaging findings predicted presence of EIC in 47% (54 of 115) of the EIC-positive cases, with MRI being more sensitive than mammography. There was a statistically significant relationship between EIC positivity and more than one surgery being required to achieve clear margins.
RESERCH PAPERS

(8804-08) 3:10 PM
Follow-up Small Bowel Follow-Through Studies after CT
Do Not Affect the Clinical Management of Small Bowel Obstructions but Do Lead to a Greater Total Radiation Dose
Roshni A. Parikh, MD, BEng, University Hospitals Case Medical Center, Cleveland, OH; Raj M. Pasupati, MD (roshni.parikh@uhohospitals.org)
PURPOSE: Computed tomography (CT) of the abdomen and pelvis is the initial imaging modality for evaluation of suspected small bowel obstruction. Improved CT imaging techniques and multiplanar reconstructions have improved the accuracy of diagnosis of small bowel obstruction, site of transition, and cause of obstruction. Follow-up small bowel follow-through (SBFT) studies are often requested by the treating physician to assess the severity of obstruction and in deciding surgical versus conservative management of these patients. The aim of this study is to evaluate the role of the SBFT in the management of small bowel obstruction already diagnosed by CT.

METHOD AND MATERIALS: A retrospective data analysis from July 2010 to December 2011 was performed. A total of 237 subjects had a CT diagnosis of a small bowel obstruction, and 25 of those subjects underwent a follow-up SBFT study. The clinical management and total radiation dose of those subjects who had CT and SBFT (n = 25) were compared with those subjects who had only CT (n = 212). Fisher’s exact 2×2 contingency table and a nonpaired sample t test were used for statistical analysis.

RESULTS: The groups compared were similar in age and gender. The clinical management of subjects with small bowel obstruction did not differ between groups (40.0% surgical and 60.0% conservative management for the CT plus SBFT group, and 38.6% surgical and 62.4% conservative management for those subjects with only CT without SBFT; P = 1.000). The average total radiation dose was significantly higher for the SBFT plus CT group compared with the CT-only group (32.9 mSv vs 12.0 mSv; P < .0001).

CONCLUSION: The addition of the SBFT study following a CT does not change the overall clinical management of small bowel obstructions but does significantly increase the total radiation dose. The clinical relevance of this study relates to the appropriate use of imaging methods in patient care without increasing radiation dose.

(8804-09) 3:20 PM
Implementation and Evaluation of a Performance Improvement Intervention to Address Physician Documentation Deficiencies in Abdominal US
Vivek V. Patil, MD, Mount Sinai Medical Center, New York, NY; Bradley N. Delman, MD; Eric J. Wilck, MD; William L. Simpson, MD* (vivek.patil@mounainsinai.org)
PURPOSE: The purpose of our study is to identify deficiencies in physician documentation in abdominal ultrasound reports, implement a performance improvement intervention to address the deficiencies, and evaluate the effect of the intervention.

METHOD AND MATERIALS: In order for a report to meet criteria for Ultrasound Abdomen Complete (USABC, CPT 76700) coding, the following eight elements are required: liver, bile ducts, gallbladder, spleen, kidneys, pancreas, IVC, and aorta. Failure to document all eight elements results in coding as Ultrasound Abdomen Limited (USABL, CPT 76705). Recently published data from a large multicenter study indicate 75.1% of reports document all eight elements. In the first phase of our study, 50 consecutive USABC reports performed as part of routine medical care were retrospectively analyzed for the presence or absence of the eight elements required for USABC coding. Subsequently, education regarding CPT coding in abdominal ultrasound and suggested standardized macros were provided to staff radiologists and residents. In the second (postintervention) phase, an additional 50 consecutive USABC reports were analyzed for the presence or absence of the eight elements.

RESULTS: In the first phase of the study, none (0%) of the 50 reports met criteria for USABC coding. The most commonly omitted elements were the IVC (present in 2% of reports) and aorta (present in 6% of reports). Postintervention, there was an increase to 37 (74%) reports meeting criteria for USABC coding. The most commonly omitted elements were again the IVC (present in 76% of reports) and aorta (present in 86% of reports). Lack of 100% compliance was secondary to failure to update a resident’s macro and inadvertently scheduled studies (ie, focused RLQ/appendicitis study scheduled as USABC).

CONCLUSION: We were able to improve USABC documentation from 0% to 74%. Our compliance rate in the postintervention group was similar to the 75.1% rate in previously published larger-scale studies. Our study illustrates the efficacy of relatively simple performance improvement interventions that may be employed for improved abdominal ultrasound documentation.

Thursday, April 11, 2013 2:00–3:30 PM
SS05: Neuroradiology; Interventional Radiology; Musculoskeletal
Location: Platinum Ballroom Salons H and I
Moderator: Pina C. Sanelli, MD, MPH

(8805-01) 2:00 PM
Visualization of Proximal Extracranial Facial Nerve on 3D T1 and T2 Sequences on High-Field MR Imager
Reza Hakimelahi, MD, University of Texas Medical Branch, Galveston, TX; Roy Riascos, MD; Tomas E. Uribe Acosta, MD; Claudia Cotes, MD, MS; John C. Heymann, MD; Gregory Chaljub, MD (rehakime@utmb.edu)
PURPOSE: The extracranial facial nerve is difficult to delineate by using conventional MR sequences. We sought to assess and compare the value of 3D thin-slice isovolumetric T1 and T2 sequences on a 3-T MR unit in better visualization of the extratemporal facial nerve.

METHOD AND MATERIALS: 3D isovolumetric sagittal T1 and T2 sequences were performed with 1-mm voxel size in 18 healthy adults (three females) on a 3-T MR unit (Magnetom Verio; Siemens, Erlangen, Germany). Multiplanar reformatting (MPR) was utilized to reconstruct axial planes. The acquired images were analyzed by two experienced neuroradiologists (R.R. and T.E.U.) for visualization of the extratemporal segment of the facial nerve from the stylomastoid foramen to pes anserinus and also the intraparotid segment main branches. The visualization was categorized into complete visualization (CV), partial visualization (PV), or no visualization (NV). The 3D T1 and T2 sequences were compared to evaluate presence of a statistically significant difference in degree of visualization. The interrater agreement was also evaluated by using the κ test.

RESULTS: A total of 36 facial nerves (18 cases) were evaluated by the raters. The entire course of the extratemporal facial nerve and its main branches was visible in 90.3% on T1 versus 30.6% on T2 as an average between the raters. Only 9.7% of facial nerves were partially visualized on T1, while it was 58.3% on T2. All facial nerves were visualized on T1; however, in 11.1% of T2 evaluations, it was not visualized. Our results showed a significant difference in visualization of the proximal extracranial facial nerve between 3D T1 and 3D T2 sequences (P = .001). The interrater agreement was poor, especially on the right side, as five cases were called partially visualized by one rater (A) while classified as completely visualized by the other rater (B). The percentage of complete visualization was 86.1% for rater A and 94.4% for rater B.

* Faculty financial disclosures are located in the Faculty Index.
CONCLUSION: Visualization of the extracranial facial nerve is essential for accurate diagnosis and safe and effective head and neck interventions. This mostly can be achieved on 3D isotropic volume T2 sequence, as compared to 3D T2 sequence, performed on 3-T MR imagers.

METHOD AND MATERIALS: We examined volumetric MRI data from a subset of the population-based Dallas Heart Study over the age of 55 without a diagnosis of dementia to determine the risk factors that best predict PCC, parietal, and hippocampal volume loss (n = 527; mean age = 61.3; 42% male, 58% female). Brain segmental volumes were generated using MRI brain imaging software (FreeSurfer). After adjusting for age, gender, ethnicity, and intracranial volume, a stepwise regression analysis was performed for each brain region with the following risk factors: presence of APOE4, diabetes, hypertension duration, smoking, alcohol use, cholesterol level (total, HDL, LDL, VLDL), triglyceride level, BMI and systolic/diastolic blood pressures.

RESULTS: APOE4 did not predict volume loss in any of the brain regions studied. PCC atrophy was associated with hypertension (P = 0.0105), alcohol use (P = 0.0056), and lower HDL (P = 0.0012). Parietal lobe atrophy was associated only with alcohol use (P = 0.0062). No risk factors predicted hippocampal atrophy.

CONCLUSION: Our data show that the PCC and parietal lobes are susceptible to atrophy from modifiable risk factors but not APOE4, suggesting that they may not be specific markers of AD pathology. This proposes that the association of these regions with AD may be due in part to the synergistic effects of environmental insults lowering the threshold for disease expression. Atrophy in the hippocampus was dissociated from modifiable risk factors and thus may be more likely to represent the effects of aging and/or AD alone.
Atherosclerosis who underwent similar imaging during the same time period. Images were independently reviewed by two blinded radiologists, who assessed arch anatomy as normal, bovine, or other variant. The original radiology reports were reviewed for reporting of arch anatomy.

RESULTS: In controls, 70% had normal arch anatomy, 24% had a bovine arch, and 6% had other arch anomalies. Among patients with significant carotid disease, these numbers were 70%, 20%, and 9%, respectively. There was no statistically significant difference between incidence of arch variants in subjects with and without carotid artery atherosclerosis (P = .97). There was good interreader agreement (κ = 0.68). Among patients with aortic arch anomalies, 22% of the original radiology reports did not mention arch anatomy.

CONCLUSION: In our experience, the percentage of bovine arch anomalies in patients with significant carotid atherosclerosis is not significantly different from those without disease. Clinicians should be aware of the high prevalence of arch anomalies, which can impact endovascular approach and management, and radiologists should be aware of the clinical importance of reporting such variants.

(BSS05-06) 2:50 PM
Bovine Arch and Carotid Artery Atherosclerosis: Are They Related?
Amanjit Baadh, MD, Winthrop-University Hospital, Mineola, NY; Caron Rockman; Robin J. Mitnick, MD; Ruth P. Lim (andybaadh@yahoo.com)

PURPOSE: Aortic arch anomalies are frequent anatomic variants. The prevalence of the most common anomaly, a bovine aortic arch, in the general population is known (8%–25%); however, the prevalence of this anomaly in patients with atherosclerosis of the carotid artery has never been investigated. A bovine arch is a variant in which the left common carotid artery has a common origin with the innominate artery. The feasibility of treating severe carotid occlusive disease by using angioplasty and stenting can be affected by the presence of these anomalies. The objective of this study is to retrospectively identify and compare the prevalence of aortic arch anomalies in patients with and without clinically significant carotid artery atherosclerosis.

METHOD AND MATERIALS: This was a single-center, retrospective case-control study in which 79 patients with significant (≥50% diameter reduction) carotid atherosclerosis who underwent CTA, MRA, or unenhanced CT imaging including the aortic arch were identified and compared with 95 randomly selected controls without carotid atherosclerosis who underwent similar imaging during the same time period. Images were independently reviewed by two blinded radiologists, who assessed arch anatomy as normal, bovine, or other variant. The original radiology reports were reviewed for reporting of arch anatomy.

RESULTS: In controls, 70% had normal arch anatomy, 24% had a bovine arch, and 6% had other arch anomalies. Among patients with significant carotid disease, these numbers were 70%, 20%, and 9%, respectively. There was no statistically significant difference between incidence of arch variants in subjects with and without carotid artery atherosclerosis (P = .97). There was good interreader agreement (κ = 0.68). Among patients with aortic arch anomalies, 22% of the original radiology reports did not mention arch anatomy.

CONCLUSION: In our experience, the percentage of bovine arch anomalies in patients with significant carotid atherosclerosis is not significantly different from those without disease. Clinicians should be aware of the high prevalence of arch anomalies, which can impact endovascular approach and management, and radiologists should be aware of the clinical importance of reporting such variants.

(BSS05-07) 3:00 PM
Team-based Learning Neuroradiology Curriculum: A Novel Approach in Radiology Resident Education
Pedro J. Diaz-Marchan, MD, Baylor College of Medicine, Houston, TX (pedrad@bcm.edu)

PURPOSE: The purpose was to replace the current lecture/case-based residency neuroradiology curriculum at Baylor College of Medicine with a more dynamic interactive one based on team-based learning techniques.

METHOD AND MATERIALS: Forty-eight residents have been divided into six groups of eight (two per year per level). Twenty-four 1-hour sessions led by the same neuroradiologist (aka the “facilitator”) are being held on Wednesdays at 4:30 PM to maximize attendance. The department’s audience response system was set so that each resident was assigned his/her own clicker, so that responses could be recorded and evaluated. Each group was assigned a clicker so that the group answers could be recorded as well. The following format was followed: (a) reading material e-mailed in advance; (b) each session starts with a 10-question quiz (aka the readiness assurance test, or RAT) based on the reading material, with two questions referred to topics discussed in previous sessions (10 min); (c) same test given but answered by the residents as a group using their group clickers (10 min); (d) questions reviewed and answers appealed (15 min); and (e) concept application (25 min). Cases are chosen by the facilitator to emphasize the important concepts. The residents evaluate the curriculum after every four sessions. Residents' performance is graded based on their performance on the (a) individual quiz, (b) group quiz, (c) mock oral board exam given halfway through and at the end of the course, and (d) performance on the neuroradiology section of the in-service in 2013.

RESULTS: This is an ongoing curriculum that will be completed and results analyzed before the 2013 AUR meeting. I will have data on residents’ performance by level, on the in-service, and several months of evaluations of the curriculum by the residents. In-service scores will be compared to data accumulated during the past 10 years.

CONCLUSION: Team-based learning is expected to be more effective than the traditional didactic or case-based curricula in teaching neuroradiology to the radiology residents. It led to better attendance to conference, to discussions, and to a more interactive environment better suited for adult education. Already the residents approve of the more interactive format.

* Faculty financial disclosures are located in the Faculty Index.
(SS05-08) 3:10 PM
Is There an Association between Abnormal MR Imaging Signal Intensity of Nerves around the Elbow and Professional Baseball Pitching?
Shrey K. Thawaid, MD, Bridgeport Hospital, Bridgeport, CT; Sahar J. Farahani; Shadpour Demehri, MD; Avneesh Chhabra, MD*
(s.thawai2@hhmi.edu)
PURPOSE: Repetitive microtrauma due to frequent throwing results in increased susceptibility to peripheral nerve injury in the professional baseball pitcher. The purpose of this study is to evaluate the association between abnormal T2 hyperintensity of the peripheral nerves around the elbow joint and professional baseball pitching.

METHOD AND MATERIALS: Axial fat-saturated T2W images were retrospectively reviewed for presence of abnormal T2 hyperintensity of the radial, median, and ulnar nerves around the elbow joint, which was defined as similar or higher signal intensity than the adjacent vessels. Following the blinded review of MR images, the frequency of abnormal T2 hyperintensity of the nerve was calculated in professional pitchers and nonpitchers. A univariate model was designed to examine the probability of significant difference in these two groups. To adjust for the effect of confounding factors and nonnormality of data distribution, a multivariate regression model was used.

RESULTS: Thirty-four subjects (11 F, 23 M; age, 49 ± 15 years) were nonpitchers, while 40 subjects (1 F, 39 M; age, 24 ± 5.8 years) were professional pitchers. Radial nerve hyperintensity was seen in 2/34 (6%) of the nonpitchers and 9/40 (23%) of the pitchers (P value, .06). Median nerve hyperintensity was seen in 3/34 (9%) of the nonpitchers and 10/40 (25%) of the pitchers (P value, .05). Ulnar nerve hyperintensity was seen in 13/34 (38%) of the nonpitchers and 19/40 (47.5%) of the pitchers (P value, .42). T2 hyperintensity values of median and radial nerves were close to being significant. After adjusting the model for age and sex as confounding factors and nonnormality of median and radial nerve data distribution, no significant difference between the professional pitchers and nonpitchers in terms of frequency of hyperintensity of the selected nerves was detected.

CONCLUSION: The results indicate that abnormal T2 hyperintensity of the peripheral nerves around the elbow joint is seen commonly in professional pitchers, although the difference was not significant statistically. A larger sample with a normal asymptomatic population which will serve as control cases might be helpful in examining the possible association.

(SS05-09) 3:20 PM
Radial Neuropathy: Reliability and Accuracy of 3-T MR Neurography
Majid Chalian, MD, Johns Hopkins Hospital, Baltimore, MD; Filippo Del Grande, MD*; Sahar J. Farahani; John Eng, MD; John A. Carrino, MD, MPH*; Avneesh Chhabra, MD* (m.chalian@gmail.com)
PURPOSE: The purpose was to evaluate the accuracy and interobserver reliability of qualitative features of radial neuropathy at 3-T (Tesla) magnetic resonance neurography (MRN).

METHOD AND MATERIALS: MRN examinations of the radial nerve (RN) performed over a period of 1 year were reviewed by three blinded independent musculoskeletal radiologists according to predefined criteria. A total of 41 examinations, 14 cases and 27 controls, were included. A combination of EMG, surgery, and clinical findings was considered as the reference. The following findings were assessed: overall normality, RN signal intensity (SI), size, course, fascicular morphology, regional skeletal muscle changes, neuroma, extensor carpi radialis brevis (ECRB) thickening, lateral intermuscular septum (LIS) entrapment, prominent radial recurrent vessels, and lateral epicondylitis. Pairwise interobserver value (weighted κ statistics) and 95% confidence intervals (CIs) were calculated by using the bootstrap technique with 1000 samples. Also, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy were calculated cumulatively and for each reader.

RESULTS: There was no statistical difference between cases and controls regarding age and gender (P > .05). There was very good (κ > 0.80) to good (κ > 0.60) interobserver agreement regarding all variables. Fascicular morphology, LIS entrapment, and ECRB thickening were the only variables with moderate (κ > 0.40) interobserver reliability, just between two readers. Cumulative sensitivity, specificity, PPV, NPV, and accuracy were 71%, 90%, 79%, 86%, and 84%. Sensitivity was statistically different between two readers (P < .05). There were no other statistical differences between sensitivity, specificity, PPV, NPV, and accuracy among the readers (P > .05).

CONCLUSION: MRN has good interobserver reliability for detection of RN pathologies. Additionally, MRN has sufficient diagnostic value to warrant the testing of abnormal nerve features as potential diagnostic criteria.

Thursday, April 11, 2013
2:00–3:30 PM

SS06: RAHSR Session
Location: Diamond Ballroom Salon 6
Moderator: Paul P. Cronin, MBBC

(SS06-01) 2:00 PM
Assessing Early Imaging Utilization in Older Adults with Back Pain by Using Multiple Data Sources
Brian W. Brensahan, PhD*, University of Washington Harborview Medical Center, Seattle, WA; Sean Rundell, MS; Bryan A. Comstock; Richard Deyo; Sean D. Sullivan, PhD; Jeffrey G. Jarvik, MD, MPH*
PURPOSE: The purpose was to describe back-related diagnostic imaging, focusing on early imaging, from Medicare claims and a large multisite back pain registry.

METHOD AND MATERIALS: We conducted descriptive analyses on two data sets to assess early imaging utilization following index visits for back pain. We identified patients using ICD-9 code for radiograph, magnetic resonance (MR), or computed tomography (CT) ≤42 days after the index visit. For the Medicare analysis, we used a 20% sample from 2004 Medicare Parts A and B and selected patients ≥67 years of age with an index visit. We excluded patients with diagnosis codes for spinal neoplasm, infection, fracture, or inflammatory arthritis within 1 year prior to the index visit. For the registry analysis, we used data from the Back pain Outcomes using Longitudinal Data (BOLD) project, which is a cohort of ~5000 patients ≥65 years old presenting to primary care with a new visit for back pain. The BOLD participants are from three integrated health systems in California, Michigan, and Massachusetts. We used the health systems’ electronic health care utilization records to identify early imaging use subsequent to the index visit. We generated descriptive statistics for the cohort and determined cumulative incidence of early imaging.

RESULTS: We generated a random sample of 70,000 eligible Medicare patients based on inclusion criteria (mean age = 77; 69.6% female). A total of 33,552 (47.9%) received imaging procedures any time after the index visit, and 28,970 (41.4%) received early imaging. The majority of Medicare beneficiaries with early imaging received radiographs—23,625 (81.5%); while 4974 (17.2%) and 825 (2.9%) received early MR and CT, respectively. For the BOLD sample, as of March 2012, a total of 2990 patients were enrolled (mean age = 74; 65% female). A preliminary BOLD sample indicated that 476 (33%), 174 (39%), and 63 (18%) participants had early imaging at three distinct HMO health systems.

* Faculty financial disclosures are located in the Faculty Index.
CONCLUSION: Preliminary descriptive results from the BOLD registry suggest that the cumulative incidence of early imaging in newly diagnosed elderly back pain patients at HMOs is lower compared to a national Medicare sample.

(SS06-02) 2:10 PM Analysis of Discordant Interpretation of Outsources CT Pulmonary Angiography

Chenchan Huang, MD, Mount Sinai Medical Center, New York, NY; Amish Patel, MD; William L. Simpson, MD* (chenchan.huang@gmail.com)

PURPOSE: In an effort to increase quality and timeliness, many hospitals have outsourced preliminary interpretation of off-hour imaging studies. The quality of the teleradiologist’s interpretation is assumed to be similar to that of an in-house radiologist attending. We present our experience with interpretation quality of outsourced off-hour CT pulmonary angiograms.

METHOD AND MATERIALS: The reports of CT pulmonary angiograms from the same 3-month period over 3 consecutive years were reviewed, and comparison was made between the preliminary and final interpretation with regard to presence of acute pulmonary embolism (PE).

RESULTS: A total of 394 CT pulmonary angiograms were performed after hours in the months of October, November, and December in the years 2007, 2008, and 2009 (94, 132, and 168 studies, respectively). 280 (71%) of these studies had discordant interpretation and 114 (29%) had discordant interpretation by the teleradiologist and in-house attending. Twenty-one (18%) discordant interpretations were the result of the teleradiologist excluding acute PE but the in-house attending finding evidence of acute PE. Ninety-two (81%) discordant interpretations were the result of acute PE being excluded by the teleradiologist but the in-house attending assessing the study as inadequate to rule out PE. One (1%) discordant interpretation was the result of acute PE being diagnosed by the teleradiologist but the in-house attending finding no evidence of acute PE.

CONCLUSION: Discordant interpretation of outsourced CT pulmonary angiograms is common. The quality provided by the teleradiologist should not be assumed equal to that of the in-house attending radiologist.

AUR Trainee Prize: 2nd Place

(SS06-03) 2:20 PM Effect of Computerized Physician Order Entry on the Quality of Physician Referrals for Abdominal CT Scans

Andrew J. Herzik, Cedars-Sinai Medical Center, Los Angeles, CA; Ximin Li, BS, MED, MPH; Paul Silka, MD; Irene Chen, MD; Mamata Chithrik, MD; Joshua Pevnick, MD, MSPH (Joshua.Pevnick@cshs.org)

PURPOSE: Clinical context improves image interpretation. We measured indication quality before and after computerized physician order entry (CPOE) implementation, to understand the effect of ordering interface on clinical context.

METHOD AND MATERIALS: Prior work (Alkasab, 2009) shows indication quality improved when an institution-specific CPOE system replaced institution-specific paper order forms for emergency department abdominal CT scans (ACTSs). However, most inpatient ACTSs rely on free-text paper orders or vendor CPOE. Also, only a single unvalidated scoring rubric (Stavem, 2004) was used. On 3/3/12, Cedars-Sinai Medical Center changed from free-text paper orders to a common vendor CPOE (Epic). The CPOE interface for ordering imaging allows selection of study-specific indications and/or free text. We randomly selected 100 inpatient ACTSs from two time periods: (1) paper period: 1/1/12–2/28/12; and (2) CPOE period: 5/1/12–6/31/12. We excluded 3/1/12–4/30/12 to allow for adoption time. For each ACTS, we obtained the indication available to the radiologist. We assessed indication quality in two ways. First, we used the aforementioned explicit scoring rubric. Two blinded readers independently used a 0–2 scale (0 = no information, 2 = detailed information) across four criteria: signs and symptoms, abnormal lab values, prior history, and relevant clinical question. Second, two blinded radiologists with experience reading ACTSs rated indication quality independently using a global implicit Likert scale (“To interpret an ACTS, the following clinical indication is extremely helpful:” 1 = strongly disagree to 7 = strongly agree). We summed the four explicit quality scores to get a global explicit quality score. We calculated mean global scores for the paper and CPOE periods using both explicit and implicit scoring.

RESULTS: During the paper and CPOE periods, the mean global explicit scores (and 95% CIs) were 1.4 (1.2–1.6) and 2.7 (2.4–2.9), respectively (P < .001). The mean global implicit scores were 4.3 (4.0–4.6) and 5.4 (5.2–5.6), respectively (P < .001).

CONCLUSION: When a common vendor CPOE interface replaced free-text paper-based ordering, indication quality for inpatient ACTSs improved, as demonstrated by two independent scoring systems.


Hamid Chalian, MD, Northwestern Memorial Hospital, Chicago, IL; Thomas H. Grant, DO; Daniel Ganger; Vahid Yaghmai, MD (hamid.chalian@gmail.com)

PURPOSE: Mainly in patients with chronic liver conditions, assessment of fibrosis and of progression to cirrhosis is of utmost importance in medical management. Until recently, liver biopsy was the only method to assess fibrosis and was considered the gold standard. Currently, several noninvasive methods (FibroScan®, EchoSens, Paris, France), acoustic radiation force impulse [ARFI] imaging, MR elastography, and serologic fibrosis markers) give comparable quality information on the stage of fibrosis and may significantly decrease the number of liver biopsies performed. We aimed to analyze the additional charges of ultrasound (US)-guided fine-needle biopsy compared to ARFI imaging for assessment of liver fibrosis and cirrhosis in the United States.

METHOD AND MATERIALS: The average cost of US-guided liver biopsy was estimated based on both direct (US guidance, liver biopsy, and pathology read) and indirect (major and minor complications) estimation of charges. The risks for minor complications not requiring hospitalization, such as pain and bleeding (39%), and for major complications requiring hospitalization (2%) were extracted from the literature. The cost of a major complication was estimated by adding the cost of a hospital room for one night to the cost of transfusion of one unit of blood. The relative charges related to an episode of major or minor complication were estimated at $1533 and $605, respectively. A decision tree was used to calculate the total additional charges of US-guided liver biopsy. The actual dollar values are considered proprietary information. Therefore, these values were converted to a ratio by dividing each by the cost of US. The ratios of complications to US-guided liver biopsy were $3.44 and $3.24, respectively. Considering the complication rates, the cost for US-guided fine-needle biopsy was 8.67 times the cost of ARFI imaging.

CONCLUSION: In the United States, it is estimated that US-guided fine-needle biopsy imposes on the health system an 8.67 times increase in cost in comparison with ARFI imaging. In selected patients, ARFI imaging may replace the need for liver biopsy, with substantial cost savings to the health system.

* Faculty financial disclosures are located in the Faculty Index.
Through group activities and small-group projects, the program has resulted in a successful CT dose reduction initiative, empowerment of faculty and staff within our department. Group topics include leadership development, problem solving, quality assessment/improvement tools, personnel management, and diversity. Readings on leadership are assigned for required review before each session, with group discussions led by a different team of fellows each week. The cornerstone of the program is a set of intensive group projects. Each of three groups selects and executes a project designed to provide a solution for a problem central to patient care. Results of the projects are presented at a formal year-end event.

**RESULTS:**
The Emory RLA has been an overwhelming success in the empowerment of faculty and staff within our department. Group projects have resulted in a successful CT dose reduction initiative, a radiology service excellence institute, and a program educating radiologists, nonclinical research faculty, technologists, radiology nurse practitioners and physician assistants, administrative managers, staff physicists, and information technologists. Protected time is arranged for each fellow to attend a full day of scheduled activities every month. The program is led by faculty/staff advisers and a core executive committee including the department chair. Each of the sessions includes lectures, group discussions, and small-group activities. Topics of early sessions include organizational structure, finances, and functioning of the department. Other topics include leadership development, problem solving, quality assessment/improvement tools, personnel management, and diversity.

**CONCLUSION:**
The Emory Radiology Leadership Academy is a model program for development of faculty and staff leadership skills. Through group activities and small-group projects, the program has resulted in major improvements in patient care in our department.

**METHOD AND MATERIALS:**
In its 4th year, the Emory Radiology Leadership Academy (RLA) is a yearlong faculty and staff development program. Approximately 12 participants are selected each year by an executive committee using nominations from prior participants and department leaders. The groups of fellows have included faculty radiologists, nonclinical research faculty, technologists, radiology nurse practitioners and physician assistants, administrative managers, staff physicists, and information technologists. Protected time is arranged for each fellow to attend a full day of scheduled activities every month. The program is led by faculty/staff advisers and a core executive committee including the department chair. Each of the sessions includes lectures, group discussions, and small-group activities. Topics of early sessions include organizational structure, finances, and functioning of the department. Other topics include leadership development, problem solving, quality assessment/improvement tools, personnel management, and diversity. Readings on leadership are assigned for required review before each session, with group discussions led by a different team of fellows each week. The cornerstone of the program is a set of intensive group projects. Each of three groups selects and executes a project designed to provide a solution for a problem central to patient care. Results of the projects are presented at a formal year-end event.

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**CONCLUSION:**
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**METHOD AND MATERIALS:**
A new fluoroscopy system with an integrated dose reduction program, compared with a radiology service excellence institute, and a program educating the faculty and staff of a large academic medical center.

**PURPOSE:**
The Emory Radiology Leadership Academy is a model program for development of faculty and staff leadership skills. Through group activities and small-group projects, the program has resulted in major improvements in patient care in our department.

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The Emory RLA has been an overwhelming success in the empowerment of faculty and staff within our department. Group projects have resulted in a successful CT dose reduction initiative, a radiology service excellence institute, and a program educating radiologists, nonclinical research faculty, technologists, radiology nurse practitioners and physician assistants, administrative managers, staff physicists, and information technologists. Protected time is arranged for each fellow to attend a full day of scheduled activities every month. The program is led by faculty/staff advisers and a core executive committee including the department chair. Each of the sessions includes lectures, group discussions, and small-group activities. Topics of early sessions include organizational structure, finances, and functioning of the department. Other topics include leadership development, problem solving, quality assessment/improvement tools, personnel management, and diversity. Readings on leadership are assigned for required review before each session, with group discussions led by a different team of fellows each week. The cornerstone of the program is a set of intensive group projects. Each of three groups selects and executes a project designed to provide a solution for a problem central to patient care. Results of the projects are presented at a formal year-end event.

**CONCLUSION:**
The Emory Radiology Leadership Academy is a model program for development of faculty and staff leadership skills. Through group activities and small-group projects, the program has resulted in major improvements in patient care in our department.
METHOD AND MATERIALS: In this IRB-approved prospective study, 166 photographs were obtained from 41 patients when they were undergoing portable chest radiography. Consecutively obtained radiographs from the same patients were chosen to generate 83 unique pairs (new and prior for comparison) for interpretation. The radiographs were combined with the corresponding photographs obtained at the time of imaging, to generate composite radiograph-photograph pairs. To simulate wrong-patient errors, mismatched pairs were generated by pairing radiographs from different patients chosen randomly from the 41 patients. Eighty-seven radiologists, with 21.14 ± 10.14 (mean ± SD) years of experience, each interpreted a unique randomly chosen set of 10 radiographic pairs. Error pairs were introduced at the rate of 5%–10%. Radiologists were randomly assigned to interpret radiographs either with or without photographs. They evaluated (a) image quality; (b) whether support lines and tubes, if any, were appropriately positioned; and (c) patient status. A free-form text field was provided for any other comments. For every radiologist, the number of mismatches (error pairs) identified during interpretation was enumerated, and the time for interpretation of each radiograph was also recorded by our viewing software.

RESULTS: The number of errors detected increased significantly from 28.57% (8/28) to 82.14% (23/28) with the introduction of photographs ($\chi^2$ test, $P < .001$). There was no significant ($P = .66$) change in interpretation time: Interpretation times without and with photographs were 59:55 ± 22:05 and 62:12 ± 25:18 minutes, respectively.

CONCLUSION: Facial photographs obtained at the point of care of portable chest radiography can significantly increase the identification of any wrong-patient errors during interpretation, without significant changes in interpretation time. Facial photographs have the potential to positively impact patient safety.

### RAHSR-ACR Award

**Is It Cost-effective to Perform CT Perfusion in Asymptomatic Patients with Aneurysmal Subarachnoid Hemorrhage?**

Jana Ivanidze, MD, PhD, Weill Cornell Medical Center, New York, NY; Ajay Gupta, MD*; Alan Segal, MD; Pina C. Sanelli, MD, MPH (jai9018@nyp.org)

PURPOSE: Aneurysmal subarachnoid hemorrhage (aSAH) is a devastating illness with long-term disability resulting in a substantial burden on health care resources. Cerebral vasospasm and delayed cerebral ischemia (DCI) are leading causes of morbidity and mortality in aSAH. CT angiography (CTA) and CT perfusion (CTP) have been shown to detect perfusion deficits thought to occur in DCI and vasospasm and thus have been added as complementary diagnostic tools in symptomatic patients. However, it is uncertain if performing CTA/CTP in asymptomatic patients improves outcomes. The purpose of this study is to determine the cost-effectiveness of CTA/CTP in asymptomatic patients.

METHOD AND MATERIALS: A decision analytic model was developed to assess health outcomes of aSAH patients with different clinical scenarios (symptomatic or asymptomatic for vasospasm and/or DCI) incorporating CTA/CTP, to determine cost-effectiveness. The results of each diagnostic test led to management options based on clinical decision making derived from consultation with specialists and published guidelines. The probabilities are derived from a cohort of aSAH patients ($n = 97$) enrolled in an IRB prospective trial at our institution. Long-term outcomes are represented as full recovery, disability, or death, based on the International Subarachnoid Aneurysm Trial (ISAT). Quality-adjusted life-years (QALYs) are used to determine effectiveness. Costs were derived from the literature and 2012 Medicare rates.

RESULTS: Cost-effectiveness (CE) parameters derived from the model for the symptomatic and asymptomatic patients are $148,544/13.75$ and $144,969/13.99$, respectively. The CE ratios for the symptomatic and asymptomatic patients are $10,800.69$ and $10,359.86$, respectively.

CONCLUSION: The goal in managing aSAH patients is to maximize QALYs, minimize costs, and maximize societal net health benefit. Performing CTA/CTP is cost-effective for both symptomatic and asymptomatic patients. Specifically, CTA/CTP in asymptomatic patients demonstrasted increased QALYs and lower costs compared with symptomatic patients, further supporting its use in asymptomatic patients for improved outcomes.

*Faculty financial disclosures are located in the Faculty Index.
AUR 2013 Research Poster Abstracts

Research posters are located in Platinum Ballroom Salon E. Each poster will be presented by its author during AMA PRA Category 1 Credit™ poster sessions scheduled for 7:00–8:15 AM, Wednesday and Thursday. The day and time follow 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 dark blue.

Cardiopulmonary Radiology

**AUR Trainee Prize: 1st Place**

(R-15) Wednesday • 7:00 AM
A Novel Analysis Algorithm for Quantitative Assessment of Myocardial CT Perfusion
Nabeel Ali, Albany Medical College, Albany, NY; Gary Liew; Synho Do; Milena Petranovic, MD; Ricardo Cury; Thomas Brady, MD*; et al

**PURPOSE:** Cardiac computed tomography (CT) has emerged as a robust modality for imaging coronary stenosis and has recently been used to evaluate myocardial abnormalities such as ischemic perfusion defects and infarction. Currently, there is limited commercially available software to allow automatic segmentation and reporting of myocardial Hounsfield unit (HU) values. This function may be important for imaging researchers to define ranges of tissue densities in normal myocardium or ischemic myocardium (defects at stress vs rest) or at sites of infarction. We have developed an image analysis algorithm that addresses this issue.

**METHOD AND MATERIALS:** The algorithm was developed by using MATLAB® (Mathworks, Natick, MA) software. The algorithm semi-automatically segments two-dimensional short-axis reformatted DICOM images of the left ventricle into regions of interest (ROIs) in accordance with American Heart Association (AHA) standards and is capable of creating nine further ROI subsegments. This includes separate endocardial, mid, and epicardial layers. Image intensity values (Hounsfield units) and relative myocardial thickness are quantitatively reported for each individual ROI and segment.

**RESULTS:** The developed algorithm yields good interobserver reproducibility, allows for comparative measures to be made with greater accuracy due to automation, and allows dramatically reduced times to quantitatively evaluate the myocardium. The algorithm allows comparison of the Hounsfield unit values at the same ROI locations between rest and stress. The reproducibility is very good: ICC of 0.89 for rest images and 0.83 for stress images. The mean time for generating ROIs for the entire heart was 11 minutes versus 22 minutes for manual tracing.

**CONCLUSION:** We have developed a novel image analysis algorithm that allows semiautomated rapid quantitative assessment of CT myocardial perfusion images. The algorithm segments short-axis DICOM images and reports the CT intensity values of numerous ROIs of the myocardium. We hope that the algorithm will facilitate investigators’ tasks of defining and validating appropriate reference values for normal, ischemic, and infarcted myocardium.

(R-16) Thursday • 7:00 AM
Diagnosing Emergent Findings on Chest and Abdominal Radiographs by Using the New iPad
Aashim Bhatia, MD; William F. Burke III, MD; Jose Pizarro; Chetan D. Rajadhyaksha, MD; Vinay Bhatia, Mount Sinai Medical Center, Miami, FL

**PURPOSE:** The FDA-approved mobile application MIM has improved the radiologist’s access to radiologic imaging for interpretation away from the traditional workstation. The MIM application has been approved for evaluation of computed tomography, magnetic resonance, and nuclear medicine imaging due to the low-resolution requirements of these modalities for interpretation on a mobile device. With the new iPad high-resolution retina display, evaluation of emergent findings on radiographs is now a possibility.

**METHOD AND MATERIALS:** Radiographs over a 6-month period were uploaded to MIMcloud™ and viewed on the new iPad for interpretation for acute findings by three board-certified radiologists and two radiology residents. Pneumothorax, fracture, and free air, among other variables, were diagnosed on radiographs of the chest and abdomen. After a 2-week interval, the same studies were viewed on a traditional workstation.

**RESULTS:** Intraobserver and interobserver variability demonstrated high accuracy of diagnosing emergent findings on radiographs. Statistical values were measured by using κ values.

**CONCLUSION:** The data, statistical analysis, and evaluations demonstrated accurate diagnosis of emergent findings on radiographs by using the new iPad and an improved response time for on-call radiologists.

Education

(R-23) Wednesday • 7:00 AM
Teaching Opportunities for Radiology Residents: A Survey of Program Directors and Residents
Chiemezie C. Amadi, MD, Allegheny General Hospital, Pittsburgh, PA; Robin L. Greenspan, MD; Matthew S. Hartman, MD

**PURPOSE:** The purpose was to explore teaching opportunities for radiology residents and whether early exposure to medical student teaching makes residents more or less likely to enter academic radiology.

**METHOD AND MATERIALS:** Two anonymous, voluntary, online multicenter nationwide surveys of radiology residency program directors and radiology residents were conducted, with the assistance of the ACR and Association of Program Directors in Radiology (APDR). Program directors and residents were asked about availability of optional or mandatory medical student teaching requirements, resident interest in teaching, level of support for resident teachers by their residency programs, and the impact of medical student teaching on the decision to enter academic radiology.

**RESULTS:** A total of 71 program directors and 79 residents participated in the respective surveys. All residency programs have medical students on rotation. Most (>90%) residency programs offer residents the opportunity to partake in medical student teaching. Most residents (>75%) have been or are currently involved in formal classroom or informal (at the workstation, during procedures, case

* Faculty financial disclosures are located in the Faculty Index.
conferences, posters, etc) medical student teaching. Most program directors (84%) rate the enthusiasm of the residents for teaching as high or extremely high. Most programs (81.1%) offer no training to improve resident teaching. Most residents (41.7%) felt that early exposure to teaching stimulated their interest and made them more likely to pursue academic careers.

**CONCLUSION:** Most radiology residency training programs offer residents the opportunity to be involved in medical student education. Enthusiasm for medical student teaching is high among American radiology residents, and most participate in medical student teaching. However, training, encouragement, and support for residents involved in medical student teaching are not available in most training programs. Early resident opportunities, training, and support of medical student teaching have the potential to increase resident interest in academic radiology and improve medical student education.

(R-24) Thursday • 7:00 AM
**Effects of Adding a Simulated Resident Readout Experience to the Standard Observational Rotation for 3rd-Year Medical Students: Preliminary Experience from a Randomized Controlled Educational Trial**

Michael Weiss, MD, Brigham and Women’s Hospital, Boston, MA; Glenn C. Gaviola, MD; Donald N. DiSalvo, MD (meweiss@partners.org)

**PURPOSE:** The purpose was to prospectively determine the educational value to medical students of simulated readout sessions during their radiology clerkship.

**METHOD AND MATERIALS:** Third-year medical students rotating through our institution’s MSK radiology section each month are randomly assigned to either the control arm or to the intervention. The control arm experiences the current standard curriculum, including an unstructured observational rotation in the reading room. The intervention arm undergoes the simulated readout in addition to the standard educational experience. The students in the intervention arm individually review a set of images for up to 30 minutes and prepare preliminary interpretations. The students then each review the cases with a board-certified MSK radiologist and have a one-on-one readout session for approximately 30 minutes. Both arms answer a questionnaire consisting of 10 questions: five multiple-choice questions aimed at rating the students’ clinical knowledge in MSK radiology, and five questions assessing their subjective feelings and opinions about radiology by using a Likert 5-point scale. The control group is given the questionnaire at the conclusion of the MSK radiology rotation. The intervention group answers the questionnaire twice, prior to and after the educational intervention.

**RESULTS:** Data are currently being collected. Preliminary data analysis will be completed prior to the AUR annual meeting. Anecdotal results based on student feedback show improvement in the medical students’ knowledge of MSK radiology, as well as in their opinions about radiology, when they experience one-on-one simulated teaching sessions, which are not currently part of the standardized curriculum.

**CONCLUSION:** Anecdotal experience suggests that 3rd-year medical students benefit from one-on-one MSK radiology teaching sessions that simulate the resident readout. We expect that this study will show improvement in the students’ clinical knowledge, as well as their understanding of the role of radiology and feelings toward the specialty.

(R-25) Wednesday • 7:00 AM
**Improving Radiology Resident Knowledge about Practice Quality Improvement, Systems-based Practice, and Practice-based Learning and Improvement: Impact of a Dedicated Practice Quality Improvement Conference for Radiology Residents**

Allyson L. Chesebro, MD, Brigham and Women’s Hospital, Boston, MA; Glenn C. Gaviola, MD (achesbro@partners.org)

**PURPOSE:** The purpose was to increase radiology residents’ awareness of the principles of practice quality improvement (PQI) determined by the Accreditation Council for Graduate Medical Education (ACGME) core competencies, determine understanding of the PQI project requirement for the American Board of Radiology (ABR), and provide a forum for discussing and applying these principles to develop PQI projects during residency.

**METHOD AND MATERIALS:** Residents at our institution participated in an initial survey to determine their baseline knowledge and attitudes about statements regarding the effectiveness of a resident conference dedicated to the principles of PQI, opinions about radiologists participating in PQI projects, and perceived competency to perform a PQI project on their own. An interactive conference explaining the importance of PQI, the principles and requirements of a PQI project, and the steps to perform a PQI project followed. The residents then participated in a small-group discussion in which they applied newly taught PQI methods by discussing one of three potential PQI projects. A postconference survey was conducted and compared to the initial survey. Paired Student’s t test analysis was performed.

**RESULTS:** Following the conference, resident knowledge was statistically higher than baseline knowledge (mean ± SD, 69.6% ± 14.8% vs 35.1% ± 17.9%; P < .001). Opinions regarding effectiveness of a PQI conference (3.8 ± 1 vs 3.3 ± 1; P = .04) and perceived competency to conduct a PQI project (3.5 ± 0.9 vs 2.4 ± 1; P < .001) were significantly higher after the PQI conference. Attitudes about the importance of radiology residents and radiologists participating in PQI projects did not differ statistically from preconference opinions (3.7 ± 1 vs 3.4 ± 1; P = .22).

**CONCLUSION:** A dedicated conference with small-group discussion and application of PQI principles and methods during residency increases residents’ knowledge while improving their perceived competency to complete a PQI project. Radiology residency programs should consider the development of a conference dedicated to the principles of PQI to increase awareness of specific ACGME core competencies and ABR requirements.

(R-27) Wednesday • 7:00 AM
**National Web-based Practice Quality Improvement Program for CT Safety in Children: State of Practice and Feedback after 3 Years of Use**

Amy C. Rowell, MD, Cincinnati Children’s Hospital Medical Center, Cincinnati, OH; Marilyn J. Goske, MD; Daniel McLinden; Seth Hall; Bin Zhang (amy.rowell@cchmc.org)

**PURPOSE:** Practice quality improvement (PQI) is a mandatory component of maintenance of certification (MOC) required by the American Board of Radiology (ABR). In 2009, we created an interactive Web-based tutorial that provided a framework and educational materials for implementing a PQI project in CT safety for children. The purpose was to determine utilization, practice patterns, and feedback from participants as to their satisfaction with this educational tool.

**METHOD AND MATERIALS:** This project received an education exemption from the IRB. The PQI module is hosted on the Image Gen- 
thly®, SPR, and ABR Web sites. The built-in survey tool was housed on a secure commercial Web site (NetTuner Corp, Tampa, FL). The data

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from the 10 survey questions were converted to an Excel spreadsheet (Microsoft Business, Redmond, WA) for statistical analysis. A numeric (from 0 to 3) was assigned to the response for 10 practice metrics, and results were measured and compared from practice to practice. A learning exercise was provided that allowed radiologists to input data for CT dose estimates from their site.

RESULTS: From July 2009 to July 2012, a total of 175 users started the program. 69/175 (39%) completed the online metrics survey. A sample of data from the survey for five of the 10 metrics showed 62% of sites provided parents with information about CT radiation safety, 20% used breast shields for CT, 85% documented contrast allergy, 51% documented LMP when applicable, and 67% performed single-phase scanning. 56/69 (81%) of users entered all or part of their CT dose data, of which 14 (25%) could correctly identify the CTDI phantom that was used. Forty-eight percent (n = 33) rated the module as good or great, and 51% (n = 35) agreed that the module instructions were easy to follow.

CONCLUSION: PQI is a new requirement by the ABR. Our results suggest that the number of users of the project is less than might be expected. The survey results suggest that quality metrics related to implementation and documentation of the performance of 10 quality metrics in pediatric CT scans remain challenging. The feedback data will be used to revise the module.

(R-28) Thursday • 7:00 AM
Ultimate Publication Rate of Unpublished Manuscripts Listed on Radiology Residency Applications
Lars J. Grimm, MD*, Duke University, Durham, NC; Charles M. Maxfield, MD (lars.grimm@duke.edu)

PURPOSE: This study is designed to assess the ultimate publication rate of unpublished manuscripts listed on radiology residency applications.

METHOD AND MATERIALS: A retrospective review was performed on all 628 Electronic Residency Application Service applications submitted to a single institution's radiology residency program in 2010. Manuscripts cited by the applicant as "accepted," "in press," "provisional accepted," or "submitted" were assessed 2 years after the application by searching PubMed and journal or conference specific Web sites. Manuscripts were classified as published if they appeared in a peer-reviewed journal with the author included. Conference proceedings listed in journal supplements were excluded. The final journal of publication was compared with the journal listed. Journal impact factors were referenced from the Web of Knowledge database.

RESULTS: Five hundred fourteen (81.8%) of the 628 applicants listed a total of 1431 manuscripts: 952 (66.5%) were reported as "published," 159 (11.1%) as "accepted," 27 (1.9%) as "provisional accepted," and 293 (20.5%) as "submitted." After 2 years, 67.9% (108/159) of manuscripts reported as "accepted" or "in press," 70.4% (19/27) of manuscripts reported as "provisional accepted," and 43.7% (128/293) of manuscripts reported as "submitted" at the time of application were published (< .01). The journal listed in the application ultimately published the manuscript in 100% (108/108) of "accepted" or "in press," 84.2% (16/19) of "provisional accepted," and 50.8% (65/128) of "submitted" manuscripts (< .01). The impact factor of the listed versus final journal of publication was 2.805 versus 2.836 (< .01) for "provisional accepted" and 4.189 versus 2.898 (< .01) for "submitted" manuscripts, respectively.

CONCLUSION: Among unpublished manuscripts listed on radiology residency applications, only 67.9% listed as "accepted" or "in press," 70.4% listed as "provisional accepted," and 43.7% listed as "submitted" were ultimately published. There was also a statistically significant decrease in impact factor of the journal that ultimately publishes "submitted" manuscripts. Program directors and residency selection committees should consider these rates of publication when assessing applicants.

(R-29) Wednesday • 7:00 AM
Monotonic Responses in Radiology Education Evaluations
Jared Bailey, MD, Indiana University School of Medicine, Indianapolis, IN; Jennifer Steele, MS; Richard B. Gunderman, MD, PhD (jarebaili@iuui.edu)

PURPOSE: A monotonic response occurs when an evaluator selects the same numeric value for all questions on an evaluation form. From a psychometric point of view, such responses usually indicate that the evaluator has not read and responded to each distinct question, compromising the value of the assessment. The Accreditation Council for Graduate Medical Education (ACGME) requires that residents evaluate faculty and faculty evaluate residents regularly. We conservatively estimate that this requirement produces over 220,000 evaluations within the diagnostic radiology training community each year. We have evaluated our own residency program to determine the frequency of monotonic responses and their association with free-text responses.

METHOD AND MATERIALS: We retrospectively reviewed one academic year of anonymous evaluation data for the period July 2010 to June 2011. Data were divided into resident of faculty (ROF) and faculty of resident (FOR) evaluations. Evaluations included required numeric responses to 12 or 13 questions scored on a 1–9 Likert scale and an optional free-text response. The data were analyzed for monotonic responses and for the presence or absence of optional free-text response.

RESULTS: During the single academic year, 2046 and 1944 evaluation requests were sent electronically to 60 residents and 96 staff, respectively, of which 1859 and 1524 were completed (90.86%, 78.39%). Of the 1859 ROF and 1524 FOR evaluations, 981 and 745 were completed with monotonic responses (52.54% and 48.88%). Of the completed ROF and FOR evaluations, 1304 and 936 did not include any optional free-text response (70.14% and 61.66%). The Pearson correlation coefficient between monotonic responses and the absence of free-text response in the FOR group is r = 0.69 (95% CI: 0.548, 0.793). The correlation between monotonic responses and the number of completed evaluations in the FOR group is r = 0.65 (95% CI: 0.49, 0.76).

CONCLUSION: The high number of monotonic responses raises questions about the value of the data being collected. The moderate to high correlation between numbers of evaluations completed, monotonic responses, and the absence of free-text responses may suggest the development of "survey fatigue."

(R-31) Wednesday • 7:00 AM
How Do Residents Learn? Radiology Resident Perceptions on Learning—A Longitudinal Study
Margaret H. Mulligan, PhD, MS, Medical College of Wisconsin, Milwaukee, WI; Cesar Lam, MD; Guillermo F. Carrera, MD

PURPOSE: One of the core assumptions of andragogy (adult learning theory) is based on the self-directedness of a learner and the individual's need for structure in a learning environment. In light of technological advancements, sophisticated learners bringing technology into training, new requirements from the Accreditation Council for Graduate Medical Education, and changes in radiology training and certification, we began an IRB-approved multipart study of teaching and learning in radiology, with the intent of understanding how resident learning occurs. The first phase focused on capturing radiology residents' perceptions of how they learn. Additional phases will focus on implications to curriculum, whether changes are needed, and faculty perceptions of teaching.

METHOD AND MATERIALS: Starting in fall 2008, residents began monthly rotation-specific self-assessment. As a part of these assessments, residents were asked two questions: (a) how they learned during the rotation, and (b) the learning method that was most true for how they learned during the rotation. Response options included...
assigned readings, independent reading, hands-on experience, lectures/teaching, other residents, faculty mentor, and other allied health professionals.

RESULTS: There were 1775 responses (n = 45) from 2008–09, 2009–10, 2010–11, and 2011–12; initial analysis was completed by rotation. Additional analysis by resident and year in training (PGY) is ongoing. Not surprisingly, hands-on “view-box” learning was deemed as the strongest factor with the majority of respondents. Notably, independent reading ranked higher than the assigned reading in all rotation areas. Also noted was the amount of learning provided by allied health professionals on some rotations.

CONCLUSION: Given our results, we could improve the resident learning environment by providing an enhanced educational structure in specific sections and rotations by (a) acknowledging and maximizing the value of quality faculty-resident interaction, (b) reevaluating lectures and teaching, (c) reexamining hands-on opportunities for learning, and (d) expanding and improving reading lists.

(R-32) Thursday • 7:00 AM
How to Make and Publish an iPad Radiology Textbook: From Start to Finish
James Chang, Seattle Children’s Hospital, University of Washington, Seattle, WA; Mahesh M. Thapa, MD (james.chang@seattlechildrens.org)
PURPOSE: Electronic tablets like the iPad are becoming more pervasive in medical education and training. To keep up with and take advantage of the advances in technology and education, we explore the software iBooks Author as a means of producing and self-publishing medical educational textbooks for residents and fellows.

METHOD AND MATERIALS: To self-publish a radiology textbook for the iPad, we used a computer running MacOS, the free software iBooks Author, and an iPad 2. iBooks Author is an app created by Apple, available only on the MacOS operating system. The app is designed as a platform for educators to create interactive textbooks more quickly and inexpensively than with traditional routes. Radiology educators with word-processing skills can easily navigate iBooks Author’s built-in tools to import text, images, videos, and Keynote presentations into one of Apple’s customizable templates. Creating interactive images, charts, tables, and multiple-choice tests enhances the educational power of the e-book. Once completed, the e-book can then be previewed on the iPad and exported as an .ibooks file or PDF file to be shared and reviewed. Publishing on Apple’s iBookstore requires an iTunes account, an ISBN (optional when publishing for free), and an understanding of the agreements and restrictions by Apple.

RESULTS: Using iBooks Author, we created a free interactive e-book for the iPad entitled Radiographic Assessment of Pediatric Foot Alignment Abnormalities. E-books published to the iBookstore for free have fewer restrictions, and the e-book may be made available outside of the Apple environment, such as on Web sites like MedEdPORTAL, a peer-reviewed site for teaching and faculty development. Publishing to the iBookstore for a profit imposes the added restriction of not being able to make the .ibook file available elsewhere.

CONCLUSION: iBooks Author provides an opportunity for medical educators to publish dynamic interactive textbooks for the iPad easily, quickly, and inexpensively. When the e-book is made available for free on the iBookstore, the restrictions are few. However, if the book is put for sale in the iBookstore, authors must understand that the agreements made with Apple can be restrictive.

(R-36) Thursday • 7:00 AM
The University of Colorado Experience: Integration of an Audience Response System into a Radiology Residency Curriculum
Tami Bang, MD, University of Colorado School of Medicine, Aurora, CO; Colin Strickland, MD*; David Rubinstein, MD; Nicole Restauri, MD
PURPOSE: The purpose is to discuss the practical applications and limitations involved in introducing an audience response system (ARS) into radiology resident education.

METHOD AND MATERIALS: Prior to integration of ARS into the curriculum, a 10-question faculty survey regarding attitudes and preferences related to ARS was distributed. Department iPads were issued to radiology residents, preloaded with educational materials, including commercial ARS response software (purchased through Turning Technologies). Subsequently, ARS technology was integrated into the residency curriculum in several areas, including the annual radiology residency retreat and proven case and morbidity and mortality conferences. Immediate feedback and evaluation of the technology were obtained through faculty assessment surveys and focused group discussions.

RESULTS: An electronic 10-question survey on ARS use and preferences yielded 31 faculty responses. Most faculty (84%) at baseline were not using ARS. However, 77% indicated a high to moderate level of interest in this technology. The greatest perceived obstacles to use included (a) learning the technology, (b) technical issues during the presentation, and (c) lack of technical support. ARS was utilized during a resident retreat and effectively anonymously assessed resident attitudes regarding mini fellowships. Challenges integrating ARS into clinical case conferences without disrupting the integrity of the experience for the resident in the “hot seat” were addressed. A departmental morbidity and mortality conference utilizing ARS, with pre- and posttest components, demonstrated improvement in resident diagnostic performance after reviewing a series of cases in thoracic radiology, with systematic identification of contributing biases and blind spots. Finally, utilization of ARS for the purpose of attendance tracking was explored. Several clear benefits, in addition to technical limitations, occurred during these experiences and will be discussed.

CONCLUSION: Audience response systems offer advantages of increased resident knowledge retention and satisfaction. This presentation illustrates several practical applications in resident education and explores both faculty attitudes and limitations of the technology.

(R-37) Wednesday • 7:00 AM
Pulmonary Embolism Teaching File: A Simple Module for Rapidly Increasing Pulmonary Embolism Recognition and Confidence among New Residents
Jamie C. Williams, BA; Takashi S. Sato, MD, University of Iowa Hospitals and Clinics, Iowa City, IA; Bruno A. Policeni, MD (shawn-sato@uiowa.edu)
PURPOSE: At our institution, junior residents are on call alone overnight. CXRs make up the highest volume of studies overnight. The initial interpretation can be difficult for a new radiologist; therefore, new residents work predominantly on CXRs during their 1st-year chest rotations. While CXRs make up the most volume, it is important to be comfortable with finding significant abnormalities on advanced imaging as well. Pulmonary embolisms (PEs) can be life-threatening, and it is important for residents to identify these critical findings when reviewing studies.

METHOD AND MATERIALS: The reports of CTAs done at our institution were retrospectively reviewed from 11/1/2011 to 2/1/2012. A total of 37 positive PE studies were collected, and eight negative studies were collected. Looped movies were created for each case. For initial testing, 25 cases (eight negative and 17 positive) were randomized and played to residents for 90 seconds each (to allow multiple passes). The presence and location of PEs and confidence were
recorded. Then precall residents were given 20 separate known positive PE movies to review on their own, scrolling on their own to develop a search pattern and hunt for PEs. A second test was done with the same initial 25 randomized cases with residents, to evaluate for improvement.

RESULTS: During the first attempt at the 25 cases, the precall residents identified fewer of the 17 PEs than those with call experience, with means of 14.67 and 15.76, respectively (P = .037). After reviewing the 20 cases with known PEs, the precall residents improved on the second attempt at the 25 cases, identifying an average of 16.60 of the 17 PEs (P = .01). During the second attempt, there was no statistical difference between the number of PEs identified by the precall residents compared to those with call experience (P = .21).

CONCLUSION: In a short period of time, residents were exposed to 45 CTAs and increased their accuracy in identifying PEs. After reviewing the 20 studies with known PEs, the precall residents’ ability to identify PEs improved, and their scores were no longer statistically different from those with call experience.

(R-38) Thursday • 7:00 AM Educating 2nd-Year Medical Students regarding Appropriate Imaging Utilization during an Emergency Radiology Elective: Our Experience
Jessica R. Leschied, MBChB, University of Michigan Health System, Ann Arbor, MI; Ursula Knoepp, MD; Carrie Hoff; Michael Mazza, MD; Katherine A. Klein, MD; Aine M. Kelly, MD, MS (jleschi@umich.edu)

PURPOSE: With advances in medical imaging over the last few decades and wider availability of complex imaging tests, physicians are constantly expected to make decisions about which test is most appropriate for a given clinical scenario. By creating an interactive case-based mini-elective, we introduced 2nd-year medical students to the American College of Radiology Appropriateness Criteria® (ACRAC) and demonstrated their value in ordering the most appropriate imaging study in the workup of common emergency room complaints.

METHOD AND MATERIALS: Thirteen students voluntarily signed up to participate in a 3-day highly interactive case-based radiology elective that covered the ACRAC, comparative-effective imaging, and the downstream risks associated with incidental findings and radiation exposure from various imaging modalities. Students were administered pre- and postcourse surveys to assess perceived effectiveness of learning outcomes utilizing a 5-point Likert scale. Responses to both surveys were compared by computing mean scores.

RESULTS: Prior to commencing the radiology elective, students responded with average scores ranging from 1.9 to 3.0 (on a scale of 1.0–5.0) when questioned about their confidence level in ordering appropriate imaging modalities. Following completion of the elective, response averages increased to a range of 4.0–4.2, a nearly twofold increase in confidence level.

CONCLUSION: At the completion of a short radiology elective, 2nd-year medical students’ perceived awareness of the indications, contraindications, and downstream effects of radiation exposure related to medical imaging greatly increased. Future directions include reinforcing this knowledge with the use of online learning modules and incorporating an objective knowledge assessment test before and after the delivery of the radiology elective.

(R-40) Thursday • 7:00 AM Cooperative Resident Call: Do Collaboration and Sleep Sharing Affect Resident Accuracy at Providing Preliminary Reads on Overnight Call?
Amanda Wiant, MD, University of Pittsburgh Medical Center, Pittsburgh, PA; William M. Peterson II, MD; Amir A. Borhani, MD; Prasad R. Shankar, MD; Philip Orons, DO (wiantam@upmc.edu)

PURPOSE: The purpose was to evaluate the effect of a shared call system on R2–R4 residents’ call performance.

METHOD AND MATERIALS: Residents at the University of Pittsburgh Medical Center (UPMC) cover the health system with three residents on 24-hour overnight call: a senior resident at the Children’s Hospital and two residents at physically different locations for adult acute inpatient care. In 2011, a policy was implemented requiring the residents to read all STAT inpatient cases at the busiest hospital (a subjectively large increase in volume). Residents were concerned that the overnight workload was negatively impacting their ability to provide optimal patient care. To address this problem, the two residents at the adult inpatient centers were moved to the same physical location in early 2012 to facilitate strategic napping and collaboration. For the month of September from 2009 to 2012, a report with the following information was generated from the RIS PACS (Imagecast; GE Healthcare) for PGY3–5 residents: the number of studies with a preliminary resident interpretation, the training level of the resident (PGY3–5), and faculty judgment of the preliminary note (agree, mild discordance, significant discordance, or no judgment). Volume of studies reported and rates of significant discordance were compared by PGY year.

RESULTS: Volume of studies read by residents in the month of September increased each year, from a low of 1821 in 2009 to a high of 3482 in 2012. Before major changes in call volume (ie, in 2009 and 2010), average overall significant discordance rate was 0.39%. After implementation of mandatory volume increase in 2011, the significant discordance rate increased to 0.58% and subsequently decreased to 0.38% after implementation of a shared call. Residents in all PGY levels showed a similar trajectory, with an initial increase in significant discordance rate with the increased volume load and a subsequent drop after implementation of a shared call. These changes in significant discordance rates were statistically significant (P < .05).

CONCLUSION: Cooperative or “buddy” call improves resident on-call performance across training levels.

(R-44) Wednesday • 7:00 AM Absence of Publication Misrepresentation among Recent Applicants to a Radiology Residency Program: A Positive Trend in the Digital Era?
Peter C. Thurlow, MD, West Penn Allegheny Health System, Pittsburgh, PA; William Rusnak, BS; Jeffrey S. Mueller, MD; Matthew S. Hartman, MD (pthurlow@wpahs.org)

PURPOSE: Previous studies have reported rates of publication misrepresentation on residency applications as high as 33%. However, the tremendous expansion of digital archiving over the last decade now allows for near-instantaneous access to the vast majority of published scientific research through online databases. The purpose of this study was to reexamine the incidence of misrepresentation of publications in recent Electronic Residency Application Service (ERAS) applications to a diagnostic radiology residency program.

METHOD AND MATERIALS: ERAS applications submitted in 2009 and 2010 to a diagnostic radiology residency program were reviewed. No identifiers were collected. Publication citations provided for peer-reviewed journal articles, abstracts, and book chapters were reviewed for accuracy. Initial verification was performed through a search of the PubMed/MEDLINE database and Google Scholar. Publications not verified by using the primary search were further
evaluated by a manual search of the primary source. Misrepresented publications were defined as publications that could not be verified by using the above methods; verified publications without the applicant author; verified publications with self-promotion of the applicant author in the order of authorship; and verified publications with omission of other authors.

RESULTS: Two hundred seven applications were reviewed. Fifty-six percent (113 of 207) of applicants listed 331 publications, including 251 journal articles, 65 abstracts, and 15 book chapters. Twenty-seven percent (89 of 331) of the publications were reported as publication pending and were excluded from the analysis. One hundred percent (242 of 242) of the publications were verified by using the above methods, including 162 journal articles, 65 abstracts, and 15 book chapters. No instances of publication misrepresentation, including nonauthorship, author self-promotion, or omission of other authors, were identified.

CONCLUSION: We report for the first time the absence of application misrepresentation among recent applicants to a diagnostic radiology residency program. This finding might reflect the influence of increased digital archiving of publications on application integrity.

Health Services for Radiology

(R-45) Thursday • 7:00 AM
Understanding Patient Satisfaction Ratings for Radiology Services by the Hospital Consumer Assessment of Healthcare Providers and Systems
Elvira V. Lang, MD, Harvard Medical School, Boston, MA; Nina A. Mayr, MD; Carley Hartings, MPH; Ronda Kelly, RT; William T. Yuh, MD, MSEE (dvellang@gmail.com)

PURPOSE: The Centers for Medicare & Medicaid Services restructured toward hospital-based value purchasing and withhold now 1% (and by 2017, will be 2%) of all inpatient operating payments. Hospitals can regain and earn additional payments through excellence in quality, toward which patient satisfaction counts 30%. Satisfaction is commonly assessed by the Hospital Consumer Assessment of Healthcare Providers and Systems (HCACHPS) survey. We evaluated how radiology departments and their subdivisions would be able to recognize, track, and, ideally, positively influence their contribution.

METHOD AND MATERIALS: HCAHPS surveys were instituted for the radiology department and MRI division of a large teaching hospital and were tracked for 1 year before and after communication training of the staff. Repeated queries of the system were performed with component analysis on the hospital intranet. We analyzed raw scores, national percentiles, and patient comments and interrelated these measures.

RESULTS: HCAHPS scores compute in a cascading fashion from averages of subscores which, in turn, average their subscores, etc, from hospital down to team levels; for example, MRI ratings encompass Overall Assessment, Facility Section, Personal Issues, Registration Function, and Test or Treatment, the latter being composed of Likelihood of Recommendation, Overall Rating of Care, and Staff Worked Together Providing Care, with the latter having more subscores. Percentiles are compared “live” to 1–2 prior years nationally and the fiscal year locally, changing constantly depending on total submissions, making retrieval of past values difficult. There were clear carryover effects: After communication training, Overall Assessment improved from the 43rd to 94th national percentile, driven mainly by Personal Issues, and, in turn, greatly improving Technical Skill perception despite factor constancy. Questions regarding care were often overshadowed by experiences of inpatient care.

CONCLUSION: Single drivers that affect the patient experience can greatly influence overall scores. Radiology departments can track their overall and division-specific attributes but risk dilution by patient experiences over which they have no influence. Provision of a Test/Radiology category separate from Treatment would be helpful.

(R-46) Wednesday • 7:00 AM
CTDI Variance in Emergency Department Head CT
Robert Wlodarski, MD, Detroit Medical Center/Wayne State University, Detroit, MI; Rubina Zahedi, MD; Shilpa Jain, MD; Wilbur L. Smith, Jr, MD

PURPOSE: The purpose was to evaluate CTDI value/dose variance of unenhanced head CTs in a busy emergency department setting and determine what portion of the variance is related to people factors, rather than CT machine factors, and how the people factor may be mitigated to diminish CTDI value/dose variance in unenhanced head CT examinations.

METHOD AND MATERIALS: The CTDI values of 574 unenhanced head CTs were evaluated at the Detroit Receiving Hospital. The mean and standard deviation (SD) were calculated. The CTDI values that fell outside of the 2-SD range were analyzed to ascertain what caused such a high variance in CTDI value/dose and were placed into categories that included “misclassification,” “repeat studies due to motion,” and “add-on studies.” The misclassification category included studies that were incorrectly classified as an unenhanced head CT when in reality they represented a different study, such as a CT perfusion study. The “repeat studies due to motion” involved studies that were repeated under the same requisition due to patient motion during the initial scan. The “add-on” category involved studies in which other exams were performed simultaneously with the unenhanced head CT. For example, a CT maxillofacial was performed in conjunction with the unenhanced head CT. After excluding the studies that showed excess CTDI value variance due to people factors, a new mean and standard deviation were calculated.

RESULTS: The mean CTDI value for the 574 studies was 52.5, and the SD was 20.0. The 2-SD range was 12.5–92.5. Of the 574 studies, 34 studies fell outside of the 2-SD range. Three studies were placed in the “misclassification” category, 24 were placed in the “repeat studies due to motion” category, and seven studies were placed in the “add-on/compound study” category. After excluding these studies, the new mean and SD calculated from a total of 540 studies were 49.0 and 4.8, respectively.

CONCLUSION: Merely recording the CTDI values of studies is insufficient to establish local levels of radiation dose. Determining the amount of CTDI variance due to people factors is critical. Only after accounting for people factors can an accurate conclusion be drawn about the amount of radiation exposure to patients for the purposes of quality control.

(R-47) Thursday • 7:00 AM
Imaging Strategies to Screen for Cervical Artery Dissection in Blunt Neck Trauma: Cost-effectiveness Comparison
Steven Munson, MD; J. Paul Jacobson, MD*, Loma Linda University Medical Center, Loma Linda, CA

PURPOSE: Blunt neck trauma (BNT) is a common presentation to the emergency department. In 1%, BNT is associated with cervical artery dissection (CAD), with a high rate of consequent stroke. While medical management with warfarin is effective stroke prophylaxis, it has a nontrivial morbidity and mortality from bleeding complications, leading to a rationale for CAD screening. Digital subtraction angiography (DSA) is the gold standard test but is expensive, with a small morbidity/mortality. MRA time-of-flight (MRA TOF), MRA contrast (MRA Con), and CT angiography (CTA) are alternative tests, each with a differing cost, sensitivity, and specificity. Our hypothesis is that DSA is the most effective, but not the most cost-effective, screening strategy for CAD in BNT.

* Faculty financial disclosures are located in the Faculty Index.
METHOD AND MATERIALS: Using decision analysis software (TreeAge Pro 2009), the utility of health states/direct costs for various screening and treatment strategies was modeled over 1 year. One-way sensitivity analysis was performed for each variable. A probabilistic Monte Carlo simulation was performed (n = 1.5 × 10^4) over the prevalence range in which screening strategies were dominant, and strategies were compared for effectiveness and incremental cost-effectiveness with a willingness-to-pay (WTP) threshold of $75,000/quality-adjusted life-year (QALY).

RESULTS: DSA is the most effective screening test for CAD (0.99 QALY) but has an incremental cost-effectiveness ratio (ICER) well above the WTP threshold. A role for screening exists when the pretest probability of CAD is from 1.7% to 15%; CTA and MRA TOF are the most cost-effective strategies, sensitive to local cost variation.

CONCLUSION: While DSA is the most effective screening strategy for CAD in blunt neck trauma, it is not cost-effective at typical willingness-to-pay thresholds. The most cost-effective strategy is (a) CTA or MRA TOF (depending on local cost) when the pretest probability of CAD is less than or equal to 15%, and (b) treat all with warfarin when the pretest probability of CAD is greater than 15%.

(R-49) Thursday • 7:00 AM
Imaging Assessment of a Prototype Silicon Hemodialyzer: A Preliminary Investigation
Olufoladare Olorunsola, MD, University of California, San Francisco, San Francisco, CA; Steven H. Kim, MD; Ryan Chang, BS; Yoo-Chen Kuo, MD; James Heller; Rishi Kant, PhD; et al (dale.olorunsola@ucsf.edu)
PURPOSE: The purpose was to investigate the utility and limitations of various imaging modalities in the noninvasive assessment of a novel compact dialyzer under development for renal replacement therapy, with specific aim toward characterizing flow and evaluating clearance parameters.

METHOD AND MATERIALS: The prototype is a 4 × 3 × 6-cm titanium cartridge consisting of “blood” and “dialysate” flow paths arranged in parallel. These are separated by eight 1 × 1-cm silicon nanopore membranes that allow the passage of small solutes via diffusion. Flow was generated by using an external peristaltic pump. Iodinated contrast was instilled through the blood flow path, while deionized water was instilled in a countercurrent direction through the dialysate flow path. Images were generated by using multidetector computed tomography (MDCT), fluoroscopy, microcomputed tomography (micro-CT), and MRI. MDCT was used to quantify clearance by plotting contrast density as a function of position along the blood flow path during steady-state contrast infusion at 1 and 20 mL/min. Both linear and exponential regressions were used to model contrast decay along the flow path.

RESULTS: Both linear and exponential models of contrast decay yielded similar results for the percentage of contrast cleared during a single pass through the cartridge. There was no measurable difference in contrast clearance when comparing 1- and 20-mL/min flow rates. Qualitative flow studies using fluoroscopy revealed flow inhomogeneity, with regionally higher flow within the corner of the cartridge opposite the blood inlet port. MRI and micro-CT were both severely limited due to the paramagnetic properties and high atomic number of the target material, respectively. We discuss and illustrate the imaging findings of several potential causes of device malfunction, including leak formation, trapped gas, and contrast-mediated nanopore clogging.

CONCLUSION: Despite the inherent challenges in imaging a predominantly metallic device, several modalities show potential in the noninvasive assessment of a novel compact dialyzer. The approaches described here can potentially be translated to evaluation of future prototypes in order to arrive at an optimized design for preclinical testing.

(R-50) Wednesday • 7:00 AM
Effect of Platelet Inhibition on Bleeding Complications in Trauma Patients on Therapy with Clopidogrel before Injury
Shannon Short; Bridgette Kram; Scott Taylor; Jason Cheng, MD, University of Kansas School of Medicine, Wichita, KS; Kamran Ali, MD; Donald Vasquez, MD
PURPOSE: The purpose was to evaluate whether trauma patients with greater than or equal to 20% platelet inhibition who were on therapy with clopidogrel (Plavix; Bristol-Myers Squibb/Sanofi, Bridgewater, NJ) before injury have an increased susceptibility for bleeding.

METHOD AND MATERIALS: This was a retrospective study examining records from October 1, 2009 to August 31, 2011 at a single institution. Inclusion criteria were trauma patients aged 18 and above who had documented usage of clopidogrel as at-home medication prior to admission. Exclusion criteria were (a) platelet count of <100 × 10^9/L, (b) patients who did not receive a P2Y12 assay (VerifyNow; Accumetrics, San Diego, CA), or (c) patients concurrently on therapy with warfarin, dabigatran, ticlopidine, or prasugrel. A test (VerifyNow system; Accumetrics, San Diego, CA) was used to determine level of platelet inhibition. A total of 144 of 4275 trauma patients during the study period were on clopidogrel prior to admission. Eighty-two patients were excluded from the study due to the listed exclusion criteria; 62 patients comprised the final study group. Of these 62 patients, 33 had a platelet inhibition of ≥20%. The other 29 patients had a platelet inhibition of <20%. Baseline characteristics (eg, age, sex, aspirin usage) between the two groups showed no statistically significant difference. The primary outcome was a composite of bleeding complications, including progression of neurologic insult (hematoma expansion or death attributed to traumatic brain injury), postoperative hemorrhage (use of packed RBCs or platelets within 7 days after surgical intervention), and initiation of massive blood transfusion (MBT) protocol (massive blood loss greater than one volume, with continued anticipated blood loss).

RESULTS: Eight patients in each of the platelet inhibition groups expressed a composite of bleeding complications (primary outcome). The only statistically significant secondary outcome was the percentage of patients in each group who underwent platelet transfusion: 51.5% of the ≥20% inhibition group needed platelet transfusion versus 10.3% in the <20% inhibition group.

CONCLUSION: There was no statistically significant difference in primary outcome measure between the two analysis groups. Thus, platelet inhibition assay on trauma patients on therapy with clopidogrel before injury may not be clinically beneficial.

Informatics

(R-51) Thursday • 7:00 AM
A Database-driven Case of the Week Application for Radiology Training Programs
Tessa S. Cook, MD, PhD*, Hospital of the University of Pennsylvania, Philadelphia, PA; Robyn G. Roth, MD; Mary Scanlon, MD (tessa.cook@uphs.upenn.edu)
PURPOSE: Case-based learning is highly valued in radiology training and is a regular highlight of society annual meetings. We present our database-driven case of the week (CoW) application, currently in its 2nd year of operation. Our semiformalized program fosters friendly competition and group learning while promoting case-based learning, a critical component of radiology education.

METHOD AND MATERIALS: Our database-driven CoW application is hosted on a freely available Web server (XAMPP; PHP-compatible with MySQL database capabilities) installed within our hospital’s firewall. The database schema includes tables that contain the

* Faculty financial disclosures are located in the Faculty Index.
weekly cases (diagnosis and associated image file), submitted diagnoses listed by participant’s name, and a score sheet to track participants’ correct answers. The CoW application is written in PHP, with scripts to display the current case, collect diagnoses, and post the explanation for the previous case. Case content can be updated weekly or queued for later weeks. For each case, an image, diagnosis, and explanation are created and uploaded to the Web server. The case table within the database is updated with the week number and diagnosis. Manual input is only required weekly to increment the numeric week tracker; the content for that week’s case is then automatically sourced from the database.

RESULTS: Our semiautomated database-driven case of the week is currently in its 2nd year of operation. Last year’s contest saw participation from more than 30 residents and 20 fellows at our large academic training program. After 10 weeks of cases this year, there has been participation from nearly 40 residents and fellows.

CONCLUSION: Our semiautomated program fosters friendly competition and group learning while promoting case-based learning, a critical component of radiology education. Our database-driven CoW application facilitates management of this application and focuses the time investment on generating educational content, rather than the formatting and online posting of the material.

PURPOSE:
The purpose was to develop a metric to quantify differences in the extent of edits that attending radiologists make to trainee preliminary MRI reports on the basis of organ system.

METHOD AND MATERIALS: All trainee preliminary and attending finalized radiology report pairs, as well as exam type codes, for all MRI examinations from 3/29/2005 to 8/14/2012 were extracted to a database and anonymized. By using open-source software, the Levenshtein distance (LD), the number of character changes required to convert a preliminary report to the finalized version, was calculated to normalize for variations in report length among reports.

RESULTS: A total of 95,529 MRI examinations were included in this analysis. The average LP (ALP) for all studies was 12.04 (95% CI, 11.92–12.15). The highest average Levenshtein percent (ALP) values observed were for breast imaging (23.09; 95% CI, 20.06–26.12) and neuroimaging (12.74; 95% CI, 12.61–12.87). The lowest ALPs observed were for musculoskeletal imaging (7.19; 95% CI, 6.87–7.51) and body imaging (8.69; 95% CI, 8.36–9.01).

CONCLUSION: This study demonstrates statistically significant differences in the ALP of the reports of different radiology divisions. This establishes that certain divisions are more likely to edit their trainee reports to a greater or lesser extent than other divisions. This may suggest differences in the difficulty of interpreting certain organ system examinations or in efficiently and effectively conveying the results of these examinations.

AUR Trainee Prize: 3rd Place

(R-53) Thursday • 7:00 AM
Measurement of the Aortic Pulse Wave Velocity in MR Imaging: An Automated Noninvasive Technique for Computing Transit Time
Akshay Goel, BS, University of Texas Southwestern, Dallas, TX; Roderick McColl, PhD; Kevin S. King, MD; Anthony Whittemore, MD; Ronald Pesheck, MD

PURPOSE: Aortic pulse wave velocity (APV) has been shown to be associated with end-organ damage independent of age, sex, and hypertension duration. The purpose of this study is to evaluate an automated approach for computing ∆t for the measurement of APV as a tool for future investigations and clinical application.

METHOD AND MATERIALS: Phase-contrast cardiac gated MRI of the aorta in the transverse plane at the level of the pulmonary artery was utilized from the Dallas Heart Study-2 (DHS2), a multiethnic population-based study of cardiovascular health. A three-step algorithm was used to analyze 300 random phase-contrast MRI studies from the DHS2 central database. The algorithm functions in three key steps: (1) isolating contours for the ascending aorta and descending aorta by using a computer vision technique known as the Hough transform; (2) using isolated contours and phase-contrast MRI to generate flow curves for the ascending and descending aorta; and (3) computing ∆t, defined as the time shift between the flow curves in the ascending aorta (AA) and descending aorta (DA), calculated by using the half maximum of AA and DA. Twenty of these studies uniformly distributed across all ∆t values were then manually analyzed with the standard approach by utilizing QFlow® (Medis v 4.1.6, Raleigh, NC), and the corresponding manually derived flow curves were used to compute ∆t. The results from the manual analysis using QFlow® were compared to results from the automated algorithm by using linear regression Bland-Altman difference analysis.

RESULTS: The mean transit time (∆t) in the 300 studies analyzed automatically was 19.5 ± 6.2 ms. In the validation set of 20 studies, linear regression analysis showed an excellent correlation between the automated (A) and manual (M) methods (r = 0.96, A = 1.06M – 1.25). Bland-Altman difference analysis showed strong agreement, with no significant bias (mean difference [A – M] = 0.0575 ± 0.817 ms).

CONCLUSION: Our automated approach for computing transit time (∆t) for the measurement of APV demonstrates excellent agreement with the standard manual method. These findings suggest this approach could serve as a useful tool for future investigations and clinical application.

Interventional Radiology

(R-55) Thursday • 7:00 AM
Work Flow Optimization in the Interventional Suite: Utilization of Bottleneck Analysis to Determine Areas of Need
Zoe A. Miller, MD, New York-Presbyterian Hospital/Weill Cornell Medical Center, New York, NY; Azeem Syed, MD, MS; Bradley B. Pua, MD (zam7001@nyu.org)

PURPOSE: The purpose of this study is to analyze the work flow at a busy interventional radiology department by utilizing bottleneck analysis. With increasing health care cuts, analyses such as these are an important tool in optimizing distribution of both financial and human resources.

METHOD AND MATERIALS: On the day of their scheduled procedure, outpatients interested in participating in this quality improvement project were given a form at check-in to our department. Time intervals evaluated were check-in, arrival in preprocedure area, IV

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placement, consent, arrival in procedure room, time out, completion of procedure, and arrival in the recovery room. These data were collected both prior to and after the addition of a new member to the health care team. The time between stages of the interventional process was analyzed in respect to the number of health care team members present on a given day. As different procedures with greatly varying procedure times were performed, the time for procedure was excluded from the data set.

RESULTS: The times between stages of the interventional process were analyzed. After an additional nurse was added to the interventional radiology health care team, times between stages of the interventional process and, indeed, the total time spent in the interventional department decreased. The time from check-in at reception to arrival in the recovery room decreased by 19% (an average of 26 minutes). The time from arrival in the preprocedure room to time in the recovery room decreased by 34% (an average of 10 minutes).

CONCLUSION: Our data not only show that addition of a member to the team decreases overall in-department time but also demonstrates what segments of the day are most affected by this change. These data will be particularly important in the coming years, as decreasing the amount of time patients spend in the department for an outpatient procedure can both increase patient satisfaction and make more efficient use of the department’s resources, such as angiography suites and recovery rooms.

(N-R7) Thursday • 7:00 AM
Utilization of Pelvic Angiography for Patients with Pelvic Fractures: Fifteen Years of Experience at a Major Level 1 Trauma Center
Bahman Roudsari, MD, PhD, University of Texas School of Public Health, Dallas, TX; Kevin J. Psoter, MPA; Sharon W. Kwan, MD (roudsari@u.washington.edu)

PURPOSE: Pelvic angiography and embolization are critical in the management of hemodynamically unstable trauma patients with pelvic fractures. Such an effect has also been demonstrated in hemodynamically stable patients with active extravasation seen on CT angiography. In this study, we evaluated the trends in the use of pelvic angiography and embolization for pelvic fractures in patients admitted to a level 1 trauma center between 1996 and 2010.

METHOD AND MATERIALS: The hospital trauma registry was linked to billing and radiology data, thereby capturing demographic, injury-related, and imaging-related data for all trauma patients admitted with pelvic fracture from June 1996 to July 2010. Using logistic regression, we estimated the odds of receiving angiography and embolization in each year, considering 2000 as the baseline for comparisons, adjusting for age, gender, mechanism of injury, ISS, length of ICU and hospital stay, and final disposition.

RESULTS: A total of 76,431 patients were admitted for trauma during the study period. Overall, 8% of patients suffered from a pelvic fracture. The proportion of the patients with pelvic fracture who underwent pelvic angiography decreased from 31% to 15% from 1996 to 2005 and has remained relatively unchanged. Multivariable logistic regression demonstrated declining odds of pelvic angiography during the study period: OR of 2.8 (95% CI: 1.6–4.9) in 1996 and OR of 0.2 (95% CI: 0.1–0.4) in 2010 compared to 2000. The annual proportion of the patients who underwent embolization after pelvic angiography varied between 52% and 68%, with an increasing trend during the study period, although not statistically significant. During the same time period, we observed a slight but significant increase in CT abdomen and pelvis utilization.

CONCLUSION: In spite of the relatively unchanged proportion of the patients with pelvic fractures admitted during the study period, we observed a significant drop in pelvic angiography use. This could be due to increasing utilization or improvement in the quality of CT, reducing the need for diagnostic angiography. However, overutilization of IR in earlier years and declining referral of trauma patients to the IR service for nonsurgical management should not be overlooked.

Nuclear Medicine

(R-80) Wednesday • 7:00 AM
Reducing Beam-hardening Artifact by Decreasing the Dose of Iohexol
Elina Zaretzky, BS, Beth Israel Medical Center, New York, NY; John Gonzales, MD; Angela M. Yim, MD (ezaretzky@chpnet.org)

PURPOSE: Artifact can significantly degrade the quality of computed tomographic (CT) images, rendering studies nondiagnostic. Beam-hardening artifact, specifically, can present diagnostic challenges for the interpreter. As an x-ray beam passes through an object, the lower-energy photons are absorbed more rapidly than the higher-energy photons. The resultant x-ray beam becomes “hardened”; that is, it has a higher energy. Hardening produces dark bands between dense objects in the image, such as bone or very dense contrast material. The standard intravenous and enteric contrast agent used at Beth Israel Medical Center is iohexol with a concentration of 240 mg of iodine/mL (Omnipaque 240; GE Healthcare). As per manufacturer recommendation, 50 mL of iohexol (Omnipaque 240) is mixed with 900 mL of water for the enteric formulation. Anecdotal accounts from attending radiologists at our institution indicate that beam-hardening artifact interferes with diagnostic interpretation of studies. We attempted to minimize this by decreasing the dose of iohexol (240 mg I/mL) from 50 mL to 25 mL while maintaining adequate bowel opacification. It was our goal to facilitate accurate interpretation of findings by improving the quality of CT images.

METHOD AND MATERIALS: A pilot study was conducted at Beth Israel Medical Center to determine whether decreasing the dose of iohexol (240 mg I/mL) from 50 mL to 25 mL would lessen beam-hardening artifact seen on contrast-enhanced CT images. A random sample of 60 CT abdomen/pelvis scans were chosen, 30 at the higher concentration and 30 at the lower concentration. The two sets of images were shown to radiologists who were then asked to come to consensus as to whether beam hardening was present or not and whether bowel was adequately opacified.

RESULTS: The preliminary study results showed that artifact was present on 27/30 CT images (90%) when a higher dose of iohexol was used (50 mL) and on 21/30 when a diluted dose was used (25 mL). The lower dose, therefore, decreases the amount of beam of hardening caused by enteric contrast.

CONCLUSION: In our preliminary study, lowering the dose of iohexol from 50 mL to 25 mL has a favorable effect on reducing beam-hardening artifact and therefore improves image quality.

Neuroradiology

(R-82) Wednesday • 7:00 AM
Increased Dural Venous Sinus Diameters in Pediatric Patients with Sickle Cell Disease: MR Venography Study
Kalie Adler, DO, Children’s Mercy Hospital, Kansas City, MO; Mariam T. Nawas, BA; Lisa H. Lowe, MD; Simran Arora, BA; Aaron Bonham, MS; Ram Kalpatthi, MD (mtn2m9@mail.umkc.edu)

PURPOSE: By age 18, cerebral infarcts are evident on magnetic resonance imaging (MRI) scans in one-third of patients with sickle cell disease (SCD). A recent study described increased cerebral blood flow transit time (CBF/T) on arterial spin-labeled perfusion MRI in SCD patients. If SCD patients are found to have abnormally large cranial venous drainage pathways, this could suggest a component of blood
shunting that could contribute to increased CBFTT and development of cognitive delay. The purpose of this study is to compare the diameters of dural venous sinuses in children with SCD with healthy controls and to assess whether these results correlate with a history of cerebral infarct among SCD patients.

METHOD AND MATERIALS: This is a retrospective review of magnetic resonance venography (MRV) studies, demographics, and medical histories of children with SCD and controls who have undergone MRV between December 2004 and March 2011. Imaging of the brain was performed with 1.5-T MR imaging with 2D time-of-flight venography. Dural sinuses were directly measured on MRV by an author who was blinded to presence or absence of SCD or history of cerebral infarct within the SCD group. MRVs demonstrating stenosis or occlusion and patients with history of dural venous thrombosis were excluded. In order to determine whether there were any differences between SCD patients and controls, or among the SCD group, a series of one-way ANOVAs that controlled for age and sex as covariates were performed. A P value of <.05 determined significance.

RESULTS: In total, there were 38 SCD and 38 control patients. SCD patients had significantly larger dural sinus diameters than controls for 12 of 13 sinuses measured, ranging from 14%–80% larger (P < .05). Among SCD patients, the only sinus that differed between those with a history of cerebral infarct and those without was the left internal jugular vein (IJV); those without had a 22% larger diameter of the left IJV (P = .043).

CONCLUSION: Patients with SCD had larger dural sinus diameters than controls regardless of the former group’s history of cerebral infarct. The reason for this anatomic difference is unknown; however, it may relate to blood shunting or the previously noted increased CBFTT in patients with SCD.

(R-84) Thursday • 7:00 AM Practical Approach to Radiation Dose Reduction and Optimization of Sinus CT Protocols
Salar Hakham, DO, Tufts Medical Center, Boston, MA; Joo Y. Cho, MD; Lindsey Lavoie, PhD; Elie Rebeiz, MD; Harprit S. Bedi, MD; Daniel Do-Dai, MD; et al (shakham@tuftsmedicalcenter.org)
PURPOSE: The purpose was to determine systematically the potential for radiation dose reduction in sinus CTs, both quantitatively and qualitatively.

METHOD AND MATERIALS: A head phantom was systematically imaged on a scanner (Siemens Somatom Definition), adjusting the mAs (23, 50, 80, 110, and 140) and the kVp (80, 100, and 120) for a total of 15 separate acquisitions. Regions of interest in air, soft tissue, and bone were then selected to calculate pixel noise on each image set. Images were then presented in a blinded fashion to nine physicians: two neuroradiology attendings, three neuroradiology fellows, two ENT attendings, and two ENT residents. Qualitative assessment by these readers was made utilizing a 0–10-point grading scale as to image quality for the purposes of diagnosis, surgical planning, and bony detail. Pearson correlation coefficient analysis was then performed. Finally, radiation dose was calculated for each scan parameter with regard to the lens dose, skin dose, and effective dose.

RESULTS: Quantitative assessment of pixel noise showed that mAs and kVp could be significantly reduced with only minimal increase in noise (7–20 HU), although those parameters resulting in the lowest radiation dose resulted in significant increase in noise (64 HU). While the degree of noise correlated with radiation dose (r = −0.54; P < .05), significant decreases in radiation dose could be achieved with only a minimal increase in noise. Finally, image noise correlated with the qualitative assessment of diagnostic confidence for sinus disease (r = 0.615; P < .01) and surgical planning (r = 0.497; P < .01). Of note, there was a stronger correlation between the diagnostic confidence of radiologists and image noise, compared to the ENT physicians (P = .04). However, there was a threshold effect whereby significant dose reduction could still be obtained with minimal change in diagnostic confidence.

CONCLUSION: Dose reduction can be achieved with minimal change in the diagnostic quality of sinus CT, both for evaluation of sinus disease and surgical planning. A systematic approach to evaluating image quality can result in the optimal radiation dose reduction while preserving diagnostic accuracy.

(R-86) Wednesday • 7:00 AM Optimization of Routine Head CT through Analysis of Individual Acquisition Parameter Variations
Flavius Raslau, MD; Paul von Herrmann, MD, University of Kentucky, Lexington, KY; Jie Zhang, PhD (flavius.raslau@uky.edu)
PURPOSE: Far more than just image interpreters, academic radiologists play an important role in image design and development, yet they face the compounded challenges of managing institutional preferences, different CT scanner technologies, and a wide range of possible acquisition parameter settings. Several sources are available for recommended CT settings, but this presentation focuses on understanding the effects of varying individual acquisition parameters with the goal of limiting specific artifacts and thereby optimizing image quality.

METHOD AND MATERIALS: Imaging analysis is undertaken on the 40-slice CT scanner (Siemens Sensation) by using a standard head phantom. The routine head CT protocol is scrutinized under different parameter settings: spiral vs sequential, pitch, kV, automatic exposure control (ie, CareDose) on versus off, effective mAs, collimation, and kernel. The resulting images are compared in terms of overall image quality, artifacts, acquisition time, and radiation dosage. Examples of specific artifacts that are scrutinized include spiral-related pinwheel streak, subcalvarial streak, streak and beam hardening at the skull base, and air-tissue interface streak.

RESULTS: The effects of varying individual acquisition parameters are illustrated in terms of overall image detail, artifact generation, acquisition time, and radiation dosage.

CONCLUSION: Recommendations are offered for ways to improve image quality and minimize specific artifacts of routine head CT studies while maintaining the necessary balance with acquisition time and radiation dosage. The “default” acquisition parameters need not be automatically accepted, but rather should be scrutinized and methodically improved.

Pediatric Radiology

AUR Trainee Prize: 2nd Place
(R-90) Wednesday • 7:00 AM Practical Method of Calculating the Size-specific Dose Estimate in CT
Roshni A. Parikh, MD, BEng, University Hospitals Case Medical Center, Cleveland, OH; Michael Wien, MD; Ronald Novak, PhD; MPH; Paul Klahr, PhD; Leslie Ciancibello, RT; Sheila Berlin, MD (roshni.parikh@uhhospitals.org)
PURPOSE: CT dose index (CTDIdvol) and dose-length product (DLP) are two universal parameters used to monitor radiation dose. These parameters do not account for patient size and therefore do not accurately reflect individual radiation dose. The American Association of Physicists in Medicine (AAPM) Task Group 204 Report details the significance and technique of calculating the size-specific dose estimate (SSDE). This project compares a manual method to calculate the SSDE described by the AAPM report (method M) with an automated method (method A).

* Faculty financial disclosures are located in the Faculty Index.
**METHOD AND MATERIALS:** Thirty-nine subjects were retrospectively collected from a database of pediatric patients who underwent body CTs (13 abdomen, 16 abdomen/pelvis, and 10 chest/abdomen/pelvis). Method M averaged two lateral measurements from the AP scout topogram at predetermined levels representing approximate maximum and minimum locations. Based on this average, the appropriate conversion factor \( f_{\text{size}} \) was obtained, by using the AAPM report, and multiplied by the CTDIvol to determine the SSDE \( (\text{SSDE} = f_{\text{size}} \times \text{CTDIvol}) \). Method A measured the level-specific SSDE by using a calculated equivalent circular diameter per slice and a level-specific CTDIvol. A mean SSDE was calculated by averaging the data from all levels. Method M and method A mean SSDEs, as well as the mean CTDIvol, were compared by using the concordance correlation coefficient \( (\rho_c) \) and paired sample \( t \) tests.

**RESULTS:** The mean SSDE is 6.05 mGy, method M, and 6.35 mGy, method A \( (P = .0049) \). While these means are statistically different, this is not likely a clinically significant difference, as the absolute difference between the two groups is 4.85% and \( \rho_c = 0.8944 \). The mean CTDIvol is 4.02 mGy. When compared with method A, these means result in statistical and clinical differences: \( P < .001, \rho_c = 0.3513, \) and an absolute difference of 45.0%.

**CONCLUSION:** In pediatric body CT, dose is grossly underestimated by the CTDIvol. While the computer algorithm is the most accurate, the manual method described in this study provides a quick and practical method for calculating SSDE that is within 5% of the automated method.

**Women’s Imaging**

(R-95) Thursday • 7:00 AM
Unifocal Invasive Lobular Cancer: How Accurately Does US Predict Tumor Size?
Rebecca L. Hultman, DO, University of Massachusetts Medical School, Worcester, MA; Monique Tyminski, DO; Jade Watkins, MD; Gopal Vijayaraghavan, MD, MPH (rebecca.hultman@umassmemorial.org)

**PURPOSE:** Sonography is considered to be more sensitive than mammography in detecting invasive lobular carcinoma (ILC) and plays an important role in diagnosis, staging, and treatment planning. The aim of this study was to compare tumor volume on ultrasound to excised tumor specimen volume to determine how reliably ultrasound estimates tumor size.

**METHOD AND MATERIALS:** Institutional review board approval was obtained to conduct this retrospective study. All cases diagnosed with pure ILC between January 2007 through December 2011 were obtained from the tumor registry. A total of 128 patients had pathology-proven ILC, and 104 underwent surgical excision (lumpectomy or mastectomy) without neoadjuvant chemotherapy. Of the 104 cases, 21 cases were excluded because an ultrasound was not performed or the ultrasound exam was interpreted as negative. An additional 17 cases were excluded because the pathology reports did not detail all dimensions of the tumor or the tumor was reported to be multifocal. A total of 66 cases were included in this study. Diagnostic ultrasounds were reviewed to determine three size dimensions in centimeters. Volumes were then calculated in cm\(^3\) \((\text{length} \times \text{width} \times \text{height})\). Pathology was reviewed to calculate volume of tumor at excision. Data were then analyzed to determine the accuracy of ultrasound in predicting unifocal tumor volume.

**RESULTS:** The tumor volumes estimated on ultrasound were compared with the volume of the excised specimen. Forty-nine of the 66 cases (74%) measured greater volume at pathology than on ultrasound. The average volume of the unifocal ILC on ultrasound imaging was 3.56 cm\(^3\), with a median of 0.99 cm\(^3\). A paired \( t \) test was performed, yielding a \( P \) value of .009, showing statistical significance.

**CONCLUSION:** While ultrasound is a useful adjunct in the evaluation of ILC, our study of unifocal ILC lesions shows that sonography underestimates true tumor size in most instances.

* Faculty financial disclosures are located in the Faculty Index.
AUR 2013 Education Poster Abstracts

Education posters are located in Platinum Ballroom Salon E. Each poster will be presented by its author during AMA PRA Category 1 Credit™ poster sessions scheduled for 7:00–8:15 AM, Wednesday and Thursday. The day and time follow 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, fellows, or 1st-year fellows) are noted in dark blue.

Abdominal Radiology

(E-01) Wednesday • 7:00 AM
Urodynamics and Micturition Studies: Radiographic and Urologic Correlation
Marlene E. Rackson, MD; Arri Iyer, MD, Beth Israel Medical Center, New York, NY; Douglas S. Katz, MD (mrackson@chpnet.org)
LEARNING OBJECTIVES: Urodynamic testing looks at how the bladder, sphincters, and urethra store and release urine. During the examination, the urologist performs a VCUG. Radiologists often interpret these examinations without history, companion studies, or really understanding the procedure. Our intent is to help radiologists learn (a) how the procedure is performed and the indications for the examination; (b) imaging findings of common lower urinary tract entities; (c) potential pitfalls of examination interpretation; and (d) how to produce an accurate report that correlates the imaging findings to the physiologic findings, rather than just routinely stating that “Images are available for review. Please correlate with the procedure report.”

CONTENT DESCRIPTION: Content Organization: I. Indications for the procedure: eg, urge and stress incontinence, dysuria, urinary frequency, incomplete bladder emptying, recurrent UTI, and difficulty initiating a urinary stream. II. Technique: Description, including video urodynamic tests, uroflowmetry, postvoid residual, cystometrics, pressure flow study, leak point measurement, and electromyography. III. Normal anatomy/normal examination: Normal VCUG images during erect voiding, with strain and nonstrain views, will be demonstrated. IV. Cases: The spectrum of common abnormalities will be presented, including cystocele, stress incontinence, overactive bladder, and postoperative sling anatomy in females; and BPH, primary bladder, sphincters, and urethra store and release urine. During the procedure report. "

(E-02) Thursday • 7:00 AM
Diffuse Cystic Disease of the Kidney: Differentiating Imaging Features
Saro Manoukian, MD, Saint Vincent Hospital, Worcester, MA; Nicholas H. Shaheen; Daniel Kowal, MD
LEARNING OBJECTIVES: 1. Review the pathophysiology of various causes of diffuse cystic disease of the kidney, including dialysis, lithium use, autosomal dominant and recessive polycystic kidney disease, multicystic dysplastic kidney, and localized cystic disease of the kidney. 2. Explain how to differentiate among these various entities through the use of MR, CT, and ultrasound imaging. 3. Highlight the clinical significance of making the correct diagnosis, given that the presence of diffuse cystic renal disease can have variable therapeutic implications ranging from no significance to renal failure leading to dialysis.

CONTENT DESCRIPTION: Diffuse cystic disease of the kidney is seen commonly as an incidental finding on imaging studies. However, there are various causes for a diffuse distribution of renal cysts, including dialysis, lithium use, autosomal dominant and recessive polycystic kidney disease, multicystic dysplastic kidney, and localized cystic disease of the kidney. Determining the etiology of these cysts is of great importance, given that their presence can vary from no significance to eventual renal failure requiring dialysis. MR, CT, and ultrasound imaging are helpful in determining the size of the kidneys, the location and size of cysts, and whether the cysts enlarge over time. This information, in conjunction with the patient’s renal function and other clinical information, can be utilized in order to make an accurate diagnosis and potentially guide therapy.

(E-03) Wednesday • 7:00 AM
Approach to MR and US Imaging of Endometriosis, Adenomyosis, and Their Complications
Saro Manoukian, MD; Nicholas H. Shaheen, Saint Vincent Hospital, Worcester, MA; Daniel Kowal, MD
LEARNING OBJECTIVES: 1. Review the pathophysiology of endometriosis and adenomyosis. 2. Explain how to use characteristic imaging features on MR and ultrasound to differentiate between endometriosis and adenomyosis. 3. Describe the potential complications secondary to endometriosis and adenomyosis, and discuss mimics of ovarian endometriomas.

CONTENT DESCRIPTION: Endometriosis and adenomyosis are gynecologic processes with characteristic pathophysiologic, clinical, and imaging differences. While adenomyosis refers to the presence of heterotopic endometrial glands within the myometrium, endometriosis involves the presence of endometrial glands outside of the endometrium and myometrium. Patients with endometriosis or adenomyosis can have a similar clinical presentation, including dysmenorrhea, pelvic pain, dyspareunia, and infertility. Patients with either entity can also be asymptomatic. Ultrasound and especially MR imaging with particular attention to the junctional zone can be of great utility in differentiating between these two pathologic processes, thereby guiding appropriate medical or surgical management. Accurate diagnosis is also important, given that endometriosis has potentially more significant complications, such as peritoneal implants and, rarely, malignant degeneration into clear cell carcinoma or endometrioid carcinoma. Finally, differentiating ovarian endometriomas from their mimics, such as borderline epithelial tumors of the ovary or mature cystic ovarian teratomas, can obviate the need for more invasive procedures such as laparoscopy or oophorectomy.

(E-04) Thursday • 7:00 AM
Tuberculous Peritonitis: Imaging Findings on CT and Differential Diagnoses of an Often Forgotten Disease
Jesus R. Diaz, MD, Texas Tech University Health Sciences Center, El Paso, TX; Nelly M. Estrada; Shaked Laks, MD (jesus.diaz@ttuhsc.edu)
LEARNING OBJECTIVES: Tuberculous peritonitis, while remaining relatively common in developing countries, can also be seen elsewhere due to increase in travel, influx of immigrant populations, wider use of immunosuppressant drugs, and incidence of immunosuppressive diseases. All of these factors lead to more frequency in general teaching hospital settings. Diagnostic challenge can be faced when patients present with atypical clinical and laboratory findings mimicking other peritoneal disease processes. The purpose of this exhibit is to (a) review the pathophysiology of tuberculous peritonitis, (b) list pathologic processes in high-risk population groups for tuberculosis, (c) review the spectrum of CT findings of tuberculous peritonitis, and (d) list differential diagnoses of tuberculous peritonitis.
CONTENT DESCRIPTION: Content Organization: I. Pathophysiology of tuberculous peritonitis. II. Review of the spectrum of imaging findings on CT in the literature. III. Sample cases with typical and atypical features and mimics.

Conclusion and Major Teaching Points: 1. Unexplained ascites with omental infiltration on CT, in the absence of findings for gynecological or gastrointestinal neoplasms, should raise suspicion for tuberculous peritonitis in patients at increased risk for mycobacterial infection. 2. Peritoneal carcinomatosis and serous papillary carcinoma, which may be indistinguishable from tuberculous peritonitis on CT imaging, should be entertained in patients with low to no risk for tuberculosis. 3. Prompt and accurate early diagnosis of tuberculous peritonitis by CT is important, since there is a good prognosis after early and appropriate initiation of therapy.

(E-05) Wednesday • 7:00 AM Imaging of Liver Transplant Complications
Jeremy B. Nguyen, MD, Tulane University Hospital and Clinic, New Orleans, LA; Kuang-Chun J. Hsieh, MD; Montu Patel, MD; Lorena Garza, MD; Mandy C. Weidenhaft, MD; Harold R. Neitzschman, Jr, MD

LEARNING OBJECTIVES: 1. Describe the surgical techniques and the normal postoperative findings in patients with liver transplant. 2. Identify the most valuable imaging modalities to assess patients with liver transplants and the diagnostic usefulness of each modality. 3. Describe the most common complications in patients with liver transplants and the appropriate therapeutic interventions.

CONTENT DESCRIPTION: Doppler ultrasound is the preliminary modality of choice for gross evaluation of posttransplanted liver complications, and it will help determine the need for further imaging. Ancillary tests include computed tomography (CT), magnetic resonance (MR), cholangiography, angiography, and scintigraphy. Each modality is different, and its diagnostic usefulness will depend on individual presentation and clinical purpose. Posttransplantation complications can be grossly classified as vascular or biliary in origin. Vascular complications include hepatic artery thrombosis and stenosis, portal vein and inferior vena cava (IVC) thrombosis and stenosis, and arteriovenous fistulas. Biliary complications can be divided into stenosis and leaks with biloma formation. Other complications to be considered include recurrent hepatitis, posttransplantation lymphoproliferative disorder (PTLD), recurrent malignancy, and adrenal gland hemorrhage. The imaging characteristics of the multiple complications will be displayed.

(E-06) Thursday • 7:00 AM Fluoroscopic Techniques to Reduce Patient and Operator Radiation Exposure: A Gastrointestinal/Genitourinary Primer
Daniel I. Glazer, MD, University of Michigan Health System, Ann Arbor, MI; Jessica R. Leschied, MB BCH; Janet E. Bailey, MD; Katherine E. Maturen, MD* (glazer@med.umich.edu)

LEARNING OBJECTIVES: 1. Describe the basic design and operation of a fluoroscopy tower. 2. Identify both the fixed and modifiable factors that affect patient and operator radiation exposure. 3. Describe techniques that may be used to decrease radiation exposure when performing fluoroscopy procedures.


(E-07) Wednesday • 7:00 AM Cystic Hepatic Lesions: A Review and an Algorithmic Approach
William M. Peterson II, MD, University of Pittsburgh Medical Center, Pittsburgh, PA; Amir A. Borhani, MD; Wendy Rhoads, MD; Amanda Want, MD; Matthew T. Heller, MD (borhaniaa@upmc.edu)

LEARNING OBJECTIVES: 1. Describe differential diagnoses for cystic focal hepatic lesions. 2. Identify distinguishing morphologic features on CT and MRI. 3. Describe an algorithm for how to approach an unknown cystic hepatic lesion and how to narrow the differential diagnosis based on the morphology, ancillary findings, and patient's history.


Summary: Cystic hepatic lesions are commonly encountered in daily practice. The differential diagnosis ranges from benign to lethal conditions, and familiarity with these diagnoses is paramount for timely diagnosis and management. This pictorial exhibit will review these conditions and provide a practical algorithmic approach to simplify diagnosis.

(E-08) Thursday • 7:00 AM Acute Cecal Conditions: Anatomy, Pathophysiology, and Multidetector CT Findings
Ka-Wah Tung, MD, University of Pittsburgh Medical Center, Pittsburgh, PA; Matthew T. Heller, MD (tung@upmc.edu)

LEARNING OBJECTIVES: 1. Identify relevant multidetector CT (MDCT) anatomic landmarks of the right lower quadrant and the cecum and its blood supply. 2. Describe key MDCT features of cecal pathology resulting in acute lower right quadrant pain. Three categories of cecal pathology include malrotation (bascule, volvulus), infectious (Yersinia enterocolitis, typhilitis), inflammatory (diverticulitis, ulcerative colitis, epiploric appendagitis, Crohn's disease), hernia, trauma, vascular (ischemia, infarction), and neoplastic (adenocarcinoma, lymphoma). 3. Discuss correlations between MDCT features of cecal pathology and clinical management and outcome.

CONTENT DESCRIPTION: Numerous acute conditions affecting the cecum cause acute abdominal pain and can lead to significant morbidity and mortality. Diagnosis of acute cecal conditions can be challenging, as variations in cecal luminal distention, morphology, and mobility can make the cecum a blind spot on axial plane alone. Multiplanar MDCT can assist the radiologist in rapidly detecting various emergent cecal conditions. Thus an appreciation of the various types of pathology that can affect the cecum and a familiarity with their key imaging findings are critical to timely diagnosis and initiation of patient management. Care must be taken to differentiate the origin of the right lower quadrant abdominal pain and to differentiate acute pathology that can affect the cecum, appendix, terminal ileum, and omentum. Herein we illustrate major categories of cecal pathology in multiple planes, including processes with malrotation, infectious, inflammatory, hernia, trauma, vascular, and neoplastic etiologies. Familiarity with these common acute cecal conditions and awareness of the differential diagnosis will facilitate prompt diagnosis and treatment, improving patient outcome.* Faculty financial disclosures are located in the Faculty Index.
(E-09) Wednesday • 7:00 AM
Perianal Fistulas: MR Imaging Characterization, Classification, and Treatment
Ka-Wah Tung, MD, University of Pittsburgh Medical Center, Pittsburgh, PA; Matthew T. Heller, MD (tungk@upmc.edu)

LEARNING OBJECTIVES: 1. Describe the anatomy and function of the perianal region, including the anal canal, anal sphincter complexes, and pelvic diaphragm, and the “anal clock” surgical approach. 2. Explain the St James’s University Hospital classification of MR imaging–based grading of fistulas and their relationships to the ischioanal fossa (ischioanal fossa), anal sphincters, and levator plate. 3. Describe surgical management and clinical outcome based on the grade of the perianal fistula.

CONTENT DESCRIPTION: Magnetic resonance imaging has recently developed to have a major impact on the preoperative assessment of perianal fistulas. An understanding of the anatomy of the perianal region and the relationship of the fistulas to the pelvic diaphragm and ischioanal fossa is crucial, as these relationships have important implications for surgical approach and clinical outcome. Herein, we describe and illustrate perianal fistulas of various complexities and grade them with an MR imaging–based grading system (St James’s University Hospital) based on these relationships: confinement to the sphincter complex, involvement of the ischioanal (ischioanal) fossa, or crossing of the levator plate. More complex fistulas require different surgical approaches that may affect continence or require a fecal diversion (colostomy). Understanding of this system can aid the radiologist in diagnosis and awareness of complex disease, improving clinical outcome.

(E-10) Thursday • 7:00 AM
Renal Cell Carcinoma: Histology Matters
Mina M. Zakí, MD, William Beaumont Hospital, Royal Oak, MI; Syed Z. Jafri, MD; Mitual Amin, MD (mina.zaki@beaumont.edu)

LEARNING OBJECTIVES: 1. Describe the current WHO classification of renal tumors. 2. Identify pertinent clinical issues related to the histologic spectrum of renal cell carcinoma (RCC), such as impact of tumor histology on prognosis and treatment. 3. Describe the characteristic imaging findings of each of the common and uncommon histologic subtypes of RCC, with correlation to histopathology and gross pathology specimens.

CONTENT DESCRIPTION: RCC is now understood as a pathologically and histologically heterogeneous spectrum of entities, including the following subtypes: clear cell RCC, papillary RCC, chromophobe RCC, collecting duct carcinoma, renal medullary carcinoma, mucinous tubular and spindle cell carcinoma, multicystic cystic RCC, Xp11.2 translocation carcinoma, hereditary cancer syndromes, neuroblastoma-associated RCC, and other unclassified subtypes. Different subtypes of RCC have specific histopathologic profiles and, commonly, unique imaging features. Imaging features of each of these subtypes will be reviewed (with emphasis on ultrasound, CT, and MRI), along with pathologic correlation. The increasing role of the radiologist in the management of these patients, including biopsy prior to nephrectomy, will also be discussed. It is becoming increasingly important for the clinicians involved in the care of patients with RCC to be aware of the various subtypes of RCC, as tumor histology, in conjunction with traditional TNM staging, provides important information, both with regard to prognosis and treatment options. This exhibit will highlight the current classification of RCC and review the characteristic imaging and pathologic features of each subtype.

(E-11) Wednesday • 7:00 AM
The Atypical Adrenal: CT Diagnosis
Douglas S. Katz, MD, Winthrop-University Hospital, Mineola, NY; Diego A. Covarrubias, MD; Esther Coronel; Mariam Moshiri, MD; John Hines, MD (dkatz@winthrop.org)

LEARNING OBJECTIVES: A wide spectrum of uncommon and unusual conditions may affect the adrenal(s), including a host of benign and malignant masses, inflammatory and infiltrative disorders, and miscellaneous benign lesions/abnormalities. Some of these are unusual, while others are rare, and they may be purposefully or incidentally detected on CT. This exhibit will show this wide spectrum of uncommon and rare, or “atypical,” conditions/disorders/lesions of the adrenal(s) that may be identified on abdominal CT examinations performed for a wide variety of indications. After reviewing this exhibit, the radiologist will be familiar with the imaging and clinical literature on these conditions and disorders.

CONTENT DESCRIPTION: By using case material from several institutions, a broad range of atypical or unusual adrenal pathology will be demonstrated on CT, and the imaging and clinical literature will be briefly reviewed. These include various cystic lesions: “adenalitis,” with swollen adrenals presenting acutely with symptoms (including in suspected viral infection), as well as incidentally; hemorrhage from a variety of causes (trauma, anticoagulation, underlying cyst, pheochromocytoma, adenoma, carcinoma, metastases, myelolipoma, post biopsy); “black” adenoma; macronodular hyperplasia; congenital adrenal hyperplasia; lymphoma; primary carcinoma (including with less common presentations, such as inferior vena cava invasion); large adenoma and large myelolipoma; extraadrenal myelolipoma; atrophy; unusual metastases/unusual presentations of metastases; cystic pheochromocytoma; and adrenal hyperdensity in shock.

(E-12) Thursday • 7:00 AM
CT of the Acute Female Pelvis
Douglas S. Katz, MD, Winthrop-University Hospital, Mineola, NY; Maria Khalid; Esther Coronel; Joseph P. Mazzie, DO; Christine O. Menias, MD; Mariam Moshiri, MD (dkatz@winthrop.org)

LEARNING OBJECTIVES: Sonography is the primary imaging modality for the evaluation of pelvic pain in female patients, especially if gynecologic pathology is suspected. However, CT is frequently used in patients presenting to emergency departments and elsewhere with otherwise nonspecific lower abdominal and pelvic pain, and CT may be the first imaging modality to demonstrate an acute gynecologic abnormality. CT can also be used prospectively in selected patients to further evaluate findings initially identified on sonography (eg, in complex pelvic inflammatory disease, when the findings extend beyond the field of view and/or involve bowel and/or the GU tract) or to evaluate equivocal findings on sonography; although to reduce radiation exposure, MR is being utilized more frequently in this situation. The purpose of this exhibit is therefore to discuss and illustrate the spectrum of gynecologic findings of the acute female pelvis that may be identified on CT, with a brief review of the imaging literature of each specific diagnosis.

CONTENT DESCRIPTION: The following topics will be covered, with brief literature reviews and CT case demonstrations: CT technique, ovarian torsion, ovarian cysts, endometrioma presenting acutely, ectopic pregnancy, unexpected intrauterine pregnancy, ovarian hyperstimulation, pelvic inflammatory disease, endometritis, ovarian vein thrombosis, uterine rupture, gynecologic neoplasms with acute presentations, and complicated uterine leiomyomas.

* Faculty financial disclosures are located in the Faculty Index.
Cardiopulmonary Radiology

(E-14) Thursday • 7:00 AM
Postesophagectomy Hiatal Hernia: A Diagnostic Challenge for Both Surgeon and Radiologist
Stacey L. Langford; John P. Fantauzzi, MD; Thomas Fabian, MD; Frederic Hellwitz, MD, Albany Medical Center, Albany, NY (langfoss@mail.amc.edu)

LEARNING OBJECTIVES: 1. Describe the rare but serious complication of postesophagectomy hiatal hernia. 2. Review four surgically corrected cases of postesophagectomy hiatal hernia with frank hernia in one case, transverse colon in left hemithorax in two cases, and both small and large bowel with mesentery in left hemithorax in one case. Findings were mistaken for normal postesophagectomy anatomy by the radiologist in at least one case. Findings were significantly more recognizable on coronal imaging than on axial images in two patients. All four cases were corrected surgically. One required resection of ischemic colon.

Conclusion: Hiatal hernia is a rare but serious complication after esophagectomy. Prevalence may be increasing with trend toward a minimally invasive transthoracic approach. Variable clinical presentation makes diagnosis challenging. Overlap of key imaging features with expected postoperative findings makes radiographic diagnosis equally difficult. Key imaging features include presence of small or large bowel in left hemithorax or above diaphragm on coronal imaging and translocation of bowel superior to the spleen. High index of suspicion is vital for diagnosis and prompt intervention.

(E-17) Wednesday • 7:00 AM
CT Pulmonary Angiography in the Pregnant Patient: Beyond the Binary of Pulmonary Embolism
William Chang, MD; Mustafa Al Qaisi, MD; Christian W. Cox, MD, National Jewish Health, Denver, CO (CoxC@NJHealth.org)

LEARNING OBJECTIVES: 1. Explain the basic physiologic changes making the pregnant patient prone to particular cardiopulmonary complications. 2. Describe a complete differential diagnosis of cardiopulmonary complications associated with pregnancy. 3. Differentiate causes of pregnancy-associated cardiopulmonary disease based on clinical picture and imaging findings. 4. Offer further guidance to the referring clinician following analysis of CT pulmonary angiography (CTPA) in the pregnant patient with cardiopulmonary disease.

CONTENT DESCRIPTION: Many articles and reviews have discussed the use and risks of CT pulmonary angiography (CTPA) in the pregnant patient, but none of them, to our knowledge, have reviewed the differential and CTPA imaging findings of the major cardiopulmonary complications associated with pregnancy. While particular conditions such as drug reaction and immunosuppression receive dedicated chapters, cardiopulmonary textbooks tend to neglect pregnancy as a unique clinical condition warranting special attention. In this review, we consider the major cardiopulmonary complications seen during the peripartum period, with a focus on the CTPA appearance of these diseases and an emphasis on subsequent management.

Content Organization: I. Introduction: Stressing the importance of considering pregnancy as a unique health state. II. Physiology of pregnancy: Covering the major points that affect the differential diagnosis of cardiopulmonary disease in the peripartum period, in addition to the normal physiologic changes seen on CTPA imaging. III. Differential diagnosis: Describing and discussing each of the major cardiopulmonary complications seen in pregnancy, along with CTPA imaging findings and examples. Complications include cardiomyopathy, drug reaction, preeclampsia, amniotic fluid embolism, infectious pneumonia, aspiration, and pulmonary embolism. IV. Further workup and management: Providing guidance on further imaging studies, lab work, or treatment to assist referring clinicians. V. Conclusion.
count and percentage are increased, while neutrophil and eosinophil percentages are normal. The CD4/CD8 T-lymphocyte ratio (>2) is typically increased in early and active disease but may be lower in more advanced disease. In hypersensitivity pneumonitis, BAL typically shows a marked lymphocytosis (often exceeding 50% of recovered cells). The CD4/CD8 ratio is usually decreased (<1). A number of ILDs have nonspecific and variable increases in the BAL cell constituents, including idiopathic pulmonary fibrosis, nonspecific interstitial pneumonia, cryptogenic organizing pneumonia, connective tissue disease–related ILD, and drug-induced ILD. In these diseases, the role of BAL is largely to exclude other processes. The main causes of BAL eosinophilia (>25% eosinophils) are idiopathic acute eosinophilic pneumonia, chronic eosinophilic pneumonia, and infection. In patients with ILD and a compatible clinical presentation, BAL fluid should be examined for the presence of hemosiderin, lipid-laden macrophages, Langerhans cells, and malignant cells, which would indicate alveolar hemorrhage, lipoide pneumonia, pulmonary Lang- erhans histiocytosis, or neoplastic disease, respectively. In summary, changes in relative and absolute numbers of cells in BAL fluid are nonspecific for a variety of ILDs but can be sufficiently characteristic to narrow the differential diagnosis.

(E-19) Wednesday • 7:00 AM
Fifty Shades of Color: Pulmonary Tumor Board through the Eyes of a Pathologist—A Primer for Radiologists

Nathan Coleman; Joel Brink, MD, University of Nebraska Medical Center, Omaha, NE; Lauren Murer, MD; Matthew DeVries, MD

LEARNING OBJECTIVES: 1. Describe the common pulmonary tumors (primary, neuroendocrine, and metastases) from a radiologic-pathologic perspective, with a focus on pathology and histologic “buzzwords.” 2. Describe certain stains or markers/mutations that pathologists use in generating differentials in terms of tumor types and origins. 3. Recognize that with increased understanding of all aspects/disciplines of tumor board conferences, radiologists are better equipped to communicate more effectively with their referring physicians.

CONTENT DESCRIPTION: Multidisciplinary tumor board conferences have quickly become a mainstay of health care delivery in which radiologists (within both academic and private practice realms) find themselves reviewing and displaying studies of various patients. This poster will focus on radiologic-pathologic correlation of common tumors that are often discussed within the context of a multidisciplinary pulmonary tumor board conference, with a focus on the pathologist’s perspective. Through an image-rich format, there will be demonstration and discussion of common lung tumors, including all non–small cell lung carcinomas; neuroendocrine tumors, including small cell carcinoma; and metastases. The various histology “buzzwords” that pathologists use will be emphasized with examples. This exhibit will also serve as a primer for radiologists in terms of acquainting them with the special stains and markers/mutations that are often referred to in conference discussions. With this information, radiologists will be better equipped to more effectively contribute in conversations with their multidisciplinary referring services.

(E-20) Thursday • 7:00 AM
The Many Faces of Sarcooidosis

Lauren Chang Sen, MD, University of Pittsburgh, Pittsburgh, PA; Jeffery Hogg, MD; Cynthia A. Britton, MD; Carl R. Fuhrman, MD (laurenchangsen@yahoo.com)

LEARNING OBJECTIVES: 1. Describe different clinical manifestations of sarcoidosis, including thoracic and extrathoracic involvement. 2. Describe the variety of imaging manifestations of sarcoidosis useful in clinical practice and for preparation for certifying examinations. 3. Identify imaging features that help correctly diagnose sarcoidosis.

CONTENT DESCRIPTION: I. Explain the common clinical presentations of sarcoidosis. II. Illustrate radiographic stages of thoracic involvement with sarcoidosis. III. Demonstrate less frequent extrathoracic sites of involvement with sarcoidosis.

(E-21) Wednesday • 7:00 AM
Difficulty Reading Chest Radiographs with Diffuse Reticular Opacities? Think SLICE—A New Diagnostic Mnemonic for the Evaluation of Diffuse Reticular Opacities with Normal to Increased Lung Volumes

Nils Schnor, MD, University of Pittsburgh Medical Center, Pittsburgh, PA; Carl R. Fuhrman, MD

LEARNING OBJECTIVES: 1. Describe clinical cases with similar patterns of interstitial lung disease (ILD) on chest radiographs and how to differentiate them with cross-sectional imaging. 2. Explain the basic pattern approach to interstitial lung disease and its importance in daily practice. 3. Describe an easy new mnemonic for evaluation of diffuse reticular opacities with normal to increased lung volumes.

CONTENT DESCRIPTION: Purpose/Aim: (1) To provide an easy mnemonic for evaluation of diffuse reticular opacities with normal to increased lung volumes. (2) To review the basic pattern approach to interstitial lung disease and its importance in daily practice. (3) To provide clinical cases with similar patterns of ILD on chest radiographs and how to differentiate them with cross-sectional imaging.

Content Organization: I. Brief review of pattern approach to interstitial lung disease on chest radiographs. II. Introduction of SLICE mnemonic for evaluation of diffuse reticular pattern opacities with normal to increased lung volumes: S = sarcoidosis; L = lymphangiomatomyasis, I = interstitial fibrosis with emphysema, C = cystic fibrosis, and E = eosinophilic granulomatosis. III. Review of imaging findings on plain film radiography and cross-sectional imaging. IV. Sample cases from the SLICE mnemonic. V. Summary.

Summary: Major teaching points: (1) A pattern approach to the evaluation of interstitial lung disease will significantly aid in the interpretation of difficult chest radiographs. (2) The following entities have a diffuse reticular pattern of opacities with normal to increased lung volumes: sarcoid, lymphangiomatomyasis, interstitial fibrosis with emphysema, cystic fibrosis, and eosinophilic granulomatosis (SLICE mnemonic). (3) Clinical history, distribution, and additional findings on HRCT can aid in differentiating the entities represented in the SLICE mnemonic.

(E-22) Thursday • 7:00 AM
Radiologic and Histopathologic Review of Extralobar Sequestration Associated with a Bronchogenic Cyst

Joseph R. Grajo, MD, University of South Florida, St Petersburg, FL; Judy Puckett, BS; Douglas Ivanicists, MD (jgrajo@health.usf.edu)

LEARNING OBJECTIVES: 1. Explain that pulmonary sequestration is a general term describing a defect that presents with large anatomic variation, and describe the classic definition of and commonly associated variables presenting with pulmonary sequestration. 2. Identify the role of different imaging modalities in the diagnosis and management of pulmonary sequestration, including pulmonary arteriogram, bronchogram, and ultrasound. 3. Describe a case of extralobar sequestration with a bronchogenic cyst, including clinical presentation.

CONTENT DESCRIPTION: Introduction: Pulmonary sequestration is classically described as lung tissue with systemic arterial supply without connection to bronchi or the trachea. It is a rare congenital defect with varying clinical presentation, as well as significant anatomic variation. This case highlights a rare occurrence of extralobar sequestration with bronchogenic cyst, in order to review the different imaging studies that are available in detection and management of pulmonary sequestration.

Methods: We will discuss the role of computed tomography angiography (CTA), pulmonary ultrasound, and bronchogram in diagnosis...
and management of pulmonary sequestration. Our case includes discussion of the patient’s history and clinical presentation, as well as the corresponding radiologic findings.

**Results:** Radiologic findings of extralobar pulmonary sequestration and common anatomic variables associated with pulmonary sequestration are presented.

**Conclusion:** The diagnosis and management of pulmonary sequestration are critically dependent on imaging. Modalities such as pulmonary ultrasound, bronchogram, and CTA provide necessary precision in evaluation of pulmonary sequestration and arterial supply in preparation for surgical excision. This case demonstrates the importance of considering these congenital defects in the differential diagnosis for various clinical presentations of respiratory symptoms in children.

**Education**

(E-26) Thursday • 7:00 AM
**Reaching Out and Speaking Up: Radiology Residents Educating the Community**
Alexandra Fairchild, MD, Brigham and Women’s Hospital, Boston, MA; Stacy E. Smith, MD; Beth Ripley, MD, PhD; Bryan P. Murphy; Barbara N. Weissman, MD*

Low visibility of radiologists in the community has led to a public misperception of the role radiologists play in the health care of Americans. As part of its initial “Face of Radiology” campaign research, the American College of Radiology found that respondents in the general public and on Capitol Hill were largely unaware that radiologists were licensed physicians with extensive training in medical imaging. In addition, patients may be unaware of what to expect when undergoing a particular imaging examination or in understanding the need for such an examination. Responding to the need for greater public understanding of a radiologist’s role and to familiarize the community with various imaging studies, the Brigham and Women’s Hospital Radiology Residency Program has designed and is implementing a Community Speakers Bureau comprised of residents discussing various topics in radiology with community groups. Examples include a discussion/video demonstration of the experience a patient should expect when undergoing an MRI or CT examination, the reality of radiation risks in CT studies, and discussions of some of the more common and/or controversial examinations, such as cancer screening through mammography and CT colonography. Each topic is selected for its relevance to the particular community group; groups include retirement communities and religious and school groups. Surveys before and after the presentations allow efficacy to be monitored. Goals of the program include (a) introduction of the radiologist as a physician specialized in medical imaging, (b) educating participants on important health care topics, (c) dispelling myths and addressing concerns related to common radiologic procedures, (d) educating patients on the importance of diagnostic and screening studies for improving health outcomes, and (e) improving radiology residents’ public speaking and communication skills. In summary, an organized residency speakers bureau with an outreach component can be effective in disseminating educational material on health topics related to radiology while providing a framework for residents as teachers in radiology and the community.

(E-30) Thursday • 7:00 AM
**Bibliometrics Application in Academic Radiology**
Issa Rezek, MD, Mayo Clinic, Rochester, MN; Nabil Wees, MD; Ravi Lingineni, MPH; David F. Kallmes, MD* (rezek.issa@mayo.edu)

**LEARNING OBJECTIVES:** The implications of bibliometrics are rapidly gaining favor in academic radiology, and the h-index is the most utilized so far. Being criticized for underestimating very highly cited articles, h-index was succeeded by newer metrics, which had not yet been evaluated in the radiology field. In this study, we applied different metrics (g-index, e-index, and generalized impact factor [GIF]) to evaluate their validity and the possible additive value to the h-index.

**CONTENT DESCRIPTION:** A random sample of radiologists practicing in the United States was drawn. Professional accomplishments were defined as academic rank and NIH grant success profile for professors and chairpersons as to August 2012. Academic rank was determined from programs’ Web sites. NIH grant success profile was determined from NIH RePORT. For each radiologist, g and e indices, along with GIF, were calculated manually by using the ISI Web of Knowledge database. Tests for differences of each index across academic ranks and NIH grant success were evaluated by using an ANOVA model. A multiple comparisons test was used to test the group differences among academic ranks. Bibliometrics of 688 radiologists from 47 programs were studied. A total of 28 (4.1%) were instructors, 271 (39.4%) associate professors, 179 (26%) professors, and 43 (6.3%) chairpersons. Professors and chairpersons had significantly higher scores of the g, e, and GIF metrics compared to the rest of the investigators (P < .0001). No significant differences were noted between instructors and assistants. Among the 222 professors and chairpersons, 50 (22.5%) had at least one NIH grant as the principal investigator at time of survey. NIH grant–awarded investigators possessed significantly higher bibliometrics (P = .0001 for g-index; P = .0001 for e-index; P = .0054 for GIF). Obtaining grants and the number of R01-like (R01, P01, and U01) grants showed a significant relation (P < .05) with g-index and e-index. No correlation was found with years of funding or total fund amount of grants. Academic rank and obtaining NIH grants were associated with higher scores of the studied metrics. Selecting the appropriate metric is dependent on committees’ aims.

(E-33) Wednesday • 7:00 AM
**Making the iPad Work for You: Top 10 iPad Apps for Radiology Education**
Daniel H. MacArthur, MD; Salar Hakham, DO, Tufts Medical Center, Boston, MA; Daniel M. Adams, MD; Harprit S. Bedi, MD (shakham@tuftsmedicalcenter.org)

**LEARNING OBJECTIVES:** 1. Describe the potential benefits of an iPad for the radiology resident. 2. Identify the myriad of resources available through the iPad. 3. Describe the top 10 radiology iPad apps for improving radiology education.

**CONTENT DESCRIPTION:** With the advent of the iPad, new resources are now available at radiologists’ fingertips. Resources available on the iPad include downloadable applications, online reference sites and search engines, downloadable books and atlases, journal articles, and electronic books. The extensive amount of information can be overwhelming. Focusing on the top 10 applications can make the iPad work more effectively for the radiologist.

* Faculty financial disclosures are located in the Faculty Index.
(E-34) Thursday • 7:00 AM
Prefab Radiology Clerkship: Based on AMSER Curriculum, AMSER Resources, and AMSER Examinations So You Can Construct Your Own Clerkship with Minimal Effort
Prapti Y. Shingala, BA; Lily Y. Zou, MD; Justin S. Alpert, MD; Judith K. Amorosa, MD, University of Medicine and Dentistry of New Jersey-Robert Wood Johnson University Hospital; New Brunswick; NJ; Jeffrey Kempf, MD (amorosa@umdnj.edu)

Based on the Alliance of Medical Student Educators in Radiology (AMSER) curriculum and other AMSR resources, we have redesigned our 4-week diagnostic radiology clerkship for 3rd- and 4th-year medical students. The redesigned clerkship consists of assigned textbooks, Web sites modules, problem-solving sessions, interactive lectures, an on-call experience, and a clinical reading room experience. In addition, we have incorporated learning resources available on the AMSR Web site, such as the AMSR Shared Resources and the Case Oriented Radiology Education module (which utilize the American College of Radiology [ACR] Appropriateness Criteria® to teach an evidence-based approach to imaging), the RSNA Clerkship Companion, and other radiation education Web sites. We have redesigned our clerkship to address the new reality of diagnostic radiology, where there is an increased emphasis on clinical productivity coupled with decreased reimbursement, which consequently means less contact time with medical students. We found that the AMSER and AMSR-related resources are valuable guides for medical student teaching and learning. We used a standardized test on Radiology ExamWeb, a national Web-based question item database and exam-taking system available to AMSER members. Using a standardized test benefits student learning and allows instructors to have immediate, empirically documented results. At a time when there is a need to restructure medical education, the implementation of a radiology clerkship based on the AMSER curriculum can help to standardize radiology medical student education. Our design of this course is a valuable resource for medical student educators in radiology. This clerkship requires limited resources, is not time-consuming to implement, and can be implemented for other medical schools and education systems.

(E-35) Wednesday • 7:00 AM
Integration of After-hours Insourced Academic Teleradiology with a Radiology Residency: How We Do It
Justin S. Alpert, MD, University of Medicine and Dentistry of New Jersey-Robert Wood Johnson University Hospital; New Brunswick, NJ; Sandip Basak, MD; Jeffrey Kempf, MD (AlpertJS@umdnj.edu)

LEARNING OBJECTIVES: 1. Describe a unique model of after-hours coverage, which integrates insourced teleradiology with a radiology residency program. 2. Identify the advantages and disadvantages of using this model of after-hours teleradiology and the effect upon resident education.

CONTENT DESCRIPTION: There is an increased demand for contemporary interpretation of radiologic examinations after hours. One model is to outsource radiology services after hours. However, this comes with disadvantages, including removing the radiologist from the point of service, diminished quality of reports, and the commoditization of radiology. For those academic institutions with a radiology residency that outsource services, minimizing the role of the resident after hours is of concern. However, at our institution, a unique insourced model has been developed, with a focus on resident education. The resident is the core provider of after-hours coverage. Supervision is provided by subspecialized teleradiologists in the United States and abroad who are medical school appointed faculty and therefore integrated into departmental activities. At our institution, resident float coverage is divided into a second shift from 4 PM to 12 AM and a third shift from 11 PM to 8 AM, Monday through Friday. Faculty teleradiology coverage dovetails with resident coverage. The resident is required to review each case first and place a preliminary interpretation into the PACS electronic note.

The faculty teleradiologist then reviews the case with the resident either electronically or by telephone. A final report is dictated by the resident thereafter. Thus the concept of the “virtual attending” is born. The advantages of this model are program director oversight, improved patient care, efficient turnaround time, and extension of resident education after hours. Disadvantages include unknown implications of continuous attending supervision on long-term resident autonomy, and the lack of face-to-face interaction between resident and attending. Our program integrates an insourced, quality- and education-driven teleradiology section with after-hours resident coverage to provide services for a major academic hospital.

(E-39) Wednesday • 7:00 AM
Checklist to Improve Radiation Awareness and Reduce Radiation Exposure: A Tool for Residents Performing Fluoroscopy
Jessica R. Leschied, MBBC, University of Michigan Health System, Ann Arbor, MI; Daniel I. Glazer, MD; Janet E. Bailey, MD; Katherine E. Maturen, MD* (jleschi@umich.edu)

LEARNING OBJECTIVES: 1. Describe the concept of standardized checklists in medicine and other industries. 2. Explain how checklists might apply to patient safety in the radiology department. 3. Enumerate the elements of a simple preprocedural checklist for gastrointestinal/genitourinary fluoroscopy. 4. Be prepared to teach radiology residents how to apply checklists to their operation of the fluoroscopy tower.

CONTENT DESCRIPTION: I. Introduction. A. History of medical checklists and their origin in the aviation industry. B. Medical checklists in radiology. II. How to build a medical checklist. A. What makes a good checklist. B. Example at our institution: “Improving our PRODUCT!”—a checklist in the form of a mnemonic, as follows: P = pulse fluoro, R = remove grid (if able), O = off pedal, D = demagnify, U = use badge (radiation badge), C = collimate, and T = tower down. C. Reinforcing the use of the checklist through weekly teaching sessions at the fluoroscopy tower. III. Measuring outcomes. A. Surveying resident attitudes and perceptions of radiation safety. B. Measuring fluoroscopy times. IV. Conclusion: This instructional poster will introduce our institution’s novel idea for improving patient and operator radiation safety during fluoroscopy procedures through the use of a simple preprocedural checklist.

(E-41) Wednesday • 7:00 AM
Development of a Resident-led Physics Curriculum with Integration of the RSNA/AAPM Physics Modules
Prasad R. Shankar, MD, University of Pittsburgh Medical Center, Pittsburgh, PA; Matthew T. Heller, MD; Jesse D. Woodard, MD; Philip Orons, DO (shankarp@upmc.edu)

LEARNING OBJECTIVES: 1. Identify the limitations and perceptions of the traditional lecture-based physics curriculum at a large academic radiology residency program. 2. Outline a novel approach to teaching radiologic physics through the establishment of a resident-led, small-group physics curriculum. 3. Describe the outcomes of these changes, both in qualitative performance on physics examinations and in subjective resident perceptions.


* Faculty financial disclosures are located in the Faculty Index.
Role of Doppler US in the Screening and Management of Upper Extremity Thrombosis

Joseph R. Grajo, MD, University of South Florida, St Petersburg, FL; Harsha Nalluri, BS (jgrajo@health.usf.edu)

LEARNING OBJECTIVES: 1. Explain the function of ultrasound as a screening tool for upper extremity thrombosis, as supported by current literature. 2. Identify the challenges posed to using ultrasound as an effective screening tool for thrombosis of the upper extremities. 3. Describe management of indwelling PICC lines in patients who are found to have upper extremity thrombosis on ultrasound.

CONTENT DESCRIPTION: Introduction: Upper extremity thrombosis presents with fewer clinical symptoms and is associated with a higher mortality rate compared to lower extremity thrombosis. Patients with indwelling PICC lines are at the greatest risk of developing upper extremity thrombosis. A literature review was performed to understand the utility of Doppler ultrasound as a screening tool for detecting upper extremity thrombosis in patients at risk and the subsequent management of PICC lines.

Methods: A literature search was performed on PubMed to find appropriate prospective registries, case series, experimental clinical risk scores, and comprehensive literature reviews.

Results: The sensitivity and specificity ranges of ultrasound in detecting upper extremity thrombosis (UET) ranged from 78% to 100% and from 82% to 100%, respectively. Experimental clinical prediction scores show some success in identifying patients at high risk of upper extremity thrombosis who would benefit most from ultrasound screening. On detecting deep upper extremity thrombosis, the patient should be immediately placed on anticoagulation if there are no contraindications. The immediate removal of PICC lines on discovering an upper extremity thrombus is not necessary except in cases of absolute contraindications. Otherwise, the PICC lines may still be used in patients who develop UET for as long as they are clinically indicated.

Conclusion: Venous ultrasound is a safe and inexpensive way to reduce mortality associated with upper extremity thrombosis. Further development of clinical prediction scales can help reduce the number of patients screened to only those at the highest risk. The immediate removal of PICC lines in the setting of UET is unnecessary unless absolute contraindications exist.

Measuring and Improving Radiology Report Turnaround Time with a Graphical Interface

Daisy Huang, MD, New York-Presbyterian Hospital/Weill Cornell Medical Center, New York, NY; Bradley B. Pu, MD (Dazeyhuang@gmail.com)

Background: Radiology report turnaround time (RTAT) has been established by the American College of Radiology as an important practice quality metric for patient care. Improving the time between image acquisition and report availability to referrers promises to streamline clinical decision making, decrease inpatient hospital stays, and improve both clinician’s and patient’s satisfaction. Reporting delays may also seriously compromise patient care, as urgent findings necessitating immediate intervention may not be communicated to the clinician appropriately. However, with an increasing case volume and the need to maintain report quality, meeting appropriate RTAT benchmarks is often overlooked by radiologists.

Evaluation: We implemented a quality improvement project in our interventional radiology (IR) department to decrease RTAT, as findings from IR procedures can have immediate implications for inpatient care and clinical decisions. We collected data for 3 months on und dictated studies and RTAT by attending physicians prior to intervention. We then compiled weekly data for each attending physician on their incomplete studies, organized by und dictated studies and preliminary studies signed only by residents or fellows. Graphical representations of these data were e-mailed to attendings and posted in the department conference room every week for several months.

Results: Mean RTAT decreased significantly for the majority of attendings after implementation of weekly graphical reminders. Faculty members whose performance did not improve initially with e-mail reminders demonstrated expedited RTAT after meetings with the department chair.

Conclusion: RTAT has become a paramount determinant in quality patient care, especially as we shift focus to practice quality improvement measures to eliminate inefficiency, contain costs, and improve clinician’s satisfaction. Recent studies have shown that pay-for-performance programs can improve RTAT. We demonstrated that even simple and cost-effective interventions such as regular monitoring with graphical interfaces can minimize reporting delays and improve work-flow efficiency.
Interventional Radiology

(E-54) Wednesday • 7:00 AM
Interventional Management of Ruptured Hepatocellular Carcinoma: A Review
Kevin S. Baker, MD; Gunjan Aeron; Ajay Malhotra, MD; Carl Tack; Atul Kumar; Ammar A. Chaudhry, MD; Stony Brook University Medical Center, Stony Brook, NY

LEARNING OBJECTIVES: 1. Describe the clinical presentation, pathophysiology, imaging findings, and diagnosis of ruptured HCC. 2. Explain the management of ruptured HCC in the acute phase. 3. Describe the prognostic factors, definitive management, and survival of patients with ruptured HCC.

CONTENT DESCRIPTION: Rupture occurs in 3%–15% of patients with hepatocellular carcinoma (HCC). It is an acute surgical emergency with a high mortality rate. The sudden onset of an acute abdomen is the most common presentation. Ultrasonography (US) and computed tomography (CT) of the abdomen are useful in demonstrating the presence of hemoperitoneum in a patient with a characteristic liver mass. Pretreatment angiography may demonstrate extravasation of contrast material or tumor hypervascularity. We will present three cases of ruptured HCC in order to review the entity’s presentation, pretreatment appearance on imaging, and treatment technique. Cases will have a review of diagnostic CT images, which show hemoperitoneum in patients with nodular/cirrhotic livers and HCC masses with characteristic early arterial enhancement. Pre- and postembolization images will also be provided, which show tumor hypervascularity and contrast extravasation, with documented resolution on postembolization intra procedural images. Text reviewing prognostic factors, definitive management, and survival of patients with ruptured HCC will also be presented.

(E-55) Wednesday • 7:00 AM
Targeting Hepatic Dome Lesions for Percutaneous Biopsy: Techniques, Challenges, and a Case Presentation Illustrating a Novel Approach
Scott Loomis, MD, University of Vermont Fletcher Allen Healthcare, Burlington, VT; Kenneth Najarian, MD

LEARNING OBJECTIVES: 1. Identify the various image-guided techniques and approaches used for percutaneous liver biopsies. 2. Describe the unique challenges encountered during image-guided percutaneous biopsies of hepatic dome lesions. 3. Explain the potential complications involved with percutaneous hepatic dome lesion biopsy.

CONTENT DESCRIPTION: Image-guided biopsy of lesions in the liver dome can be technically challenging due to lesion location, respiratory motion, etc. This is especially true when using CT guidance. Moreover, many of these lesions may only be visualized briefly on postcontrast imaging, making target visualization during needle placement particularly difficult. Topics to be discussed include (a) various imaging modalities used during percutaneous liver biopsy, (b) different biopsy approaches used for liver dome lesion biopsy (transhepatic, transthoracic, etc.), (c) particular challenges and potential complications encountered during liver dome lesion biopsy, and (d) description of a novel image-guided approach to a challenging liver dome lesion by using a case presentation. We present a case of an early-enhancing liver dome lesion in a patient with cirrhosis. The lesion was highly suspicious for hepatocellular carcinoma. Initial biopsy attempt was made by using CT guidance, at the end of which a small embolization coil was placed to mark the biopsy site. Pathology results revealed benign hepatocytes. Given the suspicious nature of the lesion, a follow-up CT scan was performed, showing the coil at the posterior edge of the liver lesion. Subsequently, the patient underwent fluoroscopically guided percutaneous biopsy by using the coil as a target. Biopsy result revealed hepatocellular carcinoma.

(E-56) Wednesday • 7:00 AM
Pelvic Congestion Syndrome: The Radiologist’s Role from Diagnosis to Treatment
Paul Thottakara, MD, William Beaumont Hospital, Royal Oak, MI; Mina M. Zaki, MD; Purushottam K. Dixit, MD; Matthias J. Kirsch, MD; Michael A. Savin, MD; Jeremy Handel, MD; et al (mina.zaki@beaumont.edu)

LEARNING OBJECTIVES: 1. Describe the pathophysiology, etiology, and typical clinical presentation of pelvic congestion syndrome (PCS). 2. Identify the central role of the radiologist in the diagnosis of PCS. 3. Describe the preprocedural evaluation and endovascular techniques used in the treatment of PCS, as practiced at our institution.

CONTENT DESCRIPTION: Introduction: Chronic pelvic pain accounts for up to 40% of all gynecologic referrals. Pelvic congestion syndrome (PCS) is an important, yet underdiagnosed, cause of chronic pelvic pain in women. Understanding of the typical imaging findings and clinical presentation of PCS is critical, as effective endovascular treatment options are available. Endovascular treatment of PCS has been found to be effective in 98%–100% of cases, and up to 85% of patients have improvement in their symptoms within 2 weeks of treatment. The objective of this exhibit is to highlight the central role of the radiologist in diagnosis and treatment of PCS.

Outline of Content: I. Introduction to chronic pelvic pain and PCS. II. Pathophysiology and etiology. III. Clinical presentation. IV. Diagnosis of PCS. A. Multimodality imaging findings of PCS, including ultrasound, CT, MRI, MRV, and angiography. B. Intraoperative findings on laparoscopy. V. Treatment of PCS. A. Preprocedural evaluation. B. Endovascular techniques. C. Outcomes and complications. VI. Future considerations.

Conclusion: PCS is an underdiagnosed cause of chronic pelvic pain in women. Accurate and early diagnosis is important, as effective endovascular therapy is available. The radiologist plays a central role in the diagnosis, management, and definitive treatment of these patients.

Musculoskeletal Radiology

(E-59) Thursday • 7:00 AM
Beyond the Anteroposterior and Axillary Views of the Shoulder: What Other Radiographic Views of the Shoulder the Academic Radiologist Needs to Know
Yulia V. Volokhina, MD, Loma Linda Medical Center, Loma Linda, CA; Kendra L. Fisher, MD

LEARNING OBJECTIVES: 1. Correctly identify the various radiographic views of the shoulder joint used in clinical practice and applicable to the academic radiology environment. 2. Explain how the specific shoulder radiographs are obtained. 3. Identify which views are helpful for diagnosis in certain clinical settings.

CONTENT DESCRIPTION: We will demonstrate radiographic examples, discuss technique, and correlate with suspected clinical pathology for the following radiographic views of the shoulder: Grashey, anteroposterior (AP) in external and internal rotation, scapular y, supraspinatus outlet, axillary, Zanca, 30° caudal tilt AP, West Point axillary, Stryker notch, serendipity, Bennett’s, and Garth views.
(E-60) Wednesday • 7:00 AM
Fundamental Approach to the MR Imaging Evaluation of Ankle Pathology
Dane Miller, MD, William Beaumont Hospital, Royal Oak, MI; Edward J. Walsh, MD; Richard Barger, Jr, MD; Shashin K. Doshi, MD (shashin.doshi@beaumont.edu)

LEARNING OBJECTIVES: 1. Describe a systematic and organized approach for the evaluation of ankle anatomy and pathology. 2. Review the more common and some less common appearances of various acute and chronic pathologic processes involving the ankle joint, including ligamentous injuries, tendon pathology, osseochondral pathology, impingement syndromes, rheumatologic diseases, and clinically relevant developmental variants. 3. Use specific imaging planes and sequences to optimize the MRI evaluation of the ankle joint. We will review the benefits and limitations of various imaging planes and sequences, as well as provide instruction on less-well-known tips to maximize the potential for a more complete assessment of the ankle.

CONTENT DESCRIPTION: This educational exhibit will provide instruction that will optimize the learner’s approach to MRI evaluation of the ankle by reviewing the fundamentals of anatomy, pathology, imaging sequences, and imaging planes. A systematic and organized approach to evaluating ankle anatomy and pathology will be presented, including an inside-out compartment-based approach. The typical anatomical appearance of the compartments, with a review of the pathologic appearance, will be provided. Understanding the strengths and weaknesses of various imaging planes and MRI sequences will better allow the learner to understand the benefits and limitations of each. We will instruct the learner on what, how, and when to look for various pathologic processes. Additional less-well-known tips will be provided to the learner to optimize MRI evaluation of the ankle, which will subsequently maximize the potential for a more complete assessment of the ankle joint.

(E-61) Thursday • 7:00 AM
MR Imaging of the PosteroMedial Corner of the Knee: Normal Anatomy and Common Injury Patterns
Shrey K. Thawait, MD, Bridgeport Hospital, Bridgeport, CT; Gaurav K. Thawait, MD; Sahar J. Farahani; John A. Carrino, MD, MPH*; Avneesh Chhabra, MD* (sthawai2@jhmi.edu)

LEARNING OBJECTIVES: 1. Describe the normal anatomy and MRI appearance of the various structures at the postero medial corner (PMC) of the knee. 2. Identify the common injury patterns of the PMC and its effect on knee stability. 3. Describe the high-resolution MRI technique and importance of different pulse sequences for imaging of the PMC. The dynamic muscular-ligamentous unit powered by semimembranosus muscle and supported by adjacent ligaments in the postero medial corner (PMC) is a crucial stabilizer of the knee. It assumes the primary role in resisting anteromedial instability in the presence of a damaged anterior cruciate ligament. While the posterolateral corner injuries have been extensively published, there is a relative paucity of literature describing the magnetic resonance imaging (MRI) of the PMC. Accurate identification of PMC injury has important implications for appropriate management of knee trauma.

CONTENT DESCRIPTION: By using high-resolution representative images from MR examinations, the following imaging findings will be illustrated: (a) normal MRI appearance of semimembranosus tendon and its expansions, posterior oblique ligament, posterior horn of the medial meniscus, medial head of gastrocnemius muscle, and medial collateral ligament; and (b) hallmark findings of PMC corner injuries. The latter include (a) muscle/tendon tears of semimembranosus and medial head of gastrocnemius; (b) ligament injury: various grades of sprains/tears of posterior oblique and medial collateral ligament; and (c) meniscocapsular injury: medial meniscal tears of the posterior horn, associated capsular separation, and tears of the tibial attachment. MRI provides high-resolution anatomical detail of the structures at the postero medial corner of the knee. Accurate and early identification of injury to important dynamic stabilizing structures may warrant operative repair instead of conservative therapy.

(E-62) Wednesday • 7:00 AM
Ammar A. Chaudhry, MD, Stony Brook University Medical Center, Stony Brook, NY; Kevin S. Baker, MD; Cheryl H. Lin, MD; Elaine S. Gould, MD (ammar.chaudhry@stonybrookmedicine.edu)

LEARNING OBJECTIVES: 1. Explain the histology and pathophysiology of superficial and deep soft-tissue fibrous lesions. 2. Describe imaging findings, including radiographs, CT, and MRI, of soft-tissue fibrous lesions. 3. Identify differential diagnoses and imaging features of mimics, with emphasis on key points that help to narrow the differential diagnosis.

CONTENT DESCRIPTION: I. Discussion of demographics and clinical manifestations. II. Case-based discussion of imaging features with imaging examples, as well as radiology-pathology correlation of fibrous lesions, including superficial and deep fibromatoses such as Dupuytren disease, “ledderhose” disease, fibrosarcoma, extra-abdominal desmoids, dermatofibroma, and dermatofibrosarcoma protuberans. III. Should we biopsy? Treatment, prognosis, and imaging follow-up of the above soft-tissue fibrous lesions. IV. Imaging examples of other soft-tissue lesions in the differential diagnosis, including neurofibromas, angiomyxoma, synovial sarcoma, myxoid liposarcoma, solitary fibrous tumors, elastofibroma, myofibroma, and hemangiopericytoma. V. What should be included in the radiologic report? VI. Chart outlining salient clinical and imaging features to review discriminating features of various fibrous lesions and their mimics. VII. Conclusion: A. Soft-tissue fibrous lesions include a wide variety of entities with clinical and imaging overlap; by the conclusion of this presentation, the radiologist should have a better understanding of soft-tissue fibrous lesions and their imaging findings. B. Differential can be narrowed by utilizing age, clinical features, location, and imaging findings. C. What the radiologist needs to know; what should be conveyed and recommended to the clinician and included in the radiology report. D. Viewer should be able to narrow the differential diagnosis, aid in the workup, and guide any potential biopsy and imaging follow-up.

(E-63) Thursday • 7:00 AM
What Is Eating the Flesh? What the Radiologist Needs to Know regarding Fasciitis and Other Associated Conditions
Ammar A. Chaudhry, MD, Stony Brook University Medical Center, Stony Brook, NY; Kevin S. Baker, MD; Cheryl H. Lin, MD; Elaine S. Gould, MD (ammar.chaudhry@stonybrookmedicine.edu)

LEARNING OBJECTIVES: 1. Describe clinical findings and imaging features of necrotizing fasciitis. 2. Identify additional soft-tissue processes resulting from infection, inflammation, injury, and/or malignancy that may mask and/or mimic necrotizing fasciitis. 3. List key points that help to narrow the differential diagnosis.

CONTENT DESCRIPTION: I. Anatomic location highlighted by using pictorial review (cartoon and/or radiographic demonstration). II. Pathophysiology of superficial and deep soft-tissue inflammatory lesions. III. Case-based demonstration of clinical and imaging features (radiograph, ultrasound, CT, and MRI) of necrotizing fasciitis, highlighting its emergent features that require immediate treatment. IV. Case examples of mimics (nonnecrotizing fascitis, myositis, myonecrosis, etc), with discussion of their different clinical/imaging features, pathophysiology, and treatment. V. Chart of salient features for quick reference. VI. Conclusion: Necrotizing fasciitis is an emergency with potential lethal outcome. Dissecting gas along fascial planes in the absence of an open wound, surgery, or penetrating trauma is essentially pathognomonic. Imaging may aid in the diag-
nosis, but findings may be negative, and thus the diagnosis remains clinical. Mimics of necrotizing fasciitis include nonnecrotizing fasciitis (eosinophilic, paraneoplastic, nodular, proliferative, ischemic, and granulomatous), myositis, neoplasm, myonecrosis, inflammatory myopathy, derenervation edema, and compartment syndrome.

(E-64) Wednesday • 7:00 AM
Imaging Review of Intra- and Extraarticular Manifestations of Crystalline Arthritis, with Emphasis on MR Imaging and CT Findings

Maryam Gul, MD, Winthrop-University Hospital, Mineola, NY; Ammar A. Chaudhry, MD; Choo W. Kim; Abbas Chaudhry; Yudell Edelstein, MD (Ammar.Chaudhry@stonybrookmedicine.edu)

LEARNING OBJECTIVES: 1. Review the clinical presentation and imaging findings of gout and CPPD arthropathy, highlighting both intra- and extraarticular manifestations. 2. Describe similarities and distinguishing features of gout and CPPD, as well as differential diagnoses, including infectious, inflammatory, neoplastic, and traumatic conditions that may mimic crystal-induced arthritis. 3. Identify key points that help to narrow the differential diagnosis.

CONTENT DESCRIPTION: I. Anatomic location of crystalline arthritis highlighted by using pictorial review (cartoon and/or radiographic demonstration). II. Case-based discussion of clinical presentation, histopathologic features, and intraarticular and extraarticular imaging findings on radiographs, CT, and MRI, as well as treatment and prognosis, of crystalline arthropathy. III. Case examples of mimics, with discussion of their different clinical findings, imaging features, histopathology, treatment, and prognosis. IV. Chart of salient features for quick reference. V. Conclusion: A. Gouty and CPPD crystals can be deposited both within joints and with extraarticular soft tissues and can involve both the axial and appendicular joints. B. A variety of entities mimic intraarticular and extraarticular manifestations, as well as the clinical presentation, of gout and CPPD deposition. By the conclusion of this presentation, the radiologist should have a better understanding of various clinical presentations of patients with gout and CPPD arthritis and their imaging findings. Differential diagnosis can be narrowed by utilizing age, clinical features, joint location, and imaging characteristics. C. What should be conveyed to the radiologist and recommended to the clinician that will aid in the workup and guide any potential biopsy and/or imaging follow-up.

(E-65) Thursday • 7:00 AM
Ewing Sarcoma and Its Many Faces

Mahsa Hoshmand, MD, Stony Brook University Medical Center, Stony Brook, NY; Cheryl H. Lin, MD; Ammar A. Chaudhry, MD; Kevin S. Baker, MD; Syed Hoda, MD; Mingqian Huang, MD; et al (clin.1110@gmail.com)

LEARNING OBJECTIVES: 1. Describe the characteristic and diverse imaging findings of Ewing sarcoma (ES). 2. Identify pathologic and cytogenetic features of ES cases for radiologic/pathologic correlation. 3. Explain how tumor staging and treatment decisions are derived from both imaging and pathologic assessments. 4. Discuss the pivotal role of the radiologist in diagnosis and management.

CONTENT DESCRIPTION: I. Pictorial essay with imaging of plain film, CT, and MRI of ES in both typical and atypical locations, including pelvis, metatarsal, ulna, skull, clavicle, spine, and extraskeletal locations. II. Pathologic correlation of ES, including morphology images, immunohistochemical profile, and associated genetic translation abnormalities. III. Discussion of how combining radiographic and pathologic findings helps the clinician at the decision making of ES treatment plans. IV. Conclusion: ES, as the second most common and one of the most lethal malignant bone tumors in children and adolescents, demonstrates a predilection for the pelvis and lower extremities, but it can occur in a variety of locations in the skeletal system, with some occurrence in extraskeletal locations. The ability to recognize the various imaging findings of ES will greatly aid in early diagnosis, with significant impact on future prognosis.

(E-66) Wednesday • 7:00 AM
Metal-on-Metal Hip Resurfacing Arthroplasty and Its Complications: A Problem for the Orthopedist, the Radiologist, and the Patient

Cheryl H. Lin, MD; Ammar A. Chaudhry, MD, Stony Brook University Medical Center, Stony Brook, NY; Kevin S. Baker, MD; James Nicholson, MD; Fazel Khan, MD; Mary Ragsdale, MD; et al (clin.1110@gmail.com)

LEARNING OBJECTIVES: 1. Explain the issues of metal-on-metal hip resurfacing arthroplasty (MOMHRA) from the perspectives of the orthopedist, the radiologist, and the patient. 2. Describe the components of MOMHRA, the imaging findings, and complications, with special emphasis on a unique complication of aseptic lymphocyte-dominated vasculitis-associated lesions (ALVALs). 3. Describe the intraoperative findings from revision of failed MOMHRA, with corresponding pathologic features and radiologic correlation. 4. Identify the key features to be included in the MOMHRA radiologic evaluation and what to include in the reports.

CONTENT DESCRIPTION: I. Photos of MOMHRA hardware components, and illustration to explain proposed reason for failure from mechanical and physiologic standpoints. II. Discuss optimization of MR imaging by utilizing metal artifact reduction sequences. III. Pictorial review of failed MOMHRA cases with before-revision MRI and plain film demonstrating complications from periprosthetic collections (pseudotumor), including cases of ALVAL and standard complications of aseptic loosenings, osteolysis, and metallosis. IV. Review intraoperative findings from revision surgery of failed MOMHRA, with special emphasis on ALVAL. V. Propose a systematic approach for radiologists in evaluating MOMHRA. VI. Conclusion: A. MOMHRA as a popular alternative arthroplasty for younger active patients shares the common complications of other arthroplasty procedures but with a unique complication of ALVAL, likely from design of small/shallow acetabular cups and large femoral heads leading to metal corrosion and/or release of metal debris, inciting adverse inflammatory reactions. B. Plain film findings of osteolysis and implant migration and MR findings of metallosis and pseudotumor are all signs for MOMHRA failure. C. Radiologists must be able to recognize MOMHRA-related complications early and suggest implant failure in a patient with hip pain, particularly to nonorthopedists.

(E-67) Thursday • 7:00 AM
Reverse Total Shoulder Arthroplasty Made Simple

Kevin S. Baker, MD, Stony Brook University Medical Center, Stony Brook, NY; Cheryl H. Lin, MD; Mahsa Hoshmand, MD; Ammar A. Chaudhry, MD; Edward Wang, MD; Mingqian Huang, MD; et al (clin.1110@gmail.com)

LEARNING OBJECTIVES: 1. Describe the biomechanics and potential complications of reverse total shoulder arthroplasty (RSA). 2. Identify the indications of RSA, with demonstration of its components. 3. Describe normal imaging appearance of RSA and its complications. 4. Explain what the radiologists need to include in the radiologic report in pre- and postoperative evaluations.

CONTENT DESCRIPTION: I. Describe the indications of RSA. II. Photos of RSA hardware components and illustrations on how the prosthesis functions mechanically. III. Pictorial review of preoperative imaging assessment and postoperative complications of RSA on images: The complications from RSA on plain film include anterosuperior dislocation (escape), scapular notching, glenosphere dissociation, aseptic loosening, acromial or scapular fracture, infection, hematoma, and nerve injury. IV. Description of a systematic radiologic evaluation in both preoperative and postoperative RSA patients, with a checklist of pertinent positive and negative findings to include in the radiology report. V. Conclusion: A. RSA, with its unique design, demands strict preoperative radiologic criteria. As such, there is an array of potential complications, somewhat different from the anatomy total shoulder arthroplasty. B. Thorough understanding of the mechanical basis of the RSA design, with a systematic approach for evaluation and a checklist, will give radiologists a good grasp to provide a meaningful report.

Faculty financial disclosures are located in the Faculty Index.
(E-68) Wednesday • 7:00 AM
"It’s Not So Hard!": Soft-Tissue Tumors of the Extremities Made Easy—A Pictorial Review for Radiology Residents
John Chua-Tuan, Texas Tech University Health Sciences Center, El Paso, TX; Mingqian Huang, MD; Brandon Fuqua; Shaked Laks, MD (shaked.laks@ttuhsc.edu)

LEARNING OBJECTIVES: 1. Describe the classification and clinical features of common soft-tissue tumors in the extremities. 2. Develop a systematic approach for MRI evaluation of extremity soft-tissue tumors, with emphasis on differential diagnoses. 3. Explain the role of imaging in the workup of soft-tissue tumors in the extremities.

CONTENT DESCRIPTION: I. Review of the classification of soft-tissue tumors in the extremities. II. Pictorial review of MRI features of major benign and malignant soft-tissue neoplasms of the extremities, including lipoma, hemangioma, fibromatosis, liposarcoma, synovial sarcoma, peripheral nerve sheath tumor, giant cell tumor of the tendon sheath, and ganglion cyst. III. Pictorial review of MRI features of common nonneoplastic soft-tissue masses in the extremities, including abscess, hematoma, and myositis ossificans. IV. Discussion of how early identification and pertinent differential diagnoses impact a patient’s prognosis.

Conclusion: Soft-tissue masses of the extremities are a diverse group of neoplastic entities and nonneoplastic mimics that pose a unique challenge for residents. The ability of a resident to use a systematic approach and form a narrowed differential diagnosis will aid clinicians in treatment planning.

(E-69) Thursday • 7:00 AM
Applications of Diffusion-weighted MR Imaging in Musculoskeletal Pathology
Natalie Chen; Arash Anavim, MD, University of California, Irvine, Irvine, CA

LEARNING OBJECTIVES: 1. Review the underlying basis of DWI MR applications to musculoskeletal (MSK) pathology, and describe the imaging appearance of MSK pathology on DWI sequences. 2. Describe the role of DWI MR in fractures, lymphoma, and whole-body imaging. 3. Identify emerging applications of DWI MR to MSK pathology.

CONTENT DESCRIPTION: I. Basics of DWI. II. Role of DWI in lymphoma: diagnostic, staging, and therapy response assessment. III. Role of DWI in vertebral fractures: differentiating acute osteoporotic versus tumor-related. IV. Role of DWI in whole-body imaging. V. Sample cases. VI. Future directions and summary.

(E-70) Wednesday • 7:00 AM
Joint Hardware Imaging: From Functional to Failure
David Nakamura, MD, University of California, Irvine, Orange, CA; Diana L. Lam, MD; Michael E. Cody, MD

LEARNING OBJECTIVES: 1. Describe the types of arthroplasty hardware materials, with emphasis on the hip. 2. Explain the mechanisms of postoperative injury and hardware failure in joints, including infection/loosening, fracture, metallosis, bead shearing, and dislocation/subluxation. 3. Explain the utility of imaging in the normal and abnormal postoperative states, including radiographs, CT, and MR imaging, with emphasis on becoming an invaluable asset to referring orthopedic physicians. 4. Describe imaging findings of normal postoperative hardware wear and tear.

CONTENT DESCRIPTION: I. Overview of a variety of orthopedic arthroplasty hardware: metal-on-metal, radiolucent components, and cemented and porous surfaces. II. Chronicity of normal postarthroplasty imaging, with discussion of specific areas prone to hardware failure at each point in time. III. Review of specific findings in postarthroplasty imaging that suggest successful surgery versus findings indicating a need for follow-up, further imaging, or surgical revision.

(E-71) Thursday • 7:00 AM
Multimodality Imaging of Kager’s Fat Pad
Kausal Mehta, MD, University of Cincinnati, Cincinnati, OH; Robert Wissman, MD; Eric England, MD (kaushal.mehta@uchealth.com)

PURPOSE: The purpose was to (a) review the normal anatomy and fascial planes of Kager’s fat pad by using a multimodality approach with plain radiography, CT, MRI, and ultrasonound; and (b) describe how various pathologic conditions or anatomic variants can alter the appearance of Kager’s fat pad on multiple imaging modalities.

METHOD AND MATERIALS: Methods included the following: (a) normal anatomy of Kager’s fat pad; (b) review of imaging findings: plain radiography, CT, MRI, and ultrasonound; (c) normal anatomic variants altering the appearance of Kager’s fat pad, with sample cases; and (d) pathologic conditions altering the appearance of Kager’s fat pad, with sample cases.

RESULTS: Increase awareness among radiologists about the normal anatomy, anatomic variants, and pathologic conditions affecting Kager’s fat pad on multiple imaging modalities.

CONCLUSION: Kager’s fat pad is well known but poorly understood. This exhibit will increase awareness about the imaging appearance of Kager’s fat pad and consequently help in improved diagnosis.

(E-72) Wednesday • 7:00 AM
Does Dark Matter? Understanding T2-Dark Cartilage Lesions
Kausal Mehta, MD, University of Cincinnati, Cincinnati, OH; Robert Wissman, MD; Eric England, MD; Joshua Appar, DO; Eric Langenderfer (kaushal.mehta@uchealth.com)

PURPOSE: Magnetic resonance (MR) imaging remains the modality of choice for noninvasive imaging of cartilage degeneration. Radiologists are most familiar with cartilage lesions that are high in signal on T2-weighted images, which include abnormalities such as softening, fissures, and delamination. Recently, several of these cartilage lesions have been described as dark on T2-weighted images. Our purpose is to review these T2-dark lesions, as well as the normal appearance of cartilage at MR imaging, with an emphasis on T2-dark cartilage.

METHOD AND MATERIALS: We will be including the spectrum of T2-dark cartilage signal examples in our exhibit: (a) Normal cartilage has a laminar appearance at MR imaging, which reflects the depth-dependent variations in the T2 of hyaline cartilage. (b) Changes in the orientation of cartilage to the main magnetic field will change the appearance of these layers and explain many of the normal variations of T2-dark cartilage. (c) Fractures in the collagen network inhibit the normal constraint of the matrix on hydrated aggrecan, allowing the tissue to swell, resulting in the more-familiar high T2-weighted cartilage lesions. (d) T2-Dark cartilage lesions, which occur more commonly with subacute or chronic cartilage injury, may appear round, oval, or linear. Such lesions have been shown to represent cartilage degeneration, fissures, and delamination at arthroscopy. (e) The cause of T2-dark cartilage is unclear but may be related to fragmentation of collagen fibrils, which could lead to more-efficient T2 relaxation.

RESULTS: The major teaching points are (a) a significant portion of normal hyaline cartilage is low in signal on T2-weighted images at MR imaging; (b) there are several T2-dark normal variations of hyaline cartilage that the radiologist should be aware of; (c) cartilage degeneration, fissures, and delamination may all appear low in signal on T2-weighted images; and (d) T2-dark cartilage lesions are not uncommon.

CONCLUSION: Most radiologists are unaware that virtually every T2-bright cartilage lesion has a corresponding T2-dark counterpart. T2-dark cartilage lesions are not uncommon. An awareness of these abnormalities will aid in the diagnosis of cartilage pathology.
(E-73) Thursday • 7:00 AM
Crystalline Disease: The Good, the Bad, the Ugly, and the Imposters
Stephane Desouches, DO, University of Missouri-Kansas City, Kansas City, MO; Jessica L. Sanchez, MD; Margaret A. Stull, MD
LEARNING OBJECTIVES: 1. Describe the pathophysiology and clinical presentation of common crystalline-induced disorders, including gout, calcium pyrophosphate deposition disease (CPPD), and hydroxyapatite deposition disease (HADD). 2. Describe the spectrum of imaging findings of crystalline-induced disease on radiography, CT, US, and MRI. 3. Identify the differential diagnostic considerations that mimic the imaging features of crystalline diseases.
CONTENT DESCRIPTION: This exhibit will provide a brief overview of the pathophysiology and clinical features of common crystalline diseases. Sample cases will emphasize the radiographic, CT, US, and MR imaging characteristics. The differential diagnosis for these disorders will be discussed and illustrated.
Summary: Crystalline-induced diseases are commonly encountered in clinical practice and may masquerade as traumatic, infectious, and other inflammatory conditions, as well as tumor and tumor-like disorders. An understanding of the varied clinical presentation and a knowledge of the broad range of imaging findings will facilitate early diagnosis and will assist in the appropriate management.

(E-74) Wednesday • 7:00 AM
Common and Uncommon Causes of Periosteal New Bone Formation: A Case Series Review
Anna Jajicek, MD*, University of Nebraska Medical Center, Omaha, NE; Craig W. Walker, MD; Timothy E. Moore, MD
LEARNING OBJECTIVES: 1. Describe the anatomy and function of the periosteum. 2. Explain formulation of a more complete differential diagnosis through the use of a case series reviewing both the common and uncommon types of periosteal reaction.
CONTENT DESCRIPTION: We will briefly review the anatomy and function of the periosteum to provide a knowledge base for better understanding of its radiologic appearance in response to various disease and physiologic processes. There are various types of periosteal reaction that can be suggestive of specific disease processes. These subtypes of aggressive and nonaggressive periosteal reaction will be reviewed in the context of the presented cases. We have compiled a case series of the most common causes of periosteal reaction, as well as many of the more unusual culprits. Sample cases will be provided within each of the following categories: (a) vascular: venous stasis; (b) infectious/inflammatory: acute and chronic osteomyelitis; (c) neoplastic: osteosarcoma, Ewing’s sarcoma, hypertrophic osteoarthropathy; (d) drug induced: voriconazole-induced fluorosis, prostaglandin therapy; (e) iatrogenic/idiopathic: periosteal reaction of the newborn, hypertrophic osteoarthropathy; (f) congenital: Caffey’s disease; (g) autoimmune: psoriatic arthritis; (h) trauma: fracture, child abuse; and (i) endocrine: thyroid acropathy.

(E-75) Thursday • 7:00 AM
Spectrum of Pigmented Villonodular Synovitis
David C. Wang, MD, University of Pittsburgh Medical Center, Pittsburgh, PA; Sara Golla, MD; Cynthia A. Britton, MD (david@wangmd.com)
LEARNING OBJECTIVES: 1. Identify the plain film, CT, and MR imaging characteristics of pigmented villonodular synovitis (PVNS) in the shoulders, hands, hips, knees, and ankles through time. 2. Describe briefly the pathologic features, presentation, treatment, and prognosis of PVNS. 3. Describe a differential diagnosis (rheumatologic diseases, chronic mechanical inflammation, and tumor, etc) for PVNS.
CONTENT DESCRIPTION: MR imaging is invaluable in the diagnosis of PVNS, which is variable in appearance from the focal to the diffuse form, as well as from joint to joint. PVNS can lead to joint destruction if untreated. The plain film, CT, and MR imaging characteristics of PVNS in the shoulders, hands, hips, knees, and ankles and their progression through time will be reviewed. The pathologic features, presentation, treatment, and prognosis of PVNS will be presented. Finally, a differential for PVNS, including rheumatologic diseases, chronic mechanical inflammation, tumor, etc, will be discussed.

(E-76) Wednesday • 7:00 AM
Soft-Tissue Calcifications: A Pictorial Review of the Differential Diagnosis and Imaging Characteristics
Paul P. Byra, MD, University of South Florida, Tampa, FL; Nisha Rao, MD
LEARNING OBJECTIVES: OBJECTIVES: 1. Identify the categories of soft-tissue calcification. 2. Describe the concise and accurate differential diagnosis of soft-tissue calcification. 3. Describe radiographic characteristics of various causes of soft-tissue calcifications.
CONTENT DESCRIPTION: i. Describe the different classifications of soft-tissue calcifications. II. Provide a comprehensive differential diagnosis and review of the imaging characteristics of the various causes. III. Illustrate examples of different types of soft-tissue calcification.

(E-77) Thursday • 7:00 AM
How to Avoid Missed Fractures: A Primer for Residents
Ivan Davis; Pushpender Gupta, MD, Wake Forest University School of Medicine, Winston-Salem, NC; Leon Lenchik, MD; David Pacholke; Scott Wuertzer (idavis@wakehealth.edu)
LEARNING OBJECTIVES: 1. Identify common fracture sites, and contrast these locations with commonly missed fractures. 2. Describe how satisfaction of search, “corner” findings, unexpected findings, and misleading history contribute to resident misses. 3. Explain our approach to reducing the number of missed fractures. 4. Describe the role of cross-sectional imaging for indeterminate fractures or suspected occult fractures.
CONTENT DESCRIPTION: We present the locations of common fractures and contrast these with locations of commonly missed fractures. The organization is by anatomic location, with sections devoted to hand, wrist, elbow, shoulder, pelvis, hip, knee, ankle, and foot. Factors contributing to missed fractures in these locations are discussed, with emphasis placed on satisfaction of search, “corner” findings, unexpected findings, and misleading history. To decrease missed fractures, the importance of fracture patterns involving multiple sites is emphasized, as well as secondary signs of a fracture. To improve fracture detection, the importance of image manipulation, including image magnification, window/level adjustment, and inversion, is stressed. For indeterminate or suspected occult fractures, recommendations for additional cross-sectional imaging are provided, based on anatomic location.

(E-78) Wednesday • 7:00 AM
Imaging of Musculoskeletal Infection
Pushpender Gupta, Wake Forest University School of Medicine, Winston-Salem, NC; Leon Lenchik, MD; Bahram Kiani; Scott Wuertzer (pugupta@wakehealth.edu)
LEARNING OBJECTIVES: 1. Describe the role of conventional radiography, ultrasound, scintigraphy, CT, and MR in the evaluation of musculoskeletal infections. 2. Identify key imaging findings in acute and chronic osteomyelitis in adults and children. 3. Identify key imaging findings in soft-tissue infections, including muscle abscesses and septic joints. 4. Discuss practical issues relating to differential diagnosis and workup of difficult cases.
CONTENT DESCRIPTION: This educational exhibit focuses on terminology, age-dependent anatomy, and pathophysiology of musculoskeletal infections. Precise terminology of bone, soft-tissue, and joint infection is emphasized. The pathophysiology of hematogenous,
contiguous, and direct spread of infection is presented. Additionally, the pathophysiology of acute and chronic infection is discussed. By using diagrams of vascular supply, the influence of age-dependent anatomy on pathophysiology is illustrated. To reinforce concepts, numerous radiographic and MR examples are provided. The roles of ultrasound, scintigraphy, and CT are described. Practical advice for working up difficult cases and establishing a differential diagnosis is included.

(E-79) Thursday • 7:00 AM
Elbow MR Imaging in Athletes
Sean Plough; Pushpendra Gupta, MD, Wake Forest University School of Medicine, Winston-Salem, NC; Leon Lenchik, MD; Scott Wuertzer; Bahram Kiani (sploof@wakehealth.edu)
LEARNING OBJECTIVES: 1. Describe normal MR appearance of ligaments and tendons of the elbow. 2. Identify key MR imaging findings of athletic injuries, including tendinopathy, tendon tears, ligament tears, muscle strains, osteochondral injuries, and fractures.
CONTENT DESCRIPTION: This exhibit is organized into five sections: (a) normal MR anatomy is reviewed, including medial collateral ligament (MCL) complex, flexor pronator group (FPG), lateral collateral ligament (LCL) complex, common extensor tendon group, biceps, and triceps; (b) MR images of medial elbow injuries are presented, including MCL tears, partial and complete FP and LCL tears, and muscle strains; (c) MR images of lateral elbow injuries are presented, including LCL tears, partial and complete extensor tendon tears, and muscle strains; (d) MR images of biceps and triceps tears are presented; and (e) MR images of osteochondral injuries and fractures are presented.

Neuroradiology

(E-81) Thursday • 7:00 AM
Carotid-Cavernous Fistula: Identification and Treatment Options
Cody R. Quirk, MD, Baylor University Medical Center, Dallas, TX; Kenneth Layton, MD (cody.quirk@baylorhealth.edu)
CONTENT DESCRIPTION: I. Pathophysiology of carotid-cavernous fistula. II. Review of imaging findings on NECT, CECT, MR, and angiography. III. List of treatment options, including the treatment we chose. IV. Summary.
Major Teaching Points: 1. Enlarged superior ophthalmic vein with proptosis and cavernous sinus enlargement on multiple modalities. 2. Clinical history and physical examination are important considerations in making the diagnosis. 3. Review of the endovascular treatment options available.

(E-83) Wednesday • 7:00 AM
Yi C. Zhang, MD, St Luke’s-Roosevelt Hospital Center, New York, NY; Alexander Chandler, MD; Nolan J. Kagetsu, MD* (yiczhang@chpnet.org)
LEARNING OBJECTIVES: Describe how to better employ evidence-based techniques to minimize lumbar puncture and myelogram complications such as meningitis and post–dural puncture headache.
CONTENT DESCRIPTION: Background: Radiology procedures involving the spine, such as lumbar punctures and myelograms, are complicated by delayed closure of dural defects, causing leakage of cerebral spinal fluid and resultant post–dural puncture headaches (PDPHs). The American Academy of Neurology has identified technical factors, such as needle type, needle gauge, bevel orientation, and stylet reinsertion, that reduce the frequency of PDPH. However, evidence-based protocols designed to minimize PDPH are not widely adopted. A rare complication of myelography is meningitis. We reviewed the literature to find evidence-based techniques and guidelines to reduce the incidence of these complications.
Methods: A literature search for techniques to minimize lumbar puncture and myelogram complications, including PDPH and meningitis, was performed in the PubMed English database from 1971 to present.
Results: A reported survey of 2287 neurologists in the United States who currently perform lumbar punctures indicates that only 2% routinely useatraumatic needles. A reported survey of 105 neurologists and neurosurgeons in the United Kingdom indicates that less than 30% routinely useatraumatic needles, and approximately 30% orient the bevel parallel to the longitudinal axis of the spinal cord. A survey of 314 neurologists in Denmark reveals that 74% useatraumatic needles. A randomized prospective study of 600 lumbar puncture patients shows that stylet reinsertion significantly reduces PDPH. A case report suggests that outbreaks of bacterial meningitis among patients undergoing myelography likely occurred because healthcare professionals did not follow published guidelines that require face masks.
Discussion: Lumbar puncture and myelogram techniques vary widely among neurologists, neurosurgeons, and neuroradiologists in the United States and abroad. We recommend the following practices to reduce complications: use ofatraumatic needles, use of smaller needle size, reinsertion of stylet prior to needle withdrawal, and use of face masks.

(E-85) Thursday • 7:00 AM
Shining with Limited Motion: Spectrum of “Diffusion-Bright” Intracranial Lesions, with Associated Mimics and Pitfalls
Salar Hakham, DO, Tufts Medical Center, Boston, MA; Michael Lanfranchi, MD; Daniel Do-Dai, MD; Harprit S. Bedi, MD; Neel Madan, MD* (shakham@tuftsmedicalcenter.org)
LEARNING OBJECTIVES: 1. Explain the basic MR principles of diffusion-weighted imaging (DWI) and diffusion-tensor imaging (DTI). 2. Describe the spectrum of pathology associated with restricted diffusion. 3. Identify the mimics and pitfalls in interpreting DWI/DTI.
CONTENT DESCRIPTION: Diffusion-weighted imaging is a critical component of brain MRI. While DWI is vital in the evaluation of acute stroke, numerous other pathologic processes are associated with decreased brownian motion. Thus, understanding the full spectrum of pathology associated with restricted diffusion is important in the interpretation of the images and can lead to improved diagnostic accuracy.
Content Organization: I. Review of basic techniques and principles in DWI/DTI. II. Systematic pictorial review of intracranial lesions with restricted diffusion, including pathology correlation when applicable; pathologic disease processes that are discussed include infarcts, neoplasms, infection, demyelination, and metabolic and degenerative disorders. III. Mimics, pitfalls, and differentiating features. After reviewing this exhibit, the viewer will be able to confidently recognize the various “diffusion-bright” intracranial lesions, to produce a rapid and accurate differential diagnosis.

* Faculty financial disclosures are located in the Faculty Index.
(E-89) Thursday • 7:00 AM
Congenital Cystic Neck Masses: Case-based Review and Radiology-Pathology Correlation
Maryam Gul, MD, Winthrop-University Hospital, Mineola, NY; Ammar A. Chaudhry, MD; Abbas Chaudhry; Steve West; Clemente T. Roque, MD; Nickoleta L. Hoefling, MD; et al (maryangul@gmail.com)

LEARNING OBJECTIVES: 1. Describe clinical presentation and imaging findings of congenital cystic neck masses. 2. Identify differential diagnoses, including infectious, inflammatory, and neoplastic conditions that may mimic congenital cystic neck masses. 3. Describe key points that help to narrow the differential diagnosis.

CONTENT DESCRIPTION: I. Anatomic location of congenital cystic neck masses highlighted by using pictorial review (cartoon and/or radiographic demonstration). II. Case-based demonstration of clinical presentation, histopathologic findings, imaging features (on radiographs, CT, and MRI, including enhancement patterns, etc), treatment, and prognosis of congenital cystic neck masses. III. Case examples of mimics, with discussion of their different clinical findings, imaging features, histopathology, treatment, and prognosis. IV. Chart of salient features for quick reference.

V. Conclusion: A. Congenital cystic neck mass is not an uncommon cause of a hypodense lesion in the head and neck region. B. A wide variety of entities mimic congenital cystic neck masses, with clinical and imaging overlap; by the conclusion of this presentation, the radiologist should have a better understanding of various clinical presentations of patients with congenital neck masses and their imaging findings. C. Differential can be narrowed by utilizing age, clinical features, location, and imaging characteristics. D. What should be conveyed in the radiology report and recommended to the clinician that will aid in the workup and guide any potential biopsy and/or imaging follow-up.

Women’s Imaging

(E-91) Thursday • 7:00 AM
MR Imaging Appearance and Appropriate Management of Breast Implant Complications
Rebecca L. Roller, MD, Penn State Hershey Medical Center, Hershey, PA; Alison L. Chetlen, DO; Julie Mack; Claudia J. Kasales, MD; Meredith Watts, MD; John D. Potochny, MD

LEARNING OBJECTIVES: 1. Describe the normal appearance of the different types of breast implants on MRI. 2. Identify the acute and delayed complications of different types of breast implants on MRI, including rupture, silicone extravasation, gel bleed, polyurethane breakdown, and peri-implant fluid collections. 3. Describe the clinical significance of implant complications and appropriate management.

CONTENT DESCRIPTION: Background Information/Purpose: Imaging of breast implants due to breast augmentation or postmastectomy reconstruction is commonly encountered by the radiologist. Breast augmentation has been performed since the late 19th century. Over the years, the surgical options and types of implants available to patients have significantly changed. Subsequently, the augmented breast can have a widely variable appearance. Magnetic resonance imaging is the most accurate method for evaluating breast implant complications and is increasingly used to screen and monitor patients who have undergone these procedures. The practicing radiologist must recognize the numerous variations in implant construction that are encountered clinically. Proper diagnosis of implant complications requires a thorough understanding of the imaging characteristics of the normal and abnormal appearance of silicone and saline single-lumen and double-lumen implants.

Key Anatomic or Pathophysiologic Issues, Imaging Findings, or Imaging Techniques: Breast MRI exams performed on all patients with implants from October 1, 2007 through October 1, 2012 will be retrospectively evaluated. Representative MRI images will illustrate the normal and abnormal appearance of silicone, saline, and double-lumen breast implants, with correlative gross photographs, mammography, surgical history, and pathologic findings.

Conclusion: MRI remains the mainstay for imaging evaluation of acute and delayed breast implant complications. The radiologist must recognize the complications of breast implants and their significance to facilitate prompt and appropriate management.

(E-92) Wednesday • 7:00 AM
Legislation Regarding Reporting of Dense Breast Tissue: What a Resident Needs to Know
Jessica Ho, MD, St Luke’s-Roosevelt Hospital Center, New York, NY (jho@chpnet.org)

LEARNING OBJECTIVES: 1. Explain new state-based legislation on reporting dense breast tissue directly to patients and possible adjunct screening options. 2. Describe new FDA-approved automated breast ultrasound system. 3. Identify current shortcomings/unanswered questions regarding new legislation.

CONTENT DESCRIPTION: Breast density is now established as an independent risk factor for developing breast cancer regardless of other known risk factors. Women with breast density in the upper quartile have an associated 3–5 times greater risk of developing breast cancer relative to women with breast density in the lower quartile. Given this fact, many states have passed or have proposed legislation requiring mammographers to report to patients directly if they have dense breast tissue. However, there is currently no consensus as to whether supplemental screening should be pursued or what modality should be used. The FDA recently approved an
automated breast ultrasound system. However, many questions are still left unanswered, including impact on morbidity/mortality, cost-effectiveness, and insurance coverage.

**Contest Organization:** I. Review MQSA 1992 legislation and what it means for patients. II. Breast density as an independent risk factor for developing breast cancer. III. New state-based legislation regarding reporting dense breast tissue to patients directly. IV. Supplemental screening options and their pros and cons. V. Automated breast ultrasound systems. VI. Current shortcomings/unanswered questions regarding new legislation.

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automated breast ultrasound system. However, many questions are still left unanswered, including impact on morbidity/mortality, cost-effectiveness, and insurance coverage.

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(E-93) Thursday • 7:00 AM

**MR Imaging Characteristics of Malignant Breast Lesions: Application for Monitoring Neoadjuvant Chemotherapy for Breast Cancers**

Mahsa Hoshmand, MD, Stony Brook University Medical Center, Stony Brook, NY; Cliff Bernstein, MD (mahsa.hoshmandkochi@stonybrookmedicine.edu)

**LEARNING OBJECTIVES:** 1. Identify the MR imaging characteristics, including morphology and enhancement patterns, of malignant breast lesions. 2. Describe breast MRI signal intensity–time curves and their usefulness in identifying malignant breasts lesions. 3. Describe the role of breast MRI in monitoring neoadjuvant chemotherapy for breast cancers.

**CONTENT DESCRIPTION:** Magnetic resonance imaging (MRI) is increasingly used for the diagnosis and characterization of breast lesions. Gadolinium-enhanced MRI has high sensitivity (approaching 100% in some studies) but lower specificity (ranging from 37% to 97%) for breast cancer detection. This presentation will be a pictorial essay that will first demonstrate the characteristic features of malignant breast lesions on MRI in a case-based overview. The discussion will include a description of the range of morphology of malignant breast lesions and their enhancement patterns on MRI. An overview of signal intensity–time curves and their application in identifying malignant lesions will then be given. Finally, the role of breast MRI in monitoring neoadjuvant chemotherapy for breast cancers will be discussed in a case-based overview of pathologically proven breast carcinomas.

(E-94) Wednesday • 7:00 AM

**Case-based Review of Imaging Features and Pathologic Correlation of the Spectrum of Breast Adenomas**

Mahsa Hoshmand, MD, Stony Brook University Medical Center, Stony Brook, NY; Paul R. Fisher, MD (mahsa.hoshmandkochi@stonybrookmedicine.edu)

**LEARNING OBJECTIVES:** 1. Identify the mammographic and sono-graphic features of breast adenomas, including the most common breast adenoma, namely, fibroadenoma, as well as less common adenomatous lesions such as tubular adenomas, lactating adenomas, nipple adenomas, giant fibroadenomas, and phyllodes tumor, which has overlapping features with other breast adenomas. 2. Recognize the clinical settings that may be associated with certain types of breast adenomas. 3. Describe pathologic features of the spectrum of breast adenomas, and understand the management approach to these lesions.

**CONTENT DESCRIPTION:** The term *adenoma* has been used to designate the true (pure) epithelial adenoma of the breast, as well as adenomatous lesions with a prominent stromal component. Fibroadenomas and nipple adenomas represent the breast adenomas with a prominent stroma. True adenomas of the breast, such as tubular adenomas, on the other hand, are well-circumscribed neoplasms composed of a proliferation of epithelial structures with sparse inconspicuous stroma. This educational exhibit will utilize a case-based approach in featuring different adenomatous lesions of the breast. Each case will illustrate and provide discussion of the mammographic and sonographic features of a specific type of breast adenoma, including tubular adenomas, lactating adenomas, nipple adenomas, and giant fibroadenomas. Phyllodes tumor is a fibroepithelial lesion that has certain features resembling adenomas and will also be discussed. The pathologic correlation will be demonstrated in each case. Finally, the clinical setting of the lesion, as well as management, will be discussed, to gain a more comprehensive understanding of these disease entities.

* Faculty financial disclosures are located in the Faculty Index.
AUR 2013 Digital Tools Electronic Exhibit Abstracts

Digital tools electronic exhibits will be displayed on Thursday, April 11, 4:00–5:30 PM, and will be located in Diamond Ballroom Salon 5. *AMA PRA Category 1 Credit™* will be awarded for attending this session. Presenting author is identified by institution name, city, and state (or country if not United States or Canada). Presentations by trainees (residents, fellows, or 1-yearfellows) are noted in **dark blue.**

(D-101) Training Module for Residents and Medical Students on Contrast Media Uses, Adverse Reactions, and Treatments
Kyle Cothron, MD, MS, West Penn Allegheny Health System, Pittsburgh, PA; Matthew S. Hartman, MD; Richard H. Daffner, MD; Linda McDonald, RN (kcothron@wpahs.org)

**PURPOSE:** Interns and medical students report that they have limited education about radiology contrast materials during their training. Using the American College of Radiology (ACR) guidelines (http://www.nxtbook.com/nxtbooks/acr/contrastmediamanual2012/) as a reference, we have developed an online case-based and interactive module focused on commonly used contrast agents. This presentation will serve as a review of contrast media basics and potential complications with associated treatments and will promote the effective communication of these principles by the viewer with clinicians.

**CONTENT ORGANIZATION:** I. Review of the use and different types of contrast media in radiologic studies. II. Review of the adverse reactions and possible complications associated with contrast media. III. Review of these principles by using an interactive quiz format.

**SUMMARY:** Interns and students report a low level of confidence with respect to radiology contrast materials, risks, complications, and treatments. As radiologists, it is incumbent on us to develop effective means of educating our clinical colleagues on the risks, benefits, treatments, and alternatives of contrast media. The ACR guidelines (http://www.acr.org/~/media/ACR/Documents/PDF/QualitySafety/Resources/Contrast%20Manual/FullManual.pdf) are available to promote the understanding and correct usage of contrast media, premedication, and treatment for adverse contrast reactions.

(D-102) Creating Resident Rotation Schedules Collaboratively by Using Freely Available Online Tools
Francisco A. Perez, MD, PhD, University of Washington, Seattle, WA; Michael F. McNeely, MD; Christopher R. Ingraham, MD; Nicholas A. Bodmer, MD; Angelisa M. Paladin, MD (fperez@uw.edu)

The scheduling of clinical rotations is a perennial challenge for program directors and chief residents. The process is particularly cumbersome for large programs with multiple training sites, as a balance is sought among resident educational, graduate medical education (GME) requirements, clinical service needs, funding restrictions, and resident preferences. Tools for overcoming this challenge are scarce; the few commercial resources can be inflexible, unwieldy, and expensive. Freely available, online document collaboration software provides a creative solution to facilitate rotation scheduling. By using these tools, a method was developed that empowers residents to build their own schedules collaboratively. Over 2 consecutive years, this method was successfully implemented at the University of Washington (UW) Department of Radiology, which assigns 48 residents to more than 50 clinical rotations at five sites of practice. The UW method for clinical rotation scheduling is described interactively, and the necessary tools are provided as a template for adoption at other residency programs. The strengths, weaknesses, and areas for future development are discussed.

Thomas J. O’Neill, MD, Texas Tech University Health Sciences Center, El Paso, TX; Arvin E. Robinson, MD; Anoop Ayyappan, MD (thomas.j.oneill@ttuhsc.edu)

**PURPOSE:** Our aim was to develop a Web application for creating and administering modular image-rich multiple-choice tests based on the curriculum published by the American Board of Radiology (ABR) and radiology societies to assess radiology residents for medical knowledge and interpretations skills essential to the practice of radiology.

**METHOD AND MATERIALS:** Our Web application was developed and designed to run on a standard LAMP stack deployment (Linux OS, Apache HTTP Web server, MySQL database, and PHP scripting language). A modular infrastructure was designed such that the core Web app remains separate from the user data and data for the radiology training packages. Source code is hosted on Google Code under the open-source MIT License. Radiology faculty at our institution generated questions for the demonstration module.

**RESULTS:** The Web application conforms to HTML5 standards and uses client-side JavaScript, with AJAX/JSON, to facilitate user interactivity. Modern, HTML5 standards–compliant browsers are compatible. Mobile client detection is implemented so content will be rendered appropriately on mobile devices, including tablets or smartphones. Residents are assigned an exam module with a due date, as prescribed by their teaching faculty, and notified via e-mail. Modules may be assigned as a timed or untimed exam, with or without the ability to review the questions at the conclusion. Multiple-choice style questions may be presented with or without associated images. After completion of a module, faculty may generate reports comparing performance of each trainee with other users who have participated in that module. Faculty may also use a review mode to review the test with a resident.

**DISCUSSION:** Assessing the medical knowledge and image interpretation skills of radiology residents is often inconsistent, and many current practices may be incongruent with the new ABR core exam testing style. We developed an open-source Web application that allows institutions to implement a structured image-rich exam and objectively track an individual trainee’s progress and relative performance.

(D-104) Pelvic US: Core Examination Study Module
Katharine D. Maglione, MD; Karen M. Lee, MD; Cash J. Horn, MD, Mount Sinai Medical Center, New York, NY

Pelvic ultrasound is a widely used diagnostic imaging modality in women’s health care. It is highly represented on the American Board of Radiology (ABR) Core Examination Study Guide, reflecting that it is an important foundation of knowledge for every radiologist. This image-centered interactive digital education exhibit will provide definitions, associated information, and imaging examples following the format of the ultrasound gynecology Core Examination Study Guide. Specific topics to be covered with regard to the uterus include normal echotexture/size/shape, endometrial thickness with the menstrual cycle, congenital anomalies, intrauterine devices and their complications, leiomyomas, adenomyosis, endometritis,

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endometrial fluid, polyp, hyperplasia, and carcinoma. Topics covered pertaining to the ovaries will include normal echotexture/shape, cysts (simple, hemorrhagic, ruptured), PCOS, endometrioma, cystadenoma/carcinoma, dermoid, germ cell tumors, ovarian torsion, PID and tubo-ovarian abscess, and ovarian cancer. Information presented on the cervix will include normal echotexture/appearance, cervical stenosis, polyp, and cancer. Fallopian tube conditions, including hydrosalpinx and pyosalpinx, will be presented, as well as saline hysterosonography. Following the presentation, there will be an interactive quiz on this subject matter, allowing participants to test their knowledge. After completing the “Pelvic US: Core Examination Study Module,” participants will be able to identify both the normal anatomy and a comprehensive range of pathology related to the female pelvis. This digital education exhibit will provide an essential fund of knowledge for the upcoming ABR exam of the future, as well as a comprehensive review for every practicing diagnostic radiologist.

(D-105) Use of Mobile Social Gaming as an Educational Tool to Teach Complex and Updated Concepts about Chemoembolization and Ablation

Vivek V. Patil, MD, Mount Sinai Medical Center, New York, NY; Zachary L. Bercu, MD; Dairon M. Garcia, MD (vivek.patil@mountsinai.org)

This exhibit demonstrates the use of a new modality, mobile social gaming, to provide an exciting and portable method to teach in-training as well as established radiologists about complex and changing concepts with regard to chemoembolization and ablation. To this end, we have developed a mobile application on the Android platform. Cases are presented via an application that allows users to download to their Google Android tablet and phone devices. An Android simulated device is provided at a separate workstation for demonstration purposes. Users are asked to provide a unique nickname to tally a score. Opponents are challenged to answer multiple questions on several cases. The answers and teaching points are provided to users during a time delay between cases. Cases include median arcuate ligament syndrome detected during liver chemoembolization, radiotherapy with Y-90, and radiofrequency/microwave ablation of HCC. The neuroscience literature is rife with studies of the association between emotional arousal and memory, which is evident during Socratic-method case conferences present in residency programs across the country. Novel technology such as the mobile application presented here may channel this concept more effectively. Prior novel learning modalities require fixed computers or individuals to be in the same room. The application we have developed leverages the mobile platform to provide a native, portable, and competitive forum for learning. Complex and updated chemoembolization and ablation concepts are easily demonstrated by using this technology.

(D-106) Medical Student Image Interpretation Skills: Use ofNarrated Screencasts Highlighting Core Anatomy and Anatomical Relationships

William J. Uffmann III, BS, University of Chicago, Chicago, IL; Kelly Ledbetter, BA; Christopher M. Straus, MD (cstraus@uchicago.edu)

Interpreting images requires the ability to use deductive and spatial reasoning to arrive at a diagnosis. Initially, anatomy is presented concurrently with anatomy refines, solidifies, and tests newly acquired anatomical knowledge. Diverging from traditional memorization, students taught to apply image interpretation skills to unknown images are able to independently develop their own spatial and anatomical knowledge beyond image recognition and memory alone. Building skills begins with teaching a comprehensive systematic approach to images. Unlike traditional cadavers, where reference landmarks are subconsciously understood and readily visible, images seldom demonstrate entire organs or structures. Instruction on image acquisition and key anatomical relationships gives the student the tools to make the early leap to understanding what is, at any point, only a partial image of a larger complex anatomical structure. Additionally, students are taught to use this spatial understanding to look in all dimensions for confirmatory structures. Only when this additional information is leveraged can a structure be confidently identified; these skills are neither inherent nor addressed in more traditional time-compressed curricula. For this purpose, the investigators developed a novel approach using screencast recordings of a “core” image file. These audiovisual files captured the narrative and mouse inputs of a course instructor discussing and deconstructing selected images. With each file representing an independent lesson in skill building, focus was placed on pivotal image information and accompanying logic required for structure identification. Serial reinforcement cues the learners to follow along, first developing and then solidifying their skills. Computerized video formatting allows the individually controlled pacing of the material that is so increasingly preferred by modern-day tech-savvy students. By stopping, replaying, speeding up, or slowing down the materials, students learn more quickly and effectively while benefiting from the student-instructor input in each lesson.

(D-107) Streamlining the Medical Imaging Anatomy Curriculum: “Core” Radiology Images for 1st-Year Medical Imaging Education

William J. Uffmann III, BS, University of Chicago, Chicago, IL; Kelly Ledbetter, BA; Christopher M. Straus, MD (cstraus@uchicago.edu)

Seeking the best method of teaching medical imaging to a 1st-year anatomy course, instructors developed a “core” image file. The impetus for the core grew out of the need for an independent learning module that could succeed in teaching radiology in a time-sensitive manner where other tools have failed. While increasingly used in anatomy, imaging materials have many problems. The sheer volume of material presented to students is often overwhelming and above the level for an introductory course. Others are disparate collections of images with little integration with course materials. In addition, students express continued concern about the difficulty of the material and the work required to learn the material as presented in a limited time. Despite these concerns, most accept the value that imaging provides. Still, no standard core material exists. Thus, a concise file of images demonstrating basic regional anatomy was created. Images from multiple modalities were chosen to illustrate key structures and clinically pertinent anatomical relationships wherever possible. Common structures were labeled with arrows, and key structures were highlighted with transparent colored overlays superimposed upon the image to make the structures more readily identifiable. Successive files progressed from simple plain films to more complex serial imaging requiring improved image understanding. Initial files emphasized image orientation, production, and skills needed for the later, more advanced imaging modalities. The result is a streamlined survey of normal radiographic anatomy that cemented the knowledge attained through dissection and didactics with a solid practice and understanding of medical imaging. It is this foundation of clinical imaging and anatomy that supports the acquisition of future advanced concepts. A concise resource that reliably covers basic concepts ensures the establishment of a standard radiologic foundation. This foundation bettered learning and evaluation, allowing students to increase the depth of their understanding. This switcher the emphasis away from superficial memorization and impresses the quality and value of deeper learning.

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"Lines and Tubes": An Interactive Learning Module Designed to Teach Medical Students and Residents the Importance of Proper Line/Medical Device Placement and the Common Complications of Misplaced Devices

Benjamin L. Harris, MD, Allegheny General Hospital, Pittsburgh, PA; Matthew S. Hartman, MD; Eli Pakravan, MD

The importance of recognizing the proper position of commonly placed lines or medical devices in the hospitalized patient is crucial to the knowledge base of any medical student or resident. Such lines and devices include central lines, Swan-Ganz catheters, pacemakers, chest tubes, intraaortic balloon pumps, and many more. At our institution, we created an interactive lecture series for the purpose of teaching these principles to medical students and entry-level residents. The lecture series yielded over 60% improvement in test scores based on pre- and postlecture evaluations. With the same principles in mind, we have created an online interactive learning tool for the learner to practice the basics of such medical devices and learn the complications that can arise from misplacement.

PURPOSE: 1. Review the proper placement of commonly used lines and medical devices in the hospitalized patient. 2. Review the complications of misplaced devices with an engaging online interactive learning tool. 3. Assess the efficacy of the self-guided online tool with a quiz-based format.

SUMMARY: Proper placement of lines and medical devices, as well as recognition of misplaced lines and medical devices, is an integral component for the knowledge base of any medical student or resident. It is the goal of this interactive cased-based module to engage the learner for the purpose of teaching these principles in a practical way.

Creating an Interactive Imaging Textbook for the iPad by Using Software Available to Educators at No Cost

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The iPad is an exciting tool for resident and medical student education in radiology. Electronic education is favored by many current trainees. The iBooks Author program, provided by Apple (Cupertino, CA) at no cost to educators, enables the creation of interactive imaging textbooks for the iPad by educators with no computer programming experience. Studies show that when adult learners are provided the opportunity to arrive at the correct answer themselves during a learning opportunity, then that learning is retained for a longer period of time than when the same information is delivered in a passive learning format such as a conventional textbook.

The iBooks Author program facilitates this with inclusion of questions in multiple formats. After answering a question, the learner is provided immediate feedback as to whether the answer is correct. If not, rather than being given the correct answer, the learner is asked to “Try again.” Example textbooks created with iBooks Author include these interactive questions at the end of each chapter, to assess student knowledge and reinforce learning. In the e-book that I created to teach breast imaging, I inserted these interactive questions throughout each chapter to encourage ongoing active learning. The high resolution of the iPad screen enables visualization of the details necessary for the interpretation of radiographic images, including the 1–2-mm calcifications that are critical in mammography interpretation. The quality of radiologic images on the iPad feels similar to that of images viewed on a PACS monitor. The iBooks Author program facilitates inclusion of still images (.jpg or .png files) and movies (.m4v files) into the e-book. Images may even be placed within the interactive questions. Inclusion of entire series from MR or CT requires the learner to find the abnormality in the series, not just on the selected slice as in conventional textbooks. This format more closely imitates clinical reading room interpretation.

CONCLUSION: The iBooks Author program is a free program that facilitates creation of interactive radiology textbooks. The breast imaging textbook that I created for the iPad by using iBooks Author will be available to view as an example.

AMSER “Don’t Miss” X-ray Lesions: The Graphic Novel

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The Alliance of Medical Student Educators in Radiology (AMSER) has developed a list of vital imaging diagnoses/findings that all medical students should know. A “comic book” has been created in Portable Document Format (PDF) that introduces students to these important diagnoses by using line drawings, radiographic images, anatomic specimens, and gross pathology. Each finding or diagnosis includes (a) a definition, (b) imaging features, (c) etiology, (d) mechanism of injury, (e) complications, and (f) pitfalls. After viewing the PDF, students should be able to recognize, define, and discuss important imaging features of the AMSER “don’t miss” lesions.

Learning Neuroradiology: A Web-based Learning Module for Medical Students

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Neuroradiology plays an integral role in the diagnosis of neurologic conditions. It is important for medical students to have an understanding of the different types of imaging studies that are used to assist in the diagnosis of diseases affecting the brain and spine, as well as the indications and contraindications of imaging tests. We have converted a lecture-based neuroradiology curriculum for 3rd- and 4th-year medical students into a self-paced Web site that enables students to learn about neuroradiology. This interactive Web-based learning module provides to the student an opportunity to review neuroimaging techniques, learn neuroanatomy, and navigate through a series of cases that review core concepts in the neurosciences. Using a Google site platform, we were able to create a site that is easily authored by course instructors without specific Web-authoring technical expertise. The instructional Web site can also be accessed by students from any location. At the end of the learning module, students should be able to recognize the differences between CT and MRI scans of the brain and spine, understand the most common indications and contraindications for brain and spine imaging, and understand the indications for contrast in neuroimaging. Students should also be able to identify important anatomic structures of the brain and spine and recognize patterns of disease, including intracranial hemorrhage, stroke, tumor, infection, and multiple sclerosis. The URL for the site is www.learningneuroradiology.com.