AUR 2015 Education Poster Abstracts

Instructional education posters are located in the Acadia Ballroom. Each poster will be presented by its author during one of the *AMA PRA Category 1 Credit*™ poster discussion sessions scheduled for 7:00–8:15 AM, Wednesday (Session 201) and Thursday (Session 301). The day and time of each poster presentation follows the presentation number. Presenting author is identified by institution name, city, and state (or country if not United States or Canada). Presentations by trainees (residents, medical students, or 1st-year fellows) are noted in **maroon**.

Abdominal Radiology

(E-01) Wednesday • 7:00 AM
Evolving MR Imaging Features of Poststereotactic Body Radiation Therapy for Hepatocellular Carcinoma in Cirrhotic Livers

Ali Pirasteh, MD, *University of Texas Southwestern Medical Center, Dallas, TX*; Jeffrey Meyer, MD★; Zabi Wardak; Takeshi Yokoo, MD

LEARNING OBJECTIVES: 1. Describe distinctly different postradiation MRI changes of hepatocellular carcinoma and its surrounding parenchyma, and distinguish them from those of other locoregional therapies, such as percutaneous ablation and chemoembolization. 2. Discuss postradiation MRI features, such as size reduction or necrosis, that may not be seen for several months after treatment completion. 3. Discuss the idea that assessment of treatment response by MRI must take into account the expected postradiation changes for both the tumor and the surrounding parenchyma.

CONTENT DESCRIPTION: Stereotactic body radiation therapy (SBRT) is an emerging locoregional therapy for hepatocellular carcinoma (HCC). Post-SBRT changes of the tumor and surrounding parenchyma are distinctly different from those of other locoregional therapies, such as percutaneous ablation and chemoembolization. Post-SBRT MRI features, such as size reduction or necrosis, may not be seen for several months after SBRT. In addition, assessment of treatment response by MRI must take into account the expected postradiation changes for both the tumor and the surrounding parenchyma. We present a case series of several patients who underwent SBRT for HCC and were subsequently followed by MRI to assess for treatment response. The evolution of multisequence MRI characteristics of the lesion, as well as of the surrounding liver parenchyma, was studied, and the characteristics were divided into acute (within 3 months), subacute (3–6 months), and chronic (after 6 months) categories. Imaging findings were correlated with clinical outcomes and the available surgical pathology reports.

(E-02) Thursday • 7:00 AM
Gastrointestinal Fluoroscopy: "Cheat Sheets" for the Digital Age

Sean N. Reynolds, MD, *University of Vermont Medical Center, Burlington, VT*; Robert D'Agostino, MD *(sean.reynolds@vtmednet.org)*

LEARNING OBJECTIVES: 1. Compare the expanded utility of digital cheat sheets, as compared to a printed paper form. 2. Explain the utility of the digital cheat sheet as a learning tool. 3. Describe methods for making digital cheat sheets easily available throughout a radiology department.

CONTENT DESCRIPTION: To aid in the teaching and performance of GI fluoroscopic studies, attendings and residents have resorted to drawings, notes, flash cards, and handbooks to help get through a day in the fluoroscopy suite. Most have, at some time, entered an exam room with a "cheat sheet," in order to decrease errors and produce correctly positioned images. To update the classic cheat sheet for the digital age, we have designed a series of PowerPoint files that (1) can be used to teach technique and positioning when an inexperienced resident joins the GI service; (2) are easily accessed and reviewed, before performing a GI exam, on all computers in the department, even after hours and on weekends; and (3) can be loaded onto a mobile device for use as a digital "cheat sheet" during the patient exam. Files are accessed via our department Web site. Each file contains a series of images and corresponding text containing hints on patient positioning, film speed, contrast type, and patient instruction so that the user can acquire the correct image in the right position for the best result. Our digital exams comprise all commonly performed or emergent fluoroscopic GI and GU studies within the department, including esophagrams, upper GI series, postoperative bariatric studies, single-contrast enemas, cystograms, and retrograde urethrograms. The exhibit will include examples of our exam "cheat sheets," highlighting the use of a department wiki in in their development, access, expansion, and improvement, their role in teaching, and their ease of use.

(E-03) Wednesday • 7:00 AM
LI-RADS Classification in Advanced Cirrhosis: A Pictorial Review

Farzad Sedaghat, MD, *Geisinger Medical Center, Danville, PA*; Anne P. Dunne, MD *(fsedaghat@geisinger.edu)*

LEARNING OBJECTIVES: 1. Describe the Liver Imaging Reporting and Data System (LI-RADS) and its utility in characterizing hepatic lesions. 2. Discuss the unique challenges of MR imaging in the setting of advanced cirrhosis. 3. Identify and characterize hepatic lesions utilizing secondary features and associated findings to increase diagnostic accuracy.

CONTENT DESCRIPTION: Hepatocellular carcinoma is the most common malignancy among patients with cirrhosis. While the establishment of the Milan criteria has provided clinicians with clear guidelines for disease management and transplant allocation, the lack of a consistent reporting paradigm has limited their utilization. The Liver Imaging Reporting and Data System (LI-RADS) offers radiologists an efficient and effective methodology for characterizing hepatic lesions and communicating these findings to referring clinicians. We present five illustrative cases demonstrating the application of LI-RADS in the setting of advanced cirrhosis: (1) case 1: HCC with delayed washout related to hepatic vein invasion (LI-RADS 5); (2) case 2: multifocal HCC with diffuse liver involvement, mimicking hypervascular metastasis (LI-RADS 4); (3) case 3: infiltrative HCC without washout (LI-RADS 3), subsequently developing central necrosis (LI-RADS 4); (4) case 4: regenerative nodule with abnormal T2 signal hyperintensity (LI-RADS 3); and (5) case 5: multiple transient hepatic attenuation differences (THADs) in the setting of portal vein thrombosis (LI-RADS 2).

Cardiopulmonary Radiology

(E-08) Thursday • 7:00 AM
How Dead Is It? No Reflow on Cardiac MR Imaging

Rydhwana Hossain, BS, MD, *Beth Israel Medical Center, New York, NY*; Hristina Natcheva, MD; Alan C. Legasto, MD *(rhossain@chpnet.org)*

LEARNING OBJECTIVES: 1. Explain the concept of reperfusion injury/no-reflow phenomenon. 2. Discuss the pathophysiology of the no-reflow phenomenon. 3. Describe multiple MRI appearances/examples of the no-reflow phenomenon. 4. Discuss the clinical significance of no reflow.

CONTENT DESCRIPTION: The no-reflow phenomenon is described in cases of deficient reperfusion of a previously ischemic tissue, despite the fact that the lumen of an occluded coronary artery has been restored. Cardiac MRI is a noninvasive technique which has great

★ Faculty financial disclosures are located in the Faculty Index.

value in predicting clinical outcomes and resultant postischemic changes in left ventricular (LV) volumes. The pathophysiology of the no-reflow phenomenon is likely multifactorial and includes both intra- and extraluminal causes, such as atherothrombotic emboli, platelets, edema, and hemorrhage. First-pass MRI sequences are more sensitive than delayed-phase contrast-enhanced MRI in detecting the no-reflow phenomenon. It has been described in at least 40% of cases with acute MI, and therefore its clinical implications are tremendous. Correct diagnosis using cardiac MRI is therefore essential in predicting LV remodeling and poor functioning.

(E-10) Thursday • 7:00 AM
Don't Ignore the "N" in TNM: A Primer for the Evaluation of Thoracic Lymph Nodes with PET/CT

Michael Chung, MD, *St Luke's-Roosevelt Hospital, New York, NY*; Rosna M. Mirtcheva-Trocheva, MD

LEARNING OBJECTIVES: 1. Discuss the IASLC lymph node map, and demonstrate how the various nodal stations are approached in different ways by clinicians and surgeons. 2. Identify the specific intrathoracic lymph nodes that are easy to miss but are clinically relevant.

CONTENT DESCRIPTION: ***Content/Organization:*** 1. Review the IASLC lymph node map and the clinically relevant intrathoracic nodal stations that are relevant to PET/CT readers. 2. Review how clinicians and surgeons approach the various nodal stations. 3. Emphasize the pertinent details for differentiating nodes that are benign versus malignant per PET/CT imaging findings. 4. Review common misnomers and the locations of commonly missed intrathoracic lymph nodes. ***Conclusions/Summary:*** Accurate and precise evaluation of intrathoracic lymph nodes and an understanding of their clinical relevance are important for producing reports that will aid clinicians in the management of complicated disease processes.

Education of Residents, Medical Students, Other

(E-12) Thursday • 7:00 AM
Learning the Business of Radiology

Sanket C. Shah, MD; Vanessa Wear, MD; Kevin Krishenbaum, MD; Michael J. Gioia, DO, *Advocate Illinois Masonic Medical Center, Chicago, IL*; Amit Marwah, MD *(sanket.shah06@gmail.com)*

LEARNING OBJECTIVES: Resident education on radiology business practice and health care policy has always taken a backseat in radiology residency curricula, despite its perceived importance. New resources are available for radiology residents, although formal curricula addressing these topics are still in the early stages of development. The implementation of a resident-focused curriculum during residency covering basic business, economic, health care policy, and medicolegal concepts as they pertain to radiology will provide an invaluable skill set. We hope to make all residents trained at our institution both knowledgeable and active in understanding the changing economics of health care. Graduates can then further build on their knowledge in their future careers to help ensure continued availability and access to quality care for their patients.

CONTENT DESCRIPTION: An anonymous survey of our former residents from our institution revealed that formal education in radiology/medicine business practice was inadequate. We designed and implemented a resident-focused curriculum regarding basic business, economic, health care policy, and medicolegal concepts as they pertain to radiology. Lectures were piloted in the 2013–2014 academic year. The course was evaluated and modified through the use of pre- and posttests, as well as surveys, while in its infancy. The lecture series goes above and beyond the ACGME Healthcare Economics Systems-based Practice requirement: (1) Lecture 1: Basic Business Concepts as They Apply to Radiology; (2) Lecture 2: Introduction to Practical Noninterpretive Concepts—Understanding RBRVU, *ICD*, and *CPT* codes; (3) Lecture 3: Understanding the Types of Radiology Business Models and the RBRVU System; (4) Lecture 4: ACOs—A Shift from Fee for Service to Fee for Value; (5) Lecture 5: HROs and Patient Safety—What It Means for Radiologists; (6) Lecture 6: Malpractice and Risk Management; (7) Lecture 7: Nuts and Bolts of Medical Contracts; and (8) Lecture 8: Future of Radiology and the Changing Role of the Radiologist. Results after year 1 demonstrate a wide range of baseline knowledge among medical students, residents, and attendings. The lecture series has been positively received by all participants.

(E-15) Wednesday • 7:00 AM
Radiology Resident Clinician-Educator Pathway

Sword C. Cambron, MD, *Dartmouth-Hitchcock Medical Center, Lebanon, NH*; Petra J. Lewis, MD* *(swordrads@gmail.com)*

LEARNING OBJECTIVES: 1. Explain the concept of a resident clinician-educator pathway and its advantages in developing future clinician-educators in radiology. 2. Describe the areas of study and application in a clinician-educator pathway. 3. Discuss how to utilize the provided clinician-educator curriculum to develop a clinician-educator pathway tailored to their home institution.

CONTENT DESCRIPTION: In the 4th year of radiology residency, there is time for residents to begin to differentiate themselves and develop expertise. While fellowships after residency can offer graduating residents further clinical subspecialization, there is a unique opportunity in the 4th year for additional training in nonclinical areas such as education, informatics research, and global health. At our program, we sought to develop several pathways that residents could take in order to gain additional expertise in these nonclinical areas. We created a "Clinician-Educator Pathway" to provide structure for residents who are interested in pursuing a career in academic radiology and teaching. This clinician-educator pathway is based on six areas of study and application. These include pedagogy, teaching, curriculum design, evaluation, mentorship, and research. In this poster, we describe each component of the pathway, along with the overall structure and suggestions for implementation. The pathway included 3 months of time divided into dedicated 2-week blocks, during which the resident is involved in several concurrent activities: (1) pedagogy: participation in educator workshops, one-on-one sessions with faculty mentors, observing teaching styles, and assigned readings; (2) teaching skills: the resident gives several lectures and workshops to junior residents and medical students, with faculty feedback; (3) curriculum design: content/curriculum for medical students and/or residents is developed with a mentor; (4) evaluation: development of multiple-choice questions for medical student exams and participates in item editing; (5) mentoring: mentors a medical student over the course of the year; and (6) educational research: development/conduction of a research project in education.

(E-17) Wednesday • 7:00 AM
Emergency Radiology Trainee Pitfalls and Interpretive Errors: A Case-based Approach

Benjamin L. Yam, MD, *Hospital of the University of Pennsylvania, Philadelphia, PA*; Pejman J. Maralani, MD *(benjamin.yam@uphs.upenn.edu)*

LEARNING OBJECTIVES: This exhibit demonstrates our experience with pitfalls and interpretive errors on call that have the potential to alter clinical management. Content is presented in a case-based format to enable radiology trainees to actively learn from our errors, thereby preventing similar errors when such cases are encountered during future independent call.

CONTENT DESCRIPTION: In our emergency radiology department and in the literature, major discrepancies are defined as discrepancies between preliminary interpretations provided by trainees during independent call and faculty-finalized radiology reports that have the potential to alter patient management in terms of diagnosis, treatment, disposition, or outcome. The potential causes for these interpretive errors by the trainee are varied and include failure to detect a finding, interpretation of a normal finding as abnormal, dismissal of an abnormality as normal or artifact-related, recognition of an abnormality

but assigning an incorrect etiology, and failure to recognize limitations of technique or recommend further imaging workup. A retrospective review of all emergency radiology reports containing major discrepancies at our institution during the calendar year of 2012 was conducted. Using this database, we identified commonly missed and misinterpreted findings, as well as less commonly missed and misinterpreted findings associated with salient teaching points. From these, we present selected studies interpreted by trainees during independent call that were subsequently classified as major discrepancies by attending faculty. For each provided case, discrepancies between the initial trainee interpretation and the final attending interpretation are described, with emphasis on interpretive pitfalls, followed by a discussion of pertinent imaging findings, differential diagnosis, and clinical management issues. Cases are presented in an engaging multimodality case-based approach to allow the reader to actively learn from our errors, with the goal of increasing performance on call.

(E-20) Thursday • 7:00 AM
Hybrid of Didactic and Hands-on Learning Modules to Prepare 1st-Year Radiology Residents for Call

Dillenia Reyes, MD, *Temple University Hospital, Philadelphia, PA*; Beverly L. Hershey, MD *(dillenia.rosica@gmail.com)*

LEARNING OBJECTIVES: 1. Identify the challenges involved in orienting and preparing 1st-year radiology residents for the various services in general and for call responsibilities. 2. Outline an innovative approach to orienting and teaching the basics to 1st-year radiology residents using a hybrid of modality/organ systems–based attending-run didactics and hands-on resident-run modules. 3. Describe the outcome of these changes in subjective resident perceptions.

CONTENT DESCRIPTION: I. Background: At our institution, "buddy call" begins approximately 3 months after starting the 1st year of radiology residency. In years past, 1st-year orientation conferences were done solely through didactic lectures in the mornings. We developed a more comprehensive and cohesive approach to orientation and call preparedness by creating a modality/organ-based curriculum with a mix of attending-run didactic lectures balanced by resident-run hands-on modules. The modules are composed of sets of actual cases in our PACS system, which the 1st-year residents can scroll through on their own to be able to apply what they have learned from didactics with the guidance of upper-year residents. II. Orientation series schedule: Lectures and modules were scheduled with a modality/organ-based approach. Lectures were followed as closely as possible by modules on the same topics to reinforce learning and to facilitate cohesive supplementary reading. III. Description of hands-on modules: Modules were done on PACS workstations with an upper-year resident walking the 1st-year residents through an approach to a given study, as well as pointers, things to look for, and troubleshooting tips for a given topic. The 1st-year residents would then go through a set of cases on the workstation on their own, with the upper-year resident remaining available to help. IV. Postimplementation resident survey. V. Other outcomes: A positive outcome of the new curriculum was the generation of additional ideas and excellent sessions from other upper-year residents as the weeks progressed, several of whom developed additional didactics and modules on topics outside of the original curriculum that they felt would be helpful.

(E-25) Wednesday • 7:00 AM
Workbooks Aren't Just for Kids

Arya Iranmanesh, MD, *University of Kentucky, Lexington, KY*; Sally A. Jones, BA; M. Elizabeth Oates, MD *(amir222@uky.edu)*

LEARNING OBJECTIVES: 1. Discuss benefits of an electronic workbook for faculty-guided/resident-directed active learning. 2. Design a system facilitating attainment of level-specific core knowledge, skills, and milestones. 3. Explain how such an interactive workbook may augment the "at-the-workstation" experience.

CONTENT DESCRIPTION: In today's technology-fueled world, radiology residents are presented with a myriad of electronic resources which augment the "at-the-workstation" clinical experience. However, there is much to be gained from the faculty's ability to distill material into an easily comprehensible form. Through the use of online software (eg, MedHub), faculty may develop an "electronic workbook" to guide residents' attainment of fundamental knowledge and requisite skills for each subspecialty rotation. A prototype "workbook" was developed and integrated into the nuclear cardiology experience. It comprises three interactive online modules tiered to level of experience: (1) myocardial perfusion imaging, (2) gated blood pool imaging, and (3) PET/shunts/other. Within each module, key expectations are constructed around "Actions" and "Activities": "Read" (eg, assigned book chapters and journal articles), "Know" (eg, anatomy/physiology, radiopharmaceuticals, interpretation), "Observe" (eg, stress test, SPECT imaging), "Perform" (eg, processing raw planar or SPECT data), "Log" (eg, cases), and "Prepare & Present" (ie, a case study). "Assignments" requiring free-text short answers to provocative questions are interwoven throughout each module, interjecting variety and challenging the resident to seek answers. A multiple-choice question test serves as the self-assessment capstone for each module. Although we showcase an innovative electronic workbook designed to foster expertise in nuclear cardiology, analogous workbooks may be constructed for other subspecialty rotational experiences. The "e-workbook" exemplifies a flexible faculty-guided, learner-directed model.

(E-30) Thursday • 7:00 AM
MR Imaging Artifacts: Recognition and Reduction

Nupur Verma, MD, *University of Washington-Harborview Medical Center, Seattle, WA*; Michael Hoff, PhD *(nverma@u.washington.edu)*

LEARNING OBJECTIVES: 1. Recognize artifacts in magnetic resonance (MR) images. 2. Identify the source of MRI artifacts, and explain the physics behind their production. 3. Describe how to manipulate the MRI environment to reduce or eliminate artifacts in MRI.

CONTENT DESCRIPTION: With increased utilization of MRI in health care, there is a greater need for artifact education in the residency curriculum. Recognizing artifacts is an essential skill for all residents and is well represented in the study guidelines of the new American Board of Radiology (ABR) board certification exam format. MRI artifacts are complicated by several contributing factors (such as the patient and objects in the field); and lack of recognition of and compensation for the artifacts can lead to acceptance of poor-quality images and even false diagnosis. We present MRI artifacts grouped by causation for ease of understanding, and we offer examples of these artifacts with proposed methods for compensation or reduction that have a practical application. Artifacts covered include those caused by the patient or objects in the scanner, those caused by the sequence or intrinsic to the sequence itself, and those caused by hardware or factors external to the scanner. These include motion (ghosting, blurring, dephasing, misregistration), off resonance (susceptibility, chemical shift, B_0 inhomogeneity), magic angle effect, aliasing, truncation (Gibbs), gradient-related (nonlinearity, eddy currents), and radiofrequency-related (inhomogeneity, interference, overflow) artifacts. We hope that with improved recognition and understanding and the ability to propose a method to reduce these artifacts, trainees should feel more comfortable in interpreting MRI exams and with the new exam format.

AUR Trainee Prize: 3rd Place

(E-31) Wednesday • 7:00 AM
Web-based Diagnostic Radiology Simulator to Augment Call Preparation

Bimal Vyas, MD, *Wake Forest Baptist Medical Center, Winston-Salem, NC*; Carol P. Geer, MD; Leon Lenchik, MD; Scott D. Wuertzer, MD *(bvyas@wakehealth.edu)*

LEARNING OBJECTIVES: 1. Discuss the educational benefits of a diagnostic radiology simulator with multiplanar multisequence capabilities. 2. Describe the typical resident and faculty work flow with a Web-based simulator.

CONTENT DESCRIPTION: Currently, the basis of radiology education is to use select images to teach specific pathology. While this approach is beneficial, an educational void in call preparation persists, in which the resident must discriminate between abnormal and normal studies, as well as identify and describe pathology within multiplanar multisequence studies. To address this void, we developed a Web-based diagnostic simulator with select cases for differing levels of resident call, including normal studies or cases with normal variants. When using the simulator, the resident reviews a case and submits a preliminary report describing the key findings. Upon submission, a final report with faculty notes is immediately available to the resident. The resident then has an opportunity to submit a question or comment with their preliminary report. Faculty can view the preliminary reports, address resident questions, and comment on any resident errors. Finally, residents can review the images, the preliminary and final reports, and faculty feedback. Currently, the simulator includes 366 cases from various specialties and imaging modalities. Thus far, 16 first- and second-year residents have submitted 816 preliminary reports. Both residents and faculty find the simulator beneficial for call preparation. For residents, the simulator produces a call experience in an environment that is conducive to learning. For faculty, the simulator provides a chance to assess residents and provide tailored feedback in preparation for call. Our simulator continues to evolve as we add new cases and improve the functionality to better represent a typical resident on-call setting.

(E-32) Thursday • 7:00 AM
A Comprehensive 1-Year Medical Student Fellowship in Radiology

Jessica G. Fried, BA, *Dartmouth Geisel School of Medicine, Lebanon, NH*; Petra J. Lewis, MD* *(Jessica.G.Fried.MED@dartmouth.edu)*

LEARNING OBJECTIVES: 1. Understand the unique benefits of a comprehensive 1-year medical student fellowship in radiology. 2. Discuss the complementary roles of research, educational, and clinical experiences. 3. Recognize opportunities and challenges in developing a similar experience at other institutions.

CONTENT DESCRIPTION: Medical students typically receive only brief exposure to the field of academic radiology during their training. These experiences tend to highlight clinical aspects of the work of academic radiologists, providing few opportunities to engage in educational and research activities that enrich the career of the radiologist in academic medicine. For the medical student considering a career in academic radiology, a 1-year intensive medical student fellowship in the department of radiology offers the student a unique window into the career path and serves to cultivate the pipeline of future academic radiologists. The comprehensive 1-year medical student fellowship in radiology at Dartmouth-Hitchcock is designed to expose the student to three key areas of academic radiology: clinical practice, research, and education. We share the outline of our fellowship format to inform efforts to create similar programs at other institutions: (1) Research: The student engages in one to two major research projects during the fellowship period. It is ideal for the student to gain exposure to various aspects of research, including grant and protocol writing, the institutional review board process, database initiation and management, study design and execution, statistical and analytical techniques, manuscript writing, and presentation of data. (2) Education: The medical student engages in various educational activities, including development of interactive teaching sessions, examination question writing, and mentorship of junior medical students. (3) Clinical: The medical student is incorporated into the work flow of the department in selected sections for 2-week rotations throughout the year, with the same responsibilities and expectations of an R1 resident. When on rotation, the student is expected to dictate studies, read out with attendings, and participate in procedures.

(E-35) Wednesday • 7:00 AM
Radiology at the Crossroads: A Novel Approach to Medical Student Education—Incorporation of Clinical Radiology into the Preclinical Years at SUNY Upstate Medical University

Krishna K. Das, MD, *SUNY Upstate Medical University, Syracuse, NY*; Hal E. Cohen, MD; Rahul Nayyar, MD; Erica G. Malvica, BS, MS; Brittany S. Cohen, BS *(dask@upstate.edu)*

LEARNING OBJECTIVES: 1. Describe the evolution of the course, "MS1 Integrated Clinical and Anatomical Radiology." 2. Describe course structure/content. 3. Describe clinical opportunities made available outside of the lecture hall. 4. Discuss results/feedback. Upon review of our poster, we hope to introduce a novel concept of education recently introduced at SUNY Upstate, which incorporates clinical medicine into the preclinical years and raises awareness/interest in the field of radiology. Over the past few years, we were able to incorporate clinical radiology into the MS1 curriculum by developing a course titled "MS1 Integrated Clinical and Anatomical Radiology." This course has become an integral part of the well-established gross anatomy program and has served as a positive educational tool and a positive force in increasing familiarity/interest in radiology. We hope that our exhibit will serve to educate and inspire academic radiologists at medical schools across the country to implement similar integration of clinical radiology into the preclinical years.

CONTENT DESCRIPTION: In the past few years, applications to radiology programs from U.S. medical graduates have markedly decreased. The number of applications to radiology peaked in 2009 and has since decreased every year. The 2013 match was the least competitive since 1998. Additionally, medical schools have been searching for innovative ways to update their traditional curriculum by incorporating the "clinical model" into the preclinical years. At SUNY Upstate, we were able to successfully incorporate clinical radiology into the medical student curriculum by developing a course titled "MS1 Integrated Clinical and Anatomical Radiology." This course has evolved to become an integral part of the standard curriculum, and we would like to share our experience with other academic radiologists. Based on our preliminary data, we believe that the MS1 course has served as a positive educational tool and has had a positive impact on increasing familiarity and interest in radiology. Future work includes tracking progress through the clinical years and through the NRMP match. We hope to gain insight into the impact on medical student applications into the radiology match and USMLE/clinical rotation performance.

(E-38) Thursday • 7:00 AM
Fourth-Year Medical Student Elective in Multidisciplinary Thoracic Oncology

Leslie E. Quint, MD, *University of Michigan Medical Center, Ann Arbor, MI*; Rishindra M. Reddy, MD *(lequint@umich.edu)*

LEARNING OBJECTIVES: Senior medical student education is trending toward increased subspecialization, and students may choose to spend much of their senior year focusing on their areas of future practice. It can be helpful to broaden the horizons of these students via multidisciplinary training that is centered on their area of primary interest. This poster describes a 4th-year student elective at our institution, entitled "Multidisciplinary Thoracic Oncology," that aims to supply students with a broad and deep experience within a very focused area of medical practice. This elective is valuable to students pursuing careers

in a variety of fields related to thoracic oncology. The objectives of this poster are to describe the methodology and curriculum content employed for this elective.

CONTENT DESCRIPTION: This 4-week elective employs a "flipped classroom" approach with didactic teaching materials that are delivered on an interactive online platform. Materials include recorded videolectures with prelecture, postlecture, and embedded multiple-choice questions (MCQs); case studies with a sequential, question/answer learning approach and embedded MCQs; a precourse quiz; and a postcourse exam. These didactic materials are viewed by students at their own time and pace, typically during evenings and weekends. During daytime hours, the students rotate through relevant clinics, seeing patients and reviewing their cases with attending faculty, and occasionally assisting in surgical or interventional procedures. The areas covered include medical oncology, pathology, pulmonology, radiation oncology, radiology, and thoracic surgery, focusing on patients with lung, esophageal, and other thoracic neoplasms. Each student presents one or more of his/her patients at the weekly thoracic tumor board meeting. The capstone project is a written case study or an oral presentation to the entire thoracic tumor board, based on a relevant topic and an actual patient. Comments from students who took this elective during the past year indicated enjoyment of "full engagement in the learning process and the patient care team" and "obtaining a well-rounded multidisciplinary understanding of the presentation and treatment of these patients."

(E-39) Wednesday • 7:00 AM
MedU Online CORE Cases Integrated with Flipped Classroom Workshops for Enhanced Engagement of Teachers and Learners

Jeffery Hogg, MD, *West Virginia University School of Medicine/Robert C. Byrd Health Sciences Center, Morgantown, WV*; Erin E. O'Connor, MD; Sravanthi Reddy, MD; Carl R. Fuhrman, MD; Laura L. Avery, MD; Petra J. Lewis, MD★ *(jhogg@hsc.wvu.edu)*

LEARNING OBJECTIVES: 1. Describe how CORE workshops can be integrated into flipped classroom teaching. 2. Identify how higher cognitive skills can be engaged for medical students with flipped classroom pedagogy for radiology instruction. 3. List factors influencing educators to engage in classroom instruction.

CONTENT DESCRIPTION: This educational poster describes (1) development of workshops that augment and enhance content delivered in MedU CORE cases, a series of online didactic instructional modules that utilize image-based case simulations in rich clinical context and teach the basic radiologic concepts all medical students need; (2) role of workshop-based flipped classroom teaching in moving the online didactic CORE cases to a primary resource, around which elective instruction is centered; (3) activation of higher cognitive skills in medical students beyond knowledge and recall of information (to include application, analysis, comparison, evaluation, and synthesis) by providing opportunities to apply and practice clinical decision making and image interpretation skills taught in the online cases to new problems in the workshops; (4) creation of a clear path for novice instructors (faculty and senior radiology residents) to become engaged in classroom instruction of 3rd- and 4th-year medical students by using minimally scripted workshops that contain instructor notes, suggested questions (with answers), tasks, and topics for exploration with students as an active learning activity, an alternative to more-passive traditional lecture-based instruction; (5) increase in elective instructor engagement in radiology elective teaching in the five pilot sites; and (6) collaboration among authors at several medical schools that produced shared resources for instructors to use, and where and how clinician-educators may find these resources.

(E-42) Thursday • 7:00 AM
Diagnostic Imaging Anatomy: An Open-Source Comprehensive Multimodality Clinical Atlas

Sukhvinder S. Dhillon, MBChB, MRCP★, *University of Alberta, Edmonton, AB*; Klaudia Nowak, MD; Elizabeth Hillier; Paul Filipow *(sdhillon@ualberta.ca)*

LEARNING OBJECTIVES: This exhibit will demonstrate a new online open-access imaging anatomy atlas. Learners at all levels will be able to review and learn multimodality imaging anatomy. The learner will be able to identify the imaging appearances of anatomy during cadaver lab work. The imaging practitioner will have labeled diagnostic images to aid in image interpretation.

CONTENT DESCRIPTION: Diagnostic imaging anatomy is increasingly being used in medical student anatomy instruction. Traditionally, these have been PowerPoint-based lectures with single jpeg images. Diagnostic imaging using cross-sectional techniques (MRI, CT, US) requires the ability to scroll through all of the images to allow a full appreciation of the 3D anatomical structure. This allows a direct correlation with dissected cadaver specimens. The department of diagnostic imaging and division of anatomy have collaborated to build an open-access online imaging atlas. This Web-based resource provides high-quality diagnostic images fully labeled and presented in a scrollable format to simulate a DICOM-based clinical case. The level of labeling detail will also provide a full resource for practicing radiologists. Anatomy labeling includes muscles, vasculature, nerves, ligaments, tendons, solid organs, hollow viscus, and skeleton in axial, sagittal, and coronal planes. All systems are included: musculoskeletal, head and spine, thoracic/cardiac, abdomen/pelvis, and vascular. All anatomical areas are presented in all modalities appropriate to clinical practice: MRI, computed tomography, ultrasound, plain radiography, and angiography (including CT and MRI). Over 120 multimodality anatomical areas will be available; 30% of the material is complete, with 75% completion expected by April 2015. The resource is a collaboration between the department of diagnostic imaging and division of anatomy. This site will have open access in January 2015.

(E-44) Thursday • 7:00 AM
Cracking the Code of the RVU: What Every Radiologist Needs to Know

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

LEARNING OBJECTIVES: 1. Explain key information about the history of the relative value unit (RVU), the current formula for RVU calculation, and how this affects the radiologist. 2. Describe how RVUs are calculated in the current U.S. medical reimbursement system, and provide examples of current RVUs for a variety of radiology imaging studies and interventional radiology procedures.

CONTENT DESCRIPTION: RVUs are a measure of value used in the Medicare reimbursement formula for physician services. RVUs are a part of the resource-based relative value scale (RBRVS), which was designed to value physician services and serve as a guide for reimbursement. In radiology, monitoring RVUs allows practice managers to identify physician productivity and reimbursement and to help address future hiring needs. The purpose of this exhibit is to educate radiologists and trainees about the history of this reimbursement system and how physicians and practices are compensated under the RBRVS. In addition, we review the three different components of the RVU and highlight the RVUs assigned to common radiology imaging studies and procedures. Two formulas are most important in determining the RVU for a particular procedure or imaging study and the overall payment. One is: Payment = Total RVU × CV. The other is: Total RVU = (Work RVU × GPCI) + (PE RVU × GPCI) = (PLI RVU × GPCI). The fundamental concepts and components of these equations will be detailed, and examples of how this applies to a variety of imaging studies will be provided. The total RVU is multiplied by a conversion factor to determine the total payment for each imaging study or procedure. This conversion

factor is updated annually and currently stands at $35.8228. The total RVU has three components: one for physician work, one for practice expense, and one for malpractice expense. Each of these three elements is multiplied by a geographic practice cost index (GPCI) that varies by geographic location. A subcommittee of the American Medical Association (called the RUC) determines and revises the RVUs, but the final decision about this is made by the Center for Medicare & Medicaid Services.

(E-45) Wednesday • 7:00 AM
The Risks of Sedentary Behavior in the Reading Room: What the Radiologist Needs to Know

Jason C. Hoffmann, MD*, *Winthrop-University Hospital, Mineola, NY*; Caroline Hoffmann, MS; Ahmed Fadl, MA, MD; Amanjit Baadh, MD; Jonathan Flug, MD, MBA *(jhoffmann@winthrop.org)*

LEARNING OBJECTIVES: Provide the radiologist with information about health risks associated with sedentary behavior. The concept of non–exercise activity thermogenesis (NEAT) will be described, and examples will be given of how to burn more calories while at work and improve overall health. A variety of basic exercises and health tips will be detailed to provide radiologists with tools to improve their health and combat the negative effects of sedentary behavior.

CONTENT DESCRIPTION: Diagnostic radiologists tend to spend a large percentage of their workday sitting down. Studies have linked sedentary behavior to multiple diseases, such as diabetes, obesity, hypertension, and heart disease. This exhibit details the association of sedentary behavior with a variety of health problems and provides a number of simple activities and techniques that can improve fitness and overall health while still meeting productivity demands of a high-volume practice. Studies have found that even for those who exercise regularly, spending increased time sitting can negate the healthy effects of exercise. Spending more time in a seated or sedentary position leads to a slowing of one's metabolism. When sitting, the body uses less energy, leading to decreased calorie burning, which can result in increased fat stores. Non–exercise activity thermogenesis (NEAT) refers to the energy expended for everything we do during activities of daily living, excluding sporting-like exercise. The concept of NEAT must be understood by radiologists, as it allows for development of multiple strategies that can be adopted to combat the ill effects of sitting down while working. Standing leads to increased movement and burning of more calories. Adding intermittent movement and stretching exercises throughout the day can be used to stimulate metabolism. As an example, keeping a small rather than large container of water at your workstation will encourage you to stand up more frequently to refill it. A variety of other techniques will be described that are efficient and easy to incorporate into a radiologist's workday but can have significant positive impact on your health.

Health Services for Radiology

(E-46) Thursday • 7:00 AM
Developing, Designing, and Applying Practice Quality Improvement Templates for Widespread Use by Professional Societies, Residencies, and Fellowships: Our Experience

Ryan B. Peterson, MD, BS, *Emory University, Atlanta, GA*; Ivan M. Dequesada II, MD; Kimberly E. Applegate, MD, MS*; Amanda S. Corey, MD* *(rpete22@emory.edu)*

LEARNING OBJECTIVES: 1. Explain the process of developing a practice quality improvement (PQI) template for widespread use by professional societies to help the radiologist fulfill maintenance of certification (MOC) requirements for the American Board of Radiology (ABR). 2. Discuss considerations in template format and design, including prior template structures, pitfalls that would hinder general use of the template, and technical obstacles. 3. Discuss the application of information assembled in the PQI template for education of residents and fellows.

CONTENT DESCRIPTION: The goal of a PQI template is to assist the radiologist in meeting part IV of the MOC requirements from the ABR. Currently, a limited number of professional societies offer such templates. We undertook the task of developing a PQI template pertaining to the fluoroscopically guided lumbar puncture. The presentation will first review considerations when selecting a topic for a PQI template and identifying a target audience, subspecialty, and professional society. Specifically, we will discuss goals of a PQI project, give examples of potential topics, and provide tips on how to work in tandem with a professional society willing to host your template. Next we will discuss a general format for templates, reviewing the literature and summarizing evidence-based medicine, and identifying potential pitfalls when designing your template. Topics will include learning to limit the scope of the template, determining the number of cases, and making it easy for the radiologist to succinctly complete the PQI module. Finally, we will present educational uses of the PQI template for residents and fellows. Reviewing the literature and presenting the best practices for a given topic provide an easily accessible framework for future radiologists. Having residents and fellows take the same pretest evaluation, having them review the evidence-based standards of practice, and providing them opportunities to apply those principles will improve their understanding of that topic. We will share our future plans in applying the PQI template for radiology residents performing fluoroscopically guided lumbar puncture.

AUR Trainee Prize: 3rd Place

(E-47) Wednesday • 7:00 AM
Ergonomics in the Workplace: What the Radiologist Needs to Know

Puneet Belani, MD, *Robert Wood Johnson Medical School-Rutgers University, New Brunswick, NJ*; Judith K. Amorosa, MD; Steven Schonfeld; Lily Zou, MD *(pbelani@univrad.com)*

LEARNING OBJECTIVES: The goal of ergonomics in radiology is to prevent injury and fatigue due to work-related conditions. This quality storyboard will describe (1) the current understanding of ergonomics among radiology residents and attendings in a large academic setting and (2) tips on improving ergonomics in the radiology reading room.

CONTENT DESCRIPTION: ***Method and Materials:*** Seventy-eight residents and attendings took part in a 10-question survey which assessed their understanding of ergonomics and its impact on their health. The initial survey identified that most radiologists and residents experienced one or more symptom (for example, wrist pain) that they believed was related to work. Additionally, they did not fare well regarding their knowledge of proper ergonomics. Subsequently, a PowerPoint presentation was created and distributed to the group to address deficiencies identified by the survey. This presentation served to provide tips on proper ergonomics as it pertains to posture, vision, sound, ambient lighting, temperature, ventilation, etc, in the radiology reading room. After 6 months, a follow-up survey consisting of five questions was distributed, with the goal of understanding whether the audience implemented changes in their daily ergonomics and whether their symptomatology improved and to identify barriers to improving workplace ergonomics. ***Results:*** The 6-month follow-up survey demonstrated that 94% of the audience found the presentation helpful and that 70% of those who incorporated advice from the presentation reported improvement in symptomatology. The biggest barrier to improving workplace ergonomics identified by the audience was lack of adjustable desks. ***Conclusion:*** Our survey initially demonstrated limited understanding among radiologists pertaining to several key factors in ergonomics. We bridged this knowledge gap by creating a PowerPoint presentation with tips on ergonomics, which was well received by the group. We also demonstrated that a majority of those who incorporated points from the presentation experienced an improvement in symptomatology.

(E-48) Thursday • 7:00 AM
A Primer on the *International Classification of Diseases (ICD)* and the Transition to *ICD-10:* What the Radiology Resident Needs to Know

Kumar Shah, MD, *Robert Wood Johnson Medical School-Rutgers University, New Brunswick, NJ*; David Walor, MD; Sandip Basak, MD; Jeffrey Kempf, MD *(kumar.shah@univrad.com)*

LEARNING OBJECTIVES: 1. Describe the history of the *International Classification of Diseases (ICD)* and its importance in epidemiology, worldwide morbidity and mortality statistics, research, and allocation of resources. 2. Describe the basic principles and role of the *ICD,* from population health to billing purposes. 3. Discuss the current use of *ICD-9* in the United States, the transition to *ICD-10* for 2015, and the role of the radiology resident.

CONTENT DESCRIPTION: The *ICD* was first developed in 1893 and is used to capture mortality and morbidity data and code health information for epidemiology, health care management, and disease prevention and treatment. It is maintained by the World Health Organization and is designed as a health care classification system of diagnostic codes for classifying diseases; in addition, these codes are used to translate a report into a billable reimbursement value. The *ICD* is revised periodically and is currently in its 10th revision. The United States, however, has been using *ICD-9* since 1975. *ICD-9* can no longer accept new diagnoses and procedures, limiting the ability to use the system to track population health statistics and outcomes. *ICD-10* will have about 141,000 codes, compared with 17,000 codes in *ICD-9,* and will have two parts in the United States, including clinical modification codes and inpatient procedure codes. The financial impact to convert to *ICD-10* in the United States will be significant. The radiology resident will be an integral member of the health care team as *ICD-10* becomes implemented and will need to understand the *ICD* system and its impact on coding, billing, and payment. One of the crucial roles of the resident will be to accurately describe the reason for an exam based on the patient's history. The exam reason must translate into a billable order and accurately correspond to any positive findings described in the radiology report. This poster will educate the radiology resident on the past, present, and future of the *ICD,* from its global importance in monitoring worldwide health trends to the resident's role in generating proper documentation in a report dictation to lead to payer reimbursement.

Informatics

(E-49) Wednesday • 7:00 AM
Evaluation of a Case-tracking Dashboard for Radiology Residency Programs

Ashwin P. Nambiar, MD, *University of Maryland Medical Center, Baltimore, MD*; Jigar B. Patel, MD; Ken Wang, MD; Daniel W. Maver, MD; Eliot L. Siegel, MD★ *(uvashwin@gmail.com)*

LEARNING OBJECTIVES: The ACGME requires that residents log cases of predetermined types in order to document competencies and demonstrate that residents have performed a minimum number of cases in relevant areas. Different institutions have adopted different methods of acquiring these data. The most common methods of case tracking will be reviewed. Manual extraction, a novel dashboard that automatically populates case logs, and a new system developed at our academic institution will be compared and evaluated relative to each other.

CONTENT DESCRIPTION: At some institutions, residents manually count different types of cases using a variety of information systems, such as a speech reporting system. At our academic medical center, a new system was created to aggregate data from multiple sources (PACS, RIS, EMR) and normalize the data to a lexicon based on the SIIM Workflow Initiative in Medicine (SWIM™). Residents can then self-report to the ACGME data entry portal. This system is updated quarterly. The commercially available platform that we evaluated is updated nightly via the speech recognition–based reporting software. Specific users are identified, and *CPT* codes associated with these users are aggregated. The *CPT* codes are then matched to ACGME-provided tables to allow tabulation of the number of 11 mandatory case types. The advantages of the University of Maryland system include the aggregation of data from different sources so that cases are not underreported. An advantage of the commercially available platform is that it is updated nightly and can easily be updated more frequently, since it is extracting data from the dictation software without the need for normalization. Neither of the systems currently works in conjunction with a resident scheduling system, which could be used to modify schedules in order for residents to get more experience in deficient areas. Furthermore, it would be helpful if the systems automatically populated the ACGME case log Web site from the acquired data. Finally, a system that would share data among different residency programs might help training programs upgrade the residency experience beyond the minimum requirements of the ACGME.

Interventional Radiology

(E-50) Thursday • 7:00 AM
"Oh, No, We Need Flow!" Cased-based Review and Therapeutic Algorithm for Recanalization of Central Venous Occlusion

FDA

Jenanan Vairavamurthy, MD; Adam Zybulewski, MD, *Mount Sinai Beth Israel, New York, NY*; Sujoy Menon, MD, MBA; James E. Silberzweig, MD; Rajesh Patel, MD; Joseph Shams *(jenanan.vairavamurthy@gmail.com)*

LEARNING OBJECTIVES: Central venous occlusions are a common complication in patients with central venous catheters, with the highest prevalence in patients with long-term catheters for hemodialysis. The therapeutic options for central vein occlusion include pharmacologic thrombolysis, balloon angioplasty, endovascular stenting, and surgical bypass. Angioplasty is recommended as the preferred therapy for central vein stenosis. However, angioplasty can be extremely problematic when central vein occlusion cannot be traversed with a guidewire. In such cases, there is reliance on the use of radiofrequency ablation wires, Glidewires, Rösch needles, and double snare techniques. Using a case-based format, we aim to educate the reader on the important angiographic findings considered when determining the approach to relieving central venous occlusions.

CONTENT DESCRIPTION: I. Overview of central venous anatomy. II. Causes and treatments of central venous occlusion. III. Cased-based review of different recanalization techniques, with an emphasis on angiographic findings. A. Guidewires. B. Recanalization with Glidewires. C. Radiofrequency ablation wires. D. Rösch needles. E. Double snare techniques. IV. Therapeutic algorithm for how to approach central venous occlusion based on angiographic findings.

(E-51) Wednesday • 7:00 AM
Role of Pre- and Postoperative Imaging in Selective Intraarterial Radionuclide Therapy: A Case-based Review

Jenanan Vairavamurthy, MD, *Mount Sinai Beth Israel, New York, NY*; Adam Zybulewski, MD; Rajesh Patel, MD; Alexander C. Kagen, MD★; James E. Silberzweig, MD *(jenanan.vairavamurthy@gmail.com)*

LEARNING OBJECTIVES: 1. Identify the indications and contraindications of selective intra-arterial radionuclide therapy (SIRT). 2. Describe the preoperative imaging evaluation of patients undergoing SIRT using case-based examples. 3. Discuss the pertinent findings on postprocedural imaging, including complications and assessing response to therapy, using case-based examples.

CONTENT DESCRIPTION: I. Indications for SIRT. II. Contraindications for SIRT. III. Preoperative imaging evaluation of patients undergoing SIRT. A. CT/MR angiography. B. Macroaggregated albumin shunt scintigraphy. 1. Calculating shunt fraction. 2. Extrahepatic activity. C. CT/MR-guided liver quantification. 1. Calculating right and left lobe

★ Faculty financial disclosures are located in the Faculty Index.

volume. 2. Dose calculation based on size. IV. Postoperative imaging evaluation of patients undergoing SIRT. A. Bremsstrahlung scan. 1. Detection of nontarget deposition. 2. Distribution of particles within the liver. B. Expected findings. 1. CT. 2. MRI. C. Assessing response to therapy. D. Complications.

(E-52) Thursday • 7:00 AM
New Frontiers in Transcatheter Arterial Chemoembolization: A Review of Current Progress and Future Directions

(FDA)

Richard Tapnio, MD, MHS, *Mount Sinai Beth Israel, New York, NY*; Eric Berkowitz, MD

LEARNING OBJECTIVES: 1. Describe transcatheter arterial chemoembolization (TACE) and its current usage in hepatocellular carcinoma. 2. Discuss major studies implementing TACE in tumors outside of the liver, with a literature review. 3. Discuss future directions of TACE, both as an alternative therapy and as an adjuvant therapy, in unresectable tumors outside of the liver.

CONTENT DESCRIPTION: We will present a literature review of transcatheter arterial embolization (TACE) and its therapeutic benefit in treating liver tumors, multi-institutional clinical data of its usage in tumors outside of the liver, and future directions of the technology as both a primary and adjuvant therapy. First, we will provide a pictorial, conceptual, and technical overview of TACE as applied to liver tumors. We will then discuss the growing progress TACE has made in malignancies of other organs, including in the lung, pancreas, and bone, along with other nonsurgical alternatives to TACE currently implemented. By the end of the presentation, one should have a broad understanding of therapy for unresectable tumors in the liver, as well as similar tumors in other organs, along with successes and failures of implementing TACE in these organs.

(E-53) Wednesday • 7:00 AM
Reducing Exposure to Scatter Radiation in the Interventional Radiology Suite: A Review of Radiation Protection Devices and How to Use Them

John P. Gonzales, MD, *Mount Sinai Beth Israel, New York, NY*

LEARNING OBJECTIVES: 1. Describe the various devices available to operators in the IR suite for the reduction of scatter radiation. 2. Compare the effectivity of the various devices in reducing exposure to scatter radiation. 3. Explain how best to use the various devices in order to maximize scatter radiation exposure reduction.

CONTENT DESCRIPTION: The educational exhibit will first describe the various types of scatter radiation protection devices, particularly those that are worn by the operator, those that are applied to the patient or are affixed to the procedure table, and those devices that are fixtures in the IR suite. Images of the various devices will be shown. The amount of scatter radiation reduction attributable to the use of each device will be provided, based on reviewed literature. Images of how best to use or combine protective devices will be shown, with emphasis on imaging geometry and device location.

(E-54) Thursday • 7:00 AM
Techniques to Create Safe Access Routes and Avoid Interposed Structures for Image-guided Interventions

Ji Buethe, MD*, *University Hospitals Case Medical Center/Case Western Reserve University, Cleveland, OH*; Nami R. Azar, MD*; John Haaga, MD; Dean Nakamoto, MD* *(ji.buethe@uhhospitals.org)*

LEARNING OBJECTIVES: Describe indications, benefits, procedural details, and outcomes/complications of the various techniques to create a safe window during a percutaneous image-guided intervention.

CONTENT DESCRIPTION: Although percutaneous image-guided interventions are minimally invasive and safe, precise planning is important to prevent serious complications. While the shortest pathway to the target is often preferred, this approach is not always possible due to intervening structures such as blood vessels, bowel, and adjacent organs. In addition, for percutaneous thermal ablations, protection of organs adjacent to the target is very important. In these situations, different techniques can be used to create a window of safe access. These techniques are illustrated in detail, along with sample cases selected from the author's institution. ***Procedure Detail:*** (1) Examples of challenging cases (abscess drainage, biopsy, ablation therapy) involving the mediastinum, lung, subphrenic region, liver, kidney, and pelvis. (2) Describe effective techniques to create a safe access route, using examples. (3) Patient positioning. (4) Instillation of saline or air. (5) Utilization of the respiratory phase. (6) Maneuvers using a US probe or compression device. (7) Emphasize visualization of intervening vascular structures/blood vessels using IV contrast administration (CT) or color Doppler (US). (8) Outcomes and complications. This educational exhibit will highlight different techniques that can be used to create a window of safe access for challenging percutaneous interventional cases.

(E-55) Wednesday • 7:00 AM
A Recipe for Making a CT Biopsy Phantom

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

LEARNING OBJECTIVES: 1. Explain the benefits of simulation training for diagnostic and interventional radiologists. 2. Describe the specific role of simulation for radiology trainees learning to perform image-guided procedures. 3. Describe an easy and inexpensive way to make a reusable phantom to teach, practice, and evaluate the image-guided percutaneous biopsy skill set.

CONTENT DESCRIPTION: Computed tomography (CT)–guided biopsy is a common procedure performed by diagnostic and interventional radiologists, with more than 600,000 performed annually in the United States. Training in interventional radiology predominantly uses the apprenticeship model, where clinical and technical skills of invasive procedures are learned while being performed on patients, which places both the patient and proceduralist at unnecessary risk. Medical education is moving toward increased use of simulation for the training and assessment of procedural skills, as it allows learners to strengthen their technical skills without incurring risk to either patient or learner. A CT biopsy phantom that is inexpensive and easy to produce would be an asset for radiology student, resident, and fellow education. This exhibit will describe the planning, development, and construction of such a phantom, which is made from ingredients that are widely available. Commercial CT biopsy phantoms are available to assist the trainee; however, these devices cost upwards of $2200 and must be replaced after repeated use. This exhibit will demonstrate the construction of a CT biopsy phantom using common nontoxic ingredients that cost approximately $20. The phantom allows the trainee to learn sterile technique, skin preparation, anesthetic injection, grid placement, and skin marking. Once the basic principles have been learned, the trainee gains insight into lesion localization and needle placement and repositioning under CT guidance. Finally, familiarity with various needles, trocars, and biopsy devices can be achieved. The phantom allows core biopsies to be obtained and examined, which confirms technical success. Mastering these core fundamentals increases skill and confidence, leading to improved patient care and safety.

Musculoskeletal Radiology

(E-56) Thursday • 7:00 AM
Acetabular Labral Tears: A Review of Predisposing Conditions, Tear Patterns, and Common Pitfalls at MR Arthrography

Barrett Luce, MD, *Baylor Scott and White, Temple, TX*; Jordan K. Fite, MD; Ricardo D. Garza-Gongora, MD *(barrett.n.luce@gmail.com)*

LEARNING OBJECTIVES: 1. Describe the normal anatomy of the acetabular labrum at MR arthrography. 2. Review various conditions predisposing to acetabular labral tears. 3. Provide a pictorial review of various acetabular labral tears and common pitfalls.

CONTENT DESCRIPTION: MR arthrography is the study of choice to evaluate for pathology of the acetabular labrum. When compared with the shoulder, MR arthrograms of the hip are less commonly performed, and as a result, many residents and non-MSK radiologists lack confidence in interpreting these examinations. The purpose of this exhibit is to provide an image-rich review of MR arthography of the hip. First, we review the normal anatomy of the acetabular labrum and its appearance on MR arthrography. In addition, the various conditions that predispose to labral pathology—osteoarthritis, femoroacetabular impingement, and developmental dysplasia of the hip—are illustrated. Finally, we demonstrate various tear patterns of the acetabular labrum, as well as potential interpretation pitfalls.

(E-57) Wednesday • 7:00 AM
Arteriovenous Malformations of the Extremities: The Natural Course if Left Untreated and the Role of MR Imaging in Diagnosis

Shannon B. Glass, MD, *Baylor University Medical Center Dallas, Dallas, TX*; Walter Cannon, MD *(shannon.barry4@gmail.com)*

LEARNING OBJECTIVES: 1. Discuss the progressive clinical course of an untreated arteriovenous malformation (AVM) and the Schobinger classification. 2. Describe the specific role of MRI in the diagnosis of AVMs of the extremities. 3. Describe the MRI features of AVMs of the extremities.

CONTENT DESCRIPTION: Arteriovenous malformations (AVMs) most commonly occur in the extremities and pelvis. Although all vascular malformations are present at birth, if located deep or if slow growing, AVMs may not be detected until adolescence or even early adulthood, after somatic growth has slowed or ceased. The Schobinger classification outlines the progressive course of an AVM if left untreated. Lesions progress from stage I ("quiescence") to stage II ("expansion") with increasing pulse and thrill. Stage III is characterized by local "destruction" associated with pain, ischemia, and necrosis. If left untreated, AVMs can progress to stage IV ("decompensation") with high-output cardiac failure. The diagnosis of a vascular malformation can usually be made correctly on the basis of clinical history and examination alone; however, diagnosis is nearly always confirmed with some form of imaging or, rarely, biopsy. All imaging modalities can provide variable degrees of diagnostic and other information for preprocedural planning and the workup of vascular malformations. However, MRI has become the imaging modality of choice in the confirmation, characterization, and differentiation of vascular malformations and their subtypes and allows for treatment planning and objective imaging follow-up post therapy. AVMs have a dramatically different appearance on MRI than their low-flow counterparts, with high-flow physiology leading to a focal or infiltrative tangle of flow voids seen on both T1- and T2-weighted imaging. The lesion can be associated with fatty hypertrophy or muscular atrophy. Unlike other vascular malformations and many hypervascular tumors, there is usually a very characteristic lack of mass effect in AVMs on MRI.

(E-58) Thursday • 7:00 AM
Simplifying the Triangular Fibrocartilage Complex

Michael E. Cody, MD, *Brigham and Women's Hospital, Boston, MA*; David Nakamura, MD; Kirstin M. Small, MD; Hiroshi Yoshioka, MD

LEARNING OBJECTIVES: 1. Explain wrist MR imaging techniques, with an emphasis on 3D isotropic sequences. 2. Describe the relevant anatomy of the triangular fibrocartilage complex (TFCC), as well as imaging pitfalls that may mimic pathology. 3. Discuss the Palmer classification for TFCC injuries, as well as the prognostic significance of various injuries.

CONTENT DESCRIPTION: The TFCC is an essential stabilizing structure of the distal radioulnar joint and ulnar carpus, with injury to this structure resulting in ulnar-sided wrist pain and joint instability. Imaging of the TFCC, however, is difficult owing to the complex geometry and the small size of its constituent components. This poster discusses available wrist MR imaging techniques, highlighting recent applications of 3D isotropic sequences. In addition, we will review the anatomy of the TFCC and examine normal structures that may simulate pathology. The Palmer classification system will be discussed and accompanied by several cases illustrating various traumatic and degenerative injury patterns. Finally, prognostic and treatment considerations for assorted injuries will be reviewed.

(E-59) Wednesday • 7:00 AM
MR Imaging of Postsurgical Articular Cartilage Repair in the Knee, with Radiologic and Arthroscopic Correlation: What the Radiologist Should Know

Seong Cheol Oh, MD, *Hospital of the University of Pennsylvania, Philadelphia, PA*; Benjamin H. Ge, MD; James L. Carey, MD, MPH; Sung Han Kim, MD *(ohseo@uphs.upenn.edu)*

LEARNING OBJECTIVES: 1. Recognize MRI appearances of articular cartilage after various cartilage repair procedures, including microfracture surgery, autologous chondrocyte implantation, and osteochondral transplantations, with radiologic and arthroscopic correlation. 2. Identify key postoperative features to recognize and communicate to the orthopedist. 3. Describe MRI findings of successful treatment, as well as signs of suboptimal outcome.

CONTENT DESCRIPTION: Various surgical methods are available for repairing knee articular cartilage. With cartilage repair procedures increasing in popularity, it is important for the radiologist to be familiar with the postoperative MRI appearance and effectively communicate relevant findings to the orthopedist. Microfracture surgery creates multiple small holes in the subchondral bone and effluxes pluripotential stem cells from the marrow into the defect to create fibrocartilaginous tissue. Autologous chondrocyte implantation traditionally consists of two stages: chondrocytes are harvested from a non–weight-bearing cartilage, reimplanted a month later into the defect, and covered by a periosteal flap with fibrin glue or sutures. Osteochondral transplantations are performed by harvesting osteochondral plugs from the patient (autograft) or a cadaver (allograft) for implantation into the defect. The cases presented illustrate the pre- and postoperative MRI appearances of articular cartilage after the above-mentioned procedures. Arthroscopic images are included for correlation. Radiologic assessment should include the degree of defect filling, morphologic characteristics of the reparative tissue or repair site, and extent of integration at the lesion borders. Suboptimal outcome is manifested by incomplete filling of the defect, thin or irregular repair tissue, and fluid signal at the graft-host interface.

Figure 1. Pre- (a, c, e) and postoperative (b ,d, f) MR images of microfracture (a, b), autologous chondrocyte implantation (c, d), and osteochondral autograft transplantation (e, f) with favorable postoperative radiologic appearances. Two anterior osteochondral harvest sites are noted, which were integrated into the weight-bearing femoral condyle (f).

(E-60) Thursday • 7:00 AM
The Many Faces of Osteosarcoma

Leo Menashe, MD, *Icahn School of Medicine at Mount Sinai, New York, NY*; George Hermann, MD; Roberto Garcia, MD; William L. Simpson, MD*

LEARNING OBJECTIVES: 1. Describe the typical imaging appearance of conventional osteosarcoma. 2. Discuss the imaging findings of rare types of osteosarcoma, including chondroblastic, telangiectatic, giant cell–rich, osteoblastoma-like, and surface tumors.

CONTENT DESCRIPTION: Osteosarcoma is the most common nonhematologic primary malignancy of the skeleton. While in most instances osteosarcoma arises at the end of the long bones between the ages of 10 and 25 years, we will review the imaging pattern of the tumor in various age groups and in unusual locations and correlate with histology. In addition to the conventional osteosarcoma, we will present the imaging findings and discuss rare types of the tumor, such as chondroblastic, telangiectatic, giant cell–rich, osteoblastoma-like, and surface tumors. Radiologists should be aware of and familiar with not only the conventional osteosarcoma but also its atypical imaging and histologic presentations.

(E-62) Thursday • 7:00 AM
Most Commonly Litigated Musculoskeletal Fractures and How to Reduce Errors in Diagnosis

William T. Randazzo, MD, *Medical College of Georgia, North Augusta, SC*; James L. Smith; Bennett S. Greenspan, MD, MS*; Yulia Melenevsky, MD *(wtrandazzo@gmail.com)*

LEARNING OBJECTIVES: 1. Identify the sites of musculoskeletal fractures that most commonly result in malpractice suits. 2. Identify the reasons why the malpractice suits are filed against radiologists. 3. Explain how to accurately diagnose the most commonly missed musculoskeletal fractures.

CONTENT DESCRIPTION: The threat of malpractice action remains a matter of concern in the specialty of radiology. A 2004 American College of Radiology Malpractice Survey found that 58% of respondents had been a defendant in a medical malpractice lawsuit or were the subject of a claim. Failure to diagnose nonspinal musculoskeletal fractures was the second most common cause of malpractice suits against radiologists and often resulted in large awards during settlement. While practicing within this litigious medicolegal climate, the recognition and reduction of specific fractures are of special importance to radiologists and, ultimately, the control of costs within the health care system. A broad overview of the types of radiology cases involved in medical malpractice claims will be discussed, with a focus on the most commonly litigated nonspinal musculoskeletal fractures. Reasons for malpractice suits, including the most common types of errors, will be listed. The sites of fractures, specifically the bones involved in trauma of the hands, wrists, feet, and ankles will be listed. The rates of each of the fractures will be annotated and will include data in relation to geographic location of the claims against radiologists. Payments resulting from the claims will be discussed by both anatomic and geographic locations. After reviewing the literature regarding claims against radiologists for commonly missed nonspinal musculoskeletal fractures, the focus of the exhibit will be a description of how to reduce errors in diagnosing these fractures, stressing the importance of diligently assessing radiographs for subtle signs of the described fractures.

(E-63) Wednesday • 7:00 AM
Labral and Ligamentous Pathology Associated with Posterior Shoulder Instability: A Pictorial Review

Stephen Jones, MD, *Scott and White Hospital/Texas A&M, Temple, TX*; Jeffrey Stevens; Ricardo D. Garza-Gongora, MD; Lauren D. Tribbey, MD

LEARNING OBJECTIVES: 1. Describe and illustrate the anatomy involved with posterior shoulder instability, including the static and dynamic stabilizers. 2. Identify the terminology and imaging findings associated with labral and ligamentous injury in patients with posterior shoulder instability. 3. Discuss the clinical presentation and treatment options of posterior shoulder instability.

CONTENT DESCRIPTION: Diagnosing labral and ligamentous pathology associated with posterior shoulder instability can be challenging due to the various acronyms and eponyms used, as well as the relative infrequency of posterior instability, which accounts for only 2%–5% of all cases of shoulder instability. As the presenting symptoms associated with these lesions are highly nonspecific, the clinician often overlooks the diagnosis. When the diagnosis is suspected, magnetic resonance (MR) arthrography is the study of choice. This exhibit will demonstrate the MR findings of labral injuries, to include the reverse Bankart lesion, posterior labrocapsular periosteal sleeve avulsion (POLPSA), and the Kim lesion. Ligamentous injuries, such as the reverse humeral avulsion of the glenohumeral ligament (RHAGL), reverse glenoid avulsion of the glenohumeral ligament (RGAGL), and the Bennett lesion, will also be reviewed. In addition to the clinical presentations, subsequent treatment options will also be discussed.

(E-64) Thursday • 7:00 AM
Wrist US: A Resident's Approach to Performing and Interpreting Wrist US

Matthew Teng, MD, *St Luke's-Roosevelt Hospital Center, New York, NY*; Robert K. Hang, MD; Kenneth S. Cooke, MD

LEARNING OBJECTIVES: 1. Identify the clinical indications for wrist ultrasound. 2. Describe the basic imaging techniques and procedures, "how-to-scan" a wrist ultrasound, and normal anatomical landmarks. 3. Explain potential pitfalls of ultrasound of the wrist. 4. Discuss how to become more comfortable with performing and interpreting wrist ultrasound.

CONTENT DESCRIPTION: Musculoskeletal (MSK) ultrasound offers a readily available and inexpensive means of imaging joints. The development of high-resolution ultrasound technology has resulted in better imaging of superficial soft tissues, with the capability of providing diagnostic images. However, the comfort level of performing and interpreting MSK ultrasound still varies greatly. Many radiologists, including MSK specialists, are still uncomfortable with MSK ultrasound. This exhibit will be a general review of "how to" perform an ultrasound of the wrist. This will include proper ultrasound scanning techniques, including machine settings, probe positioning, and a review of the normal anatomical relationships on ultrasound. Specifically, we will be reviewing how to image the soft tissues of the wrist, including the extensor tendons, scapholunate ligament, the carpal tunnel, Guyon canal, and various joints within the wrist. We would also review potential pitfalls specific to wrist ultrasound, as it is essential to high diagnostic accuracy and preventing misdiagnosis. The ultimate goal of the exhibit is to help radiologists improve their comfort level when performing and interpreting wrist ultrasound.

(E-65) Wednesday • 7:00 AM
Systematic Approach to Musculoskeletal US Imaging of the Elbow

Robert K. Hang, MD, *St Luke's-Roosevelt Hospital Center, New York, NY*; Matthew Teng, MD; Daniel Yoon, MD; Kenneth S. Cooke, MD *(rhang@chpnet.org)*

LEARNING OBJECTIVES: 1. Review the clinical indications for performing an ultrasound of the elbow. 2. Describe the basic ultrasound techniques, including patient positioning and transducer types, for optimal elbow imaging. 3. Review and be familiar with the appearance of anatomical structures of the elbow on ultrasound. 4. Avoid potential sonographic pitfalls involving the elbow. 5. Perform basic musculoskeletal ultrasound imaging of the elbow.

CONTENT DESCRIPTION: Musculoskeletal ultrasound offers an inexpensive and quick imaging modality in assessing for causes of elbow pain. As ultrasound is an accessible tool in most offices and emergency departments, its use should be considered to provide valuable diagnostic information. This instructional exhibit will provide to the inexperienced user a basic approach to and understanding of how to

perform an ultrasound of the elbow. Sonographic scanning techniques and settings, as well as patient and transducer, will be discussed by systematically compartmentalizing the elbow into anterior, medial, lateral, and posterior sections. Recognizing normal anatomy within each compartment will be emphasized, including tendons, ligaments, nerves, and joint spaces. Specific attention will be paid to identification of the distal biceps tendon, anterior joint recess, radial nerve, posterior interosseous nerve, common extensor tendon, radiocapitellar joint, common flexor tendon, medial collateral ligament, triceps tendon, cubital tunnel with ulnar nerve, and olecranon fossa. Potential pitfalls, such as anisotropy and normal posterior interosseous nerve flattening that may mimic entrapment syndrome, will also be reviewed. From this exhibit, the reader should understand the clinical indications for and be familiar with performing basic musculoskeletal ultrasound of the elbow.

(E-66) Thursday • 7:00 AM
Fix Those Bones: What Every Radiologist Should Know about Orthopedic Hardware

Hing Yee Eng, BA, MD, *St Luke's-Roosevelt Hospital Center, New York, NY*; Jennifer J. Choi, MD, BS; Bo Li, MD; Carlos L. Benitez, MD *(heng@chpnet.org)*

LEARNING OBJECTIVES: 1. Review the different types of orthopedic hardware most commonly used; photographs of orthopedic hardware will be correlated with radiographic and CT images to provide a pictorial overview. 2. Discuss the types of orthopedic hardware routinely used for each of the major joints and bones in the body. 3. Identify potential complications of orthopedic hardware, with case examples. 4. Discuss the current guidelines for radiologic follow-up and clinical management of orthopedic hardware postoperatively.

CONTENT DESCRIPTION: Accurate radiologic evaluation of orthopedic hardware requires recognition of the normal imaging appearance, an understanding of the hardware function, anticipation of the associated complications, and knowledge of the applicable clinical management. A pictorial review of the most commonly used orthopedic hardware will be presented by category (wires, screws, nails, pins, spacers, cages, plates, rods, washers, suture anchors, hooks, implants/grafts, and prostheses). Photographs and radiologic images (plain film and CT) will be juxtaposed for direct correlation. The clinical indication, applicable patient population, mechanism, and expected postoperative course for each type of hardware will be included. The specific types of orthopedic hardware used for treatment of common pathologies in the major joints of the body will also be discussed by joint (spine, shoulder, elbow, hand/wrist, hip/pelvis, knee, and ankle/foot) and bone. A case-based review of the potential complications will follow with a few examples, with emphasis on the current guidelines for postoperative radiologic follow-up. After viewing this exhibit, the reader will gain an understanding of the physical and imaging appearances of each type of orthopedic hardware, the main types of hardware used for each joint, and the postoperative management. This knowledge will help the radiologist properly interpret orthopedic hardware on routine imaging and provide more valuable clinical input regarding patient care.

(E-67) Wednesday • 7:00 AM
Ulnar-sided Wrist Pain: Review of the Imaging and Clinical Characteristics

Sayed Ali, MD, *Temple University Hospital, Philadelphia, PA*

LEARNING OBJECTIVES: 1. Identify the multitude of etiologies responsible for ulnar-sided wrist pain. 2. Describe the imaging characteristics of the common etiologies. 3. Recognize imaging artifacts and normal variants that may lead to misdiagnoses. 4. Discuss a checklist approach to hone in on the diagnosis.

CONTENT DESCRIPTION: This exhibit will present a pictorial guide of the multiple etiologies responsible for the clinical entity of ulnar-sided wrist pain, which can help the radiologist to focus on particular anatomical structures. The entities that are responsible for this clinical picture are extensive and include osseous pathology such as ulna styloid process fractures, ulna styloid impaction due to an elongated styloid process or styloid process nonunion, fractures of the pisiform and hook of hamate, and a third carpometacarpal joint "boss." Other traumatic or arthritic causes include ulnar impingement syndrome, ulna impaction syndrome, Kienböck disease with negative ulna variance, osteoarthritis, rheumatoid arthritis, and crystal arthritis, including calcium pyrophosphate dihydrate (CPPD) deposition disease. Tendon-related causes include tendinosis, tendon tear, tenosynovitis, and extensor carpi ulnaris (ECU) subluxation with an ECU subsheath tear. Triangular fibrocartilage complex (TFCC) tears, especially those located at the ulna attachment, as well as the normal variant of a prominent ulna recess simulating TFCC tear, will be shown. Finally, ulnar nerve pathology with nerve compression by an accessory abductor digiti minimi muscle or ganglion cyst, as well as ulnar neuritis or neuroma, will be demonstrated. This pictorial review will focus on the more common pathologies, as well as the MRI artifacts and normal variants that simulate disease, thereby allowing the radiologist to develop a comprehensive checklist approach to diagnosis.

(E-68) Wednesday • 7:00 AM
Tendon Pathology in Trauma CT Scans: A Guide for the Busy Radiologist

Sayed Ali, MD, *Temple University Hospital, Philadelphia, PA*; Stephen Ling, MD

LEARNING OBJECTIVES: 1. Identify the common tendon injuries encountered while interpreting trauma CT scans, including postsurgical cases. 2. Describe the imaging characteristics of these entities. 3. Recognize imaging artifacts and normal variants that may lead to misinterpretation.

CONTENT DESCRIPTION: Tendon injuries are frequently encountered in trauma patients during a CT evaluation but are underrecognized, as the focus is on the osseous pathology. In addition, many believe that tendon pathology can only be adequately assessed on MRI or ultrasound. We will demonstrate tendon entrapment by bone fragments, tendon tear, and laceration or perforation either by bone fragments or by surgical screws and pins. We will illustrate tendon displacement by bone fragments or surgical hardware, and tendon subluxation from retinacular injuries, including posterior tibial tendon and peroneal tendon subluxation. Traumatic lipohematoma of the tendon sheath will be illustrated, and the risk of subsequent tendon rupture will be emphasized. Fracture fragments migrating into tendon sheaths will also be shown. Lipohematoma of the subacromial-subdeltoid bursa in patients with proximal humerus fractures often indicates associated rotator cuff tear, and examples on CT with MRI correlation will be shown. Infective tenosynovitis and rupture, both posttraumatic and postsurgical, will be shown. Finally, artifact from metallic hardware often obscures tendon evaluation, and examples of these artifacts and ways to reduce them on both CT and MRI will be demonstrated.

(E-69) Wednesday • 7:00 AM
Hindfoot Reconstructive Surgery: An Imaging Approach

Sayed Ali, MD, *Temple University Hospital, Philadelphia, PA*

LEARNING OBJECTIVES: 1. Identify the common surgical procedures performed in the hindfoot. 2. Describe a checklist approach to determine the indication for the procedure and the expected outcome. 3. Identify common complications.

CONTENT DESCRIPTION: Postoperative hindfoot procedures are commonly seen in daily practice. Radiologists can readily identify the individual procedure, such as an osteotomy or pin/screw fixation; but when procedures are combined together, radiologists often have difficulty in determining the exact procedure that was performed and the indication and expected outcomes for the procedure. We will demonstrate, as space permits, the following procedures: Cotton medial cuneiform osteotomy, Evans calcaneal osteotomy, medial calcaneal slide procedure for pes planus, triple hindfoot arthrodesis, ankle arthrodesis, tibiotalocalcaneal arthrodesis, and subtalar joint arthrodesis. Also demonstrated will be various tendon transfers with bone anchors, such as

an extensor hallucis transfer (or Jones procedure) for claw deformity of the great toe, flexor hallucis longus to calcaneus transfer in severe Achilles tendinosis, Cole and Dwyer osteotomies for pes cavus, Keck and Kelly procedures, and retrocalcaneal exostectomy with Achilles detachment and reimplantation for Haglund deformity. A checklist approach will be demonstrated to identify the procedures and to evaluate the expected outcome. Common complications will be shown.

(E-70) Thursday • 7:00 AM
Skeletal "Do Not Touch" Lesions: The Well Recognized and the Underrecognized, from Head to Toe

Sayed Ali, MD, *Temple University Hospital, Philadelphia, PA*

LEARNING OBJECTIVES: 1. Identify the multiple skeletal conditions that should not be biopsied or further investigated. 2. Identify the pertinent demographics that will enable the radiologist to refine the differential diagnosis. 3. Describe a checklist approach to make a diagnosis.

CONTENT DESCRIPTION: Multiple skeletal lesions should not be further investigated, as their clinical and imaging characteristics should be diagnostic. Advanced imaging is expensive and can be inconclusive. Biopsy is invasive, expensive, and also often inconclusive. If inconclusive, the wrong management may be implemented. Biopsy may also introduce intractable infection, especially in the maxillofacial bones. We will demonstrate imaging examples of these lesions, which include posttraumatic lesions such as myositis ossificans, healing fractures with abundant bony callus, cortical avulsive injury (cortical desmoid), subchondral cysts or geodes, and discogenic vertebral sclerosis. Normal variants that may simulate disease include the posterior distal femoral metaphyseal stripe, dorsal defect of the patella, pseudocyst of the proximal humerus and radius, osteopoikilosis, and arachnoid granulations in the calvaria. Other characteristic nonaggressive conditions include nonossifying fibroma, bone islands or infarcts, unicameral bone cysts, synovial herniation pits, and the calcaneal pseudotumor. Less well-known lesions that will be demonstrated include florid osseous dysplasia and odontomas in the maxilla and mandible, and arrested pneumatization of the basisphenoid. Patient demographics, lesion location, and imaging characteristics will be emphasized in order to refine the differential and avoid further imaging or biopsy.

(E-71) Wednesday • 7:00 AM
Hirayama Disease

Juan Gomez, MD; Jeremy B. Nguyen, MD, MS, *Tulane University Hospital and Clinics, New Orleans, LA*; Enrique Palacios, MD; Mandy C. Weidenhaft, MD; Harold R. Neitzschman, Jr, MD *(jnguye2@tulane.edu)*

LEARNING OBJECTIVES: 1. Discuss the entity known as Hirayama disease (HD) and its primary predisposing factors. 2. Identify the protocol to diagnose HD based on different body positions at the time of the imaging study. 3. Describe the characteristic features of HD in imaging studies. 4. Identify the association between imaging findings and clinical manifestations of HD. 5. Discuss a literature review of the treatment and management of HD.

CONTENT DESCRIPTION: Hirayama disease (HD), also known as juvenile muscular atrophy of distal upper extremity, is an uncommon, slowly progressive disease that affects mostly men in their 2nd to 3rd decade of life. It was first reported in 1959 by Hirayama in Japan. HD has since been reported in other countries, but the patient population is primarily of southeast Asian descent. HD has an insidious onset with atrophy occurring primarily unilaterally in the distal upper extremities, primarily the forearm and hand, with relative sparing of the brachioradialis muscle. HD is believed to be caused by chronic microvascular ischemic damage to the lower cervical spinal cord that occurs during neck flexion. It is progressive in nature and then plateaus within an average of 6 years. It is important to identify the disease early in its course so that progression of spinal cord atrophy can be avoided. Magnetic resonance imaging (MRI) of the cervical spinal cord typically reveals the pathognomonic features of anterior displacement of the posterior dura and cord at the lower cervical spinal canal. Two confirmed cases of HD are reported. Discussions of pathophysiology, clinical manifestations, imaging findings, and treatment are presented.

AUR Trainee Prize: 2nd Place

(E-72) Thursday • 7:00 AM
A Pain in the Abs: Radiologic Review of Endometriosis within the Abdominal Wall and Image-guided Intervention

Benjamin Triche, MD, *University of Alabama at Birmingham, Birmingham, AL*; Michael G. Rodriguez, MD; Charles B. Smith, MD *(btriche@uabmc.edu)*

LEARNING OBJECTIVES: 1. Review the pathophysiology and clinical presentation of abdominal wall endometriosis. 2. Review the imaging characteristics of abdominal wall endometriosis, including appearances on CT, MRI, and US. 3. Review image-guided interventional techniques, including CT- or US-guided biopsy and image-guided radiofrequency ablation. 4. Review the potential pitfalls and complications of image-guided interventions, specifically in the setting of suspected abdominal wall endometriosis.

CONTENT DESCRIPTION: Seeding of endometrial cells into the abdominal wall is a known complication of uterine surgery, particularly after cesarean section. This exhibit focuses on the imaging characteristics of abdominal wall endometriosis and a review of image-guided diagnostic and therapeutic interventions. Potential procedural pitfalls will be reviewed, including seeding of endometrial cells along the biopsy track. The strategies to prevent these complications will be discussed.

(E-73) Wednesday • 7:00 AM
Postoperative Imaging of the Wrist: What the Surgeon Wants to Know

David Nakamura, MD; Michael E. Cody, MD; Helen Hye Ryong Kim, MD, *University of California at Irvine, Irvine, CA (dnakamura1@gmail.com)*

LEARNING OBJECTIVES: 1. Describe pathologic imaging findings which may require surgical intervention. 2. Discuss detailed and specific observations about postoperative changes to the wrist. 3. Identify postoperative complications or hardware failure in the wrist.

CONTENT DESCRIPTION: I. Overview of wrist injuries or degenerative changes on imaging which may require surgical intervention. Pathology will include debilitating first carpometacarpal/scaphotrapeziotrapezoidal osteoarthritis; posttraumatic osteoarthritis of the wrist; carpal coalition; and acute traumatic injury, including longitudinal split tear of the ulnotriquetral ligament, scaphoid waist fracture, and ulnar impaction and impingement. II. Discussion of postoperative changes associated with the above-listed pathologies, including volar buttress plate fixation, scaphoid fracture with Herbert or Acutrak screw fixation, total wrist arthroplasty, trapeziectomy, ligament reconstruction with tendon interposition (LRTI), and ulnar osteotomy. III. Brief case presentation of postoperative complications of the wrist on imaging and their prognostic significance; full discussion of appropriate terminology for effective communication with the surgeon.

(E-74) Thursday • 7:00 AM
Kager's: The Well-known but Poorly Understood Fat Pad

Kaushal Mehta, MD, *University of Cincinnati, Cincinnati, OH*; Daniel L. Wannemacher, MD; Eric B. England, MD; Rahul Nath, DO; Jason Passafiume, MD; Robert D. Wissman, MD; et al

LEARNING OBJECTIVES: 1. Describe the normal anatomy and functions of Kager's fat pad, using a multimodality approach with plain radiography, CT, ultrasound, and MRI. 2. Discuss various anatomic variants and pathologic conditions that can alter the appearance of Kager's fat pad on multiple imaging modalities.

CONTENT DESCRIPTION: Many abnormal conditions of the ankle can involve Kager's fat pad, and careful attention to the borders of this triangle and to the angles formed by these borders may indicate an abnormality, warranting further imaging. This poster will provide a comprehensive review of the normal and abnormal appearance of Kager's fat pad, using a multimodality approach. Topics discussed will include the normal anatomy of Kager's fat pad, as well as patterns of edema that may involve the fat pad and provide a suggestion of the underlying etiology. Several examples will be provided of anatomic variants that can alter the appearance of Kager's fat pad. Additionally, examples of pathologic conditions that can alter the appearance of Kager's fat pad will be demonstrated. These include abnormalities related to the Achilles tendon, bursae of the ankle, calcaneus, flexor hallucis longus tendon, and the ankle joint.

(E-75) Wednesday • 7:00 AM
Meniscal Root Tears: Rooting through the Information

Rahul Nath, DO, *University of Cincinnati Health Center, Cincinnati, OH*; Jason Passafiume, MD; Ben Brown; Daniel L. Wannemacher, MD; Robert D. Wissman, MD; Kaushal Mehta, MD; et al *(rnath83@gmail.com)*

LEARNING OBJECTIVES: 1. Identify the normal anatomic appearance of the meniscal root. 2. Describe the MR imaging appearance and associated findings of meniscal root pathology. 3. Discuss images of anterior horn meniscal root pathology in the setting of tibial plateau fracture.

CONTENT DESCRIPTION: The purpose of this educational poster is a focus on the meniscal root. Tearing of the meniscal root is an uncommon but important finding. Studies have shown that a posterior root tear simulates a total meniscectomy, with increase in contact pressure. Associated findings with root tears of the meniscus include parameniscal cysts, meniscal extrusion, and degenerative arthritis. Therefore, the treatment for meniscal roots tears is surgical repair with either transtibial bone tunnel or suture anchor fixation. It is important for the radiologist to recognize and correctly describe meniscal root tears. The meniscal root attaches the meniscus to the central tibial plateau. The osseous attachment helps to maintain the circumferential tension. Meniscal root tears consist of radial tears, as well as avulsions. The most common location for root tears involves the posterior medial meniscal root. Less-common anterior root avulsions have been described previously in association with medial tibial plateau fractures. Recently described in the literature is a rim of insertional edema at the posterior horn meniscal root attachment that may be a precursor for meniscal root tears. We will show and describe cases of root tears and their associated findings, in addition to a unique case of an anterior horn lateral meniscus root avulsion in the setting of a lateral tibial plateau fracture.

(E-76) Thursday • 7:00 AM
Femoral Acetabular Impingement: A Pictorial Translation of MR Imaging Correlates to Radiographic and Clinical Indicators of Disease

Jason Meigs, DO, *University of Kansas-Wichita, Wichita, KS*; Akash C. Joshi, MD; Cory Pfeifer, MD *(jmeigs@kumc.edu)*

LEARNING OBJECTIVES: 1. Explain the clinical significance of femoral acetabular impingement (FAI). 2. Demonstrate the use of MR images to describe typical joint angles and parameters used in the diagnosis of femoral acetabular impingement. 3. Describe the utilization of pictorial content to depict the correlation between radiographic and MRI findings of FAI. 4. Identify evidence of positive and negative findings. 5. Describe the importance of the contribution that the radiologist can make to surgical planning.

CONTENT DESCRIPTION: Both cam-type femoral acetabular impingement and pincer-type femoral acetabular impingement have been described radiographically and clinically. While the alpha angle, lateral central edge angle, Tönnis angle, roof angle, and equatorial edge angles can yield suggestive indicators of disease, these parameters have been classically described via radiography, CT, or ultrasound. MRI, when performed in conjunction with arthrography, can add vital labral detail and enhance the diagnosis of disorders of the hip common to the young adult. In keeping with the mission of providing high-quality service to our orthopedic colleagues, we routinely describe all of the above parameters based on MRI alone. The authors will present a pictorial description of each of these angles, how to measure them on MRI exams ordered to assess the hip in the young adult, and provide imaging examples of positive and negative findings.

(E-77) Wednesday • 7:00 AM
Role of Plain Films in Diagnosing Wrist Dislocations/Ligamentous Injuries: Often an Underutilized Modality That Can Diagnose Complex/Rare Cases Utilizing Simple Rules

Rami W. Eldaya; Jorge A. Lee Diaz, MD, *University of Texas Medical Branch, Galveston, TX*; Glenn M. Garcia, MD *(rweldaya@utmb.edu)*

LEARNING OBJECTIVES: 1. Analyze the frontal and lateral images to maximize detection of carpal ligamentous/dislocation injuries. 2. Explain the pathophysiology of these injuries, with radiologic imaging correlations, to simplify their complexity and increase appreciation of pattern of radiologic findings of each injury. 3. Describe simple rules, such as Gilula lines, to suggest/diagnose these complex injuries.

CONTENT DESCRIPTION: First, through multiview plain films and colorful cartoons, we will review the complex-ligamentous anatomy of the wrist, highlighting the ligaments and normal alignment. Second, we will review the frontal, oblique, and lateral views, with emphasis on each view's importance in evaluation of wrist dislocation/ligamentous injuries, while highlighting the strengths and exposing the limitations of each view. While doing so, we will also introduce the historically important Gilula lines in evaluation of such injuries. Third, we will review the pathophysiology of such injuries, with emphasis on the perilunate-lunate injury complex 4 stages. To simplify the pathophysiology, we will accompany each stage with highlighted radiographic images. Fourth, we will reenforce the attendees' knowledge by presenting cases of the most common of these injuries and let attendees work through them. This will help familiarize the attendees with these injuries in case they encounter them in real life and will further enhance their understanding by applying the acquired knowledge. Finally, we will introduce a rare case (dorsal lunate dislocation) that most, if not all, have not seen before and prove that applying the simple acquired rules of evaluation with understanding of anatomical relationships will allow the attendee to reach the right diagnosis.

(E-78) Thursday • 7:00 AM
CT Metal Artifact Reduction in Total Knee Arthroplasty: An Explanation of Current Techniques through Images

(FDA)

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

LEARNING OBJECTIVES: 1. Explain the basic physics of how metal in total knee arthroplasty (TKA) affects CT scans. 2. Recognize the common types of hardware artifacts seen in CT. 3. Evaluate new solutions to reduce the metallic artifact in CT for the examination of a TKA.

CONTENT DESCRIPTION: With the increase in the number of knee arthroplasties and the expanded role of CT in postsurgical long-term evaluation of postprocedural complications, there is an increasing interest in developing metal artifact reduction sequences to achieve reliable diagnostic tests. With an emphasis on images, we educate the radiologist on standard and novel methods to reduce artifact from TKA by covering the following topics: (1) Review basic CT physics. (2) Demonstrate common types of CT metal artifacts, and explain the physics behind them. (3) Introduce Iterative metal artifact reduction (IMAR), a metal artifact reduction technique; and discuss its physics, advantages, and disadvantages. (4) Present images of conventional sequences and

IMAR. (5) Explain possible advantages of IMAR in clinical scenarios, including evaluation of the prosthesis, the bone, and soft tissue adjacent to the TKA.

(E-80) Thursday • 7:00 AM
Application of Nonlinear Iterative Reconstruction in Musculoskeletal MR Imaging

(FDA)

Lan N. Vu, MD, PhD, *University of Texas Medical Branch Radiology, Galveston, TX*; Thaddeus Sze, MD; Frank L. Goerner, PhD; Jorge A. Lee Diaz, MD; Esther Raithel*; Abraham Padua, RT*; et al *(lnvu@utmb.edu)*

LEARNING OBJECTIVES: 1. Explain the basic physics behind MRI and the concept of iterative reconstruction. 2. Identify the benefits of this new technique, specifically evaluation of the acquisition time and quality of the images. The combination of nonlinear iterative reconstruction combined with sparse incoherent undersampling is a new technique of acquiring MR images at a markedly reduced scan time without significantly affecting the image quality for diagnostic purposes. This technique takes advantage of the inherent sparsity of the MR images in the wavelet domain such that minimal data in the k-space are needed to reconstruct the desired image. The technique is applied to MR musculoskeletal imaging in this project to reduce imaging time and to increase throughput using an accelerated 3D SPACE sequence prototype. A reduction of acquisition time by 63% compared to a standard protocol is demonstrated without significant image degradation.

CONTENT DESCRIPTION: MR Imaging is time-consuming because the process of phase encoding and acquiring samples over the entire k-space is long. Many techniques have been invented and used, such as turbo spin-echo (TSE) and parallel imaging, to reduce the acquisition time. Nonlinear reconstruction is a new technique that combines the technique of alternative k-space filling methods and iterative reconstruction. The technique can be used in conjunction with other techniques to further reduce imaging time. In this project, we describe the underlying technique and show how we applied it to musculoskeletal imaging, particularly knee imaging, and reduced imaging time by 63% over the conventional protocol without affecting the diagnostic information of the images.

(E-81) Wednesday • 7:00 AM
Alternative Treatment of Desmoid Tumors with Image-guided Percutaneous Cryoablation Therapy

Adam Militana, MD, *Vanderbilt University, Nashville, TN*; Brent A. Roach, BA, MD; John J. Block, MD; Katherine Hartley, MD *(brent.a.roach@vanderbilt.edu)*

LEARNING OBJECTIVES: 1. Explain why management of aggressive fibromatosis is evolving away from surgery as first-line treatment, with increased emphasis on watchful waiting, medical management, and, in some cases, experimental less-invasive image-guided therapies. 2. Discuss the biology of cryotherapy and how percutaneous cryotherapy can be safely utilized in the effective management of select desmoid tumors not amenable or refractory to other treatments. 3. Describe strategies to facilitate successful and comfortable treatment of extraabdominal desmoids with cryotherapy.

CONTENT DESCRIPTION: Desmoid tumors, or aggressive fibromatoses, are rare benign fibrous neoplasms originating from the musculoaponeurotic structures throughout the body. When extraabdominal, these lesions most commonly arise from the rectus abdominus musculature in postsurgical patients; however, the lesions can involve any skeletal muscle. The neoplastic cells invade surrounding structures, leading to entrapment and degeneration of muscle and neurovascular bundles. Although desmoid tumors have no metastatic potential, they are locally aggressive, and recurrence is common following surgical excision, necessitating investigation of alternative forms of therapy. Aside from watchful waiting and surgical excision, alternative treatment methods include radiation therapy, chemotherapy, and, most recently, percutaneous thermal ablation, including cryotherapy. While several groups have reported the successful treatment of desmoid tumors with cryotherapy, the literature remains limited. In this exhibit, we will review our experience to date treating peripheral desmoid tumors with cryotherapy, including clinical and technical considerations. Imaging and treatment outcomes of several illustrative cases will be reviewed. After reviewing this exhibit, the radiologist should be able to understand basic desmoid tumor pathophysiology, current management options, basic principles of cryotherapy, and potential drawbacks of treatment.

(E-82) Thursday • 7:00 AM
Avulsion Fractures in the Foot: Telltale Radiographic Signs to Avoid Mismanagement

Jessica A. Rotman, MD, *Weill Cornell New York-Presbyterian Hospital, New York, NY*; Michael L. Loftus, MD; Roger J. Bartolotta, MD

LEARNING OBJECTIVES: This educational exhibit emphasizes the importance of early diagnosis and management of subtle avulsion fractures in the foot. This exhibit will review all foot avulsion fractures, their respective mechanisms of injury, clinical and radiographic presentations, and most appropriate courses of treatment.

CONTENT DESCRIPTION: Foot avulsion fractures are frequently missed on initial exam and misdiagnosed as ankle sprains due to their similar clinical presentations, involving swelling, ecchymosis, ligamentous laxity, tenderness, and decreased range of motion. It is imperative that these fractures are diagnosed early to guide management, as delays can result in nonunion, reinjury, and long-term disability. This exhibit will review the location, mechanism, clinical presentation, imaging, and treatment of each of the following avulsion fractures: (1) talus (lateral process, posterior process); (2) calcaneus (anterior process, dorsolateral process, posterior tuberosity); (3) navicular (median tuberosity, dorsal surface); (4) cuboid (plantar surface); (5) fifth metatarsal (pseudo-Jones vs Jones); and (6) plantar plate.

(E-83) Wednesday • 7:00 AM
Differential Diagnosis of Osteosclerosis

Tamera H. Matherne, MD; Brian D. Connolly, DO, *West Virginia University, Morgantown, WV*; Thuan-Phuong Nguyen, MD *(thmatherne@hsc.wvu.edu)*

LEARNING OBJECTIVES: 1. Differentiate between developmental and acquired causes of sclerotic bone disease. 2. Identify characteristic imaging features of different types of osteosclerosis. 3. Describe the pathophysiology and complications associated with osteosclerosis.

CONTENT DESCRIPTION: The educational exhibit is a pictorial essay creating a framework for differentiating various causes of osteosclerosis and associated imaging features. We briefly review the differential diagnosis of developmental and acquired causes of bony sclerosis. Several examples of each category will be presented, with characteristic features emphasized to aid in narrowing the differential diagnosis. Each example will have information about the patient population affected, the location of osteosclerosis, the pattern of osteosclerosis, imaging indications, and complications of disease manifested on imaging.

Nuclear Medicine

(E-84) Thursday • 7:00 AM
Radium-223 Therapy for Treatment of Prostate Cancer Bone Metastases: What the Radiologist Needs to Know

Kumar Shah, MD, *Robert Wood Johnson Medical School-Rutgers University, New Brunswick, NJ*; Jeffrey Kempf, MD; Lisa Fletcher, MA, RT; Alissa Aboff; Murray Becker, MD; Michael Alvarez; et al *(JKempf@Univrad.com)*

LEARNING OBJECTIVES: 1. Explain the mechanism of action, indications, and administration guidelines for radium-223 therapy for patients with symptomatic castration-resistant osseous metastatic prostate cancer. 2. Describe the survival benefit, tolerability, and safety profile of radium-223, including the results of the recent phase 3 trial.

3. Discuss case studies and future directions, including the role of radium-223 treatment in combination with chemotherapeutic agents, as well as its potential efficacy for treatment of other cancers.

CONTENT DESCRIPTION: Radium-223 is an alpha emitter that was FDA approved on May 15, 2013, for treatment of patients with symptomatic castration-resistant prostate cancer bone metastases. In this exhibit, we review radium-223's mechanism of action, safety profile, and survival benefit, as well as phase 3 clinical trial results. Patient selection and dosing, along with work flow and administration guidelines, will be discussed. In addition, the biodistribution of radium-223, along with radiation safety precautions, potential side effects, and outpatient instructions, will be reviewed. We will present case studies, along with patient followup and correlative imaging with MDP bone scintigraphy and sodium fluoride PET bone imaging. Future applications will be discussed, including the possible role of radium-223 in combination with chemotherapy and the potential utility of radium-223 for treatment of other cancers.

Neuroradiology

(E-85) Wednesday • 7:00 AM
Fluoroscopy-guided Lumbar Puncture Technique: A Guide for Trainees on Procedure, Professionalism, and Dose Optimization

FDA

Ivan M. Dequesada II, MD; Ryan B. Peterson, MD, BS, *Emory University, Atlanta, GA*; Amanda S. Corey, MD★; Kimberly E. Applegate, MD, MS★ *(ivan.dequesada@emory.edu)*

LEARNING OBJECTIVES: 1. Explain the key technical parameters affecting radiation dose in fluoroscopy-guided lumbar puncture (FGLP), and recommended techniques to reduce exposure. 2. Identify the appropriate indications, as well as the rationale for periprocedural testing, documentation, and clinical care in FGLP. 3. Describe current recommendations to improve quality in FGLP, such as professionalism aspects, the Joint Commission time-out procedure, and proven sterile techniques.

CONTENT DESCRIPTION: ***Radiation Safety:*** This section will review topics in radiation safety in FGLP. We will begin by reviewing expected fluoroscopic times, as well as patient factors affecting exposure. We will then discuss required radiation protection measures, including dose monitoring. Finally, recommendations will be given regarding dose reduction techniques when performing FGLP, such as the use of collimation and pulsed-mode fluoroscopy. ***Pre- and Postprocedure Considerations:*** This section will review topics in pre- and postprocedure considerations, such as appropriate indications, review of the patient's history, labs, and imaging. In addition, bleeding considerations will be discussed, including when to discontinue anticoagulation medications. Finally, the recommended elements of a FGLP procedure report will be reviewed. ***Professionalism and Procedure Management:*** This section will review the quality and safety recommendations regarding the FGLP procedure. We will begin by reviewing the required elements of informed consent, including possible complications of FGLP. We will then review the time-out process, sterile technique, and local anesthesia. Finally, we will review the current recommendations to prevent postprocedure headache and leak.

(E-86) Thursday • 7:00 AM
Educational Review of the Artery of Percheron: A Small Anatomic Variant with Grand Implications

Sara Ali, MD, *Harlem Hospital Center, New York, NY*; Leszek Pisinski, MD; Ozan Toy; Alan Krauthamer, MD

LEARNING OBJECTIVES: 1. Describe the four vascular territories of the thalamus and the various arteries supplying it, including the anatomic variant, the artery of Percheron. 2. Provide a comprehensive differential diagnosis for bithalamic lesions. 3. Explain how to narrow the differential diagnosis for bithalamic lesions and increase diagnostic accuracy of bithalamic infarction through awareness of the artery of Percheron and its characteristic supply to the medial thalami.

CONTENT DESCRIPTION: I. Introduction: goals and objectives. II. Anatomy/pathophysiology: comprehensive review of the four vascular territories of the thalamic nucleus and origins of the arteries which supply each of the various territories; explanation of the artery of Percheron, a rare anatomic variant single artery supplying the bilateral paramedian thalami and sometimes the rostral midbrain. III. Discussion of the differential diagnosis of bithalamic lesions. IV. Description of imaging findings of artery of Percheron (AOP) infarction and how they can be utilized to narrow the differential diagnosis, ultimately leading to more accurate diagnosis. V. Representative images from five cases of AOP infarction from our institution: various imaging planes and modalities will be used, including CT, MRI, and MRA, in order to describe the findings. VI. Conclusion: Bilateral paramedian thalamic infarcts are uncommon and should prompt investigation for possible occlusion of the artery of Percheron.

(E-89) Wednesday • 7:00 AM
Identifying Calvarial Lesions: It Can Be Hard!

Robert K. Hang, MD; Arie Neymotin, DO, *Mount Sinai St Luke's-Roosevelt Hospital, New York, NY*; Jungwhan Choi, MD; Francisco Delara, MD

LEARNING OBJECTIVES: 1. Identify the bones that make up the normal calvarial anatomy. 2. Describe congenital bony variants. 3. Identify and distinguish between benign and malignant calvarial abnormalities. 4. Explain and be able to offer recommendations for further workup, if necessary.

CONTENT DESCRIPTION: Assessment of bony skull lesions can be difficult, especially with MRI, where bone is not optimally characterized. The purpose of this educational exhibit is to demonstrate and gain familiarity with bony pathologies involving the skull. This exhibit will provide a retrospective illustrative review of imaging findings of various conditions that may arise primarily within or may be found secondarily within the skull. Some of these covered disease entities have characteristic findings on CT or MRI, with a limited differential diagnosis. These findings will be emphasized, to aid the radiologist in improved detection and diagnosis. While obtaining a definitive diagnosis is not always possible, identifying a lesion's subcategory may direct further clinical investigation or alter therapeutic management. To reinforce common imaging findings related to specific entities, a case-based categorical approach will be presented encompassing bony lesions, including diseases that secondarily erode into the skull. Entities will be subdivided into congenital variants, manifestations of metabolic derangement, and benign and malignant neoplasms. A few examples include persistent craniopharyngeal canal, fossa navicularis magna, hyperparathyroidism, Paget's disease, fibrous dysplasia, hematic cyst, giant cell tumor, metastatic disease, intraosseous hemangioma, chondrosarcoma, and intraosseous meningioma. Awareness and recognition of common imaging patterns of various diseases are important in radiologists' evaluation of skull lesions.

(E-90) Thursday • 7:00 AM
Congenital Sensorineural Hearing Loss: A Pictorial Review of Inner Ear Lesions

Lauren D. Tribbey, MD, *Texas A&M Health Science Center-Baylor Scott and White Health, Temple, TX*; Harold Sonnier, MD; Stephen Jones, MD

LEARNING OBJECTIVES: 1. Describe the normal anatomy of the osseous and membranous labyrinth, as well as neural anatomy within the internal auditory canal. 2. Review the epidemiology of congenital sensorineural hearing loss and the classification systems typically used to divide subtypes. 3. Describe radiologic features of the congenital inner ear lesions associated with sensorineural hearing loss, and provide case examples of the more commonly encountered anomalies. 4. Discuss the surgical implications of imaging findings.

CONTENT DESCRIPTION: Congenital sensorineural hearing loss has an estimated incidence of one in 1000 neonates, and inner ear malformations are found on imaging in approximately 15%–20% of

these patients. High-resolution temporal bone CT and MR imaging are complementary modalities with the ability to detect abnormalities and anatomic variants that often have a major impact on surgical planning. In this presentation, we will review the radiologic manifestations of congenital inner ear malformations, including enlarged vestibular aqueduct syndrome, Mondini's deformity, Michel's dysplasia, and cochlear nerve deficiency. Case examples of the more common malformations will be provided for illustrative purposes. Additional preoperative findings of importance to the surgeon are also discussed.

(E-91) Wednesday • 7:00 AM
Intralabyrinthine Schwannoma: An Uncommon but Important Differential Diagnostic Consideration of Postcontrast Cochlear Enhancement on MR Imaging

Tirath Y. Patel, MD, *University of Toledo Medical Center, Toledo, OH*; Mark Buehler II, MD; Hassan B. Semaan, MD *(Tirath.Patel@utoledo.edu)*

LEARNING OBJECTIVES: Intralabyrinthine schwannomas are rare tumors originating from the distal branches of the vestibulocochlear nerve, with only a few hundred reported cases and with most within the vestibular labyrinth. Through a series of cases, the learner will (1) describe the clinically relevant anatomy, (2) identify the imaging characteristics of intralabyrinthine schwannomas, and (3) differentiate this entity from other diagnoses when intralabyrinthine enhancement is present on MRI.

CONTENT DESCRIPTION: ***Anatomy:*** Structures of the inner ear will be presented through the prism of MR imaging. This section will specifically focus on the distal vestibulocochlear nerve and its appearance on MR imaging. Next, a short synopsis of the neurotology literature will be presented, emphasizing the imaging and anatomic findings that would change clinical management and/or surgical approach of intralabyrinthine schwannomas. ***Pathology and Imaging Findings:*** A summary of the current radiologic literature on intralabyrinthine schwannomas will be provided, describing the demographics, frequency, and pathogenesis of the entity, emphasizing that the lesion may not be as infrequent as previously assumed. Via MR images, this section will also include references to vestibulocochlear schwannomas that occur in more typical locations. Finally, imaging characteristics of intralabyrinthine schwannomas will be presented. ***Differential Diagnosis:*** Labyrinthitis is an important differential diagnosis to intralabyrinthine schwannomas when confronted with intralabyrinthine enhancement on postgadolinium MR imaging. We will demonstrate imaging characteristics of labyrinthitis and describe an approach to differentiate this entity from intralabyrinthine schwannomas based on the pattern and temporal profile of enhancement. ***Summary:*** A short summary will be provided, enabling the learner to quick assimilate information about intralabyrinthine schwannoma as a clinical entity, its MR imaging characteristics, and differential diagnostic considerations.

(E-92) Thursday • 7:00 AM
Unusual Imaging Manifestations of Plasmacytomas of the Head and Neck

FDA

Sarah Castillo, MD; Juan Gomez, MD; Anish Patel, MD, *Tulane University School of Medicine, New Orleans, LA*; Jeremy B. Nguyen, MD, MS; Enrique Palacios, MD; Mandy C. Weidenhaft, MD; et al *(jnguye2@tulane.edu)*

LEARNING OBJECTIVES: 1. Discuss the pathophysiology of plasmacytomas and their subtypes. 2. Identify the characteristic features of plasmacytomas of the head and neck on imaging studies and histopathology slides. 3. Describe the unusual locations and symptomatic manifestations of plasmacytomas. 4. Describe the most common differential diagnosis as related to plasmacytomas. 5. Discuss a literature review of the treatment and prognosis of plasmacytomas based on their classification.

CONTENT DESCRIPTION: Plasmacytomas of the head and neck are an uncommon process, accounting for only 1% of all head and neck cancer. They resemble other disease processes and are often difficult to discern. In this case series founded in the tumor registration system of Tulane University Hospital from 2003 through 2013, the radiologic findings and background for multiple cases of plasmacytomas involving the cerebellopontine angle, nasopharynx, sinonasal cavity, hard palate, thyroid, clivus, frontal bone, cervical vertebrae, and the posterior parietal calvaria are presented. Imaging modalities, including magnetic resonance imaging (MRI), computed tomography (CT), radiographs, and angiographic studies, are utilized to demonstrate imaging features of plasmacytomas in the head and neck. Plasmacytomas are discrete masses originating from a proliferation of monoclonal plasma cells that are classified as (1) solitary plasmacytomas of the bone (SPB) when limited to the skeleton, (2) extramedullary plasmacytomas (EMP) when they occur in the soft tissues, or (3) multiple plasmacytomas that represent primaries or recurrence. Plasmacytomas are a related but separate entity from multiple myeloma. They are locally contained lesions that are radiosensitive and carry a relatively good prognosis. As such, they are definitively managed with radiotherapy and surgery, as opposed to systemic chemotherapy. This series aims to increase the recognition of these pathologic processes, despite their rare and unusual manifestations, through the presentation and discussion of imaging findings of head and neck plasmacytomas.

AUR Trainee Prize: 1st Place

(E-93) Wednesday • 7:00 AM
Pediatric Head CT Protocol Optimization: Simultaneously Lowering Radiation Dose and Eliminating Artifacts

Sarah M. Deraney, MD, *University of Kentucky Medical Center, Lexington, KY*; Flavius D. Raslau, MD; Edward Escott* *(smi237@uky.edu)*

LEARNING OBJECTIVES: 1. Explain the differences between adult and pediatric head CT protocols. 2. Describe appropriate radiation dose for pediatric head CT scans according to the new ACR accreditation guidelines as of July 2013. 3. Identify two causes of subcalvarial high-attenuation artifact, and discuss its mitigation by adjusting scan parameters.

CONTENT DESCRIPTION: ***Radiation Dose Reduction:*** Differences between adult and pediatric head CT protocols will be discussed, including the proper use of automated tube exposure control (AEC), sequential versus spiral acquisition techniques, and radiation dose limits. The new ACR CT accreditation mandate will be reviewed. This specifies that $CTDI_{vol}$ for head CT scans should not exceed 35 mGy for patients under 15 years of age. At our institution, 61 consecutive pediatric patients scanned in 1 month revealed that 48% of those patients received adult-level radiation dose ($CTDI_{vol}$ ~60 mGy). The cause was rooted in technologist practice, such that adult protocols were utilized if the patient weight exceeded 50 kg. Technologists were instructed to utilize pediatric protocols, regardless of weight, because the scanner's AEC would scale the radiation dose in proportion to patient size. The effectiveness of this countermeasure was documented for the next 6 months. With gradually improved technologist compliance, the number of studies with more-than-appropriate radiation decreased from 48% to 4%. ***Artifact Mitigation:*** We will review two forms of subcalvarial high-attenuation artifact discovered in routine pediatric protocols. In one case, the artifact persisted on every slice and was related to inappropriately fast rotation time of 0.5 second. In the other case, the artifact appeared with periodic regularity on one end of the scan beam during sequential acquisition, which was best explained by off-focal radiation. These artifacts were successfully mitigated by increasing rotation time to 0.75 second in the first case and decreasing the number of detectors from 24 to 12 in the second case. Other radiologists may be facing similar artifacts and could benefit from our mitigation strategies.

(E-94) Thursday • 7:00 AM
Use of Imaging in the Workup of Patients with Vocal Cord Paralysis

Michael L. Adix, MD, *University of Michigan Health System, Ann Arbor, MI*; Gaurang V. Shah, MD; Robbi Kupfer; Erin McKean; Myria Petrou, MA, MBBCh

LEARNING OBJECTIVES: 1. Describe the course of the vagus and recurrent laryngeal nerves from the mediastinum to the brainstem, injury of which results in vocal cord paralysis; and identify imaging landmarks that allow us to define the course of these nerves on imaging studies. 2. Describe imaging findings related to common and more unusual etiologies of injury of the vagus and recurrent laryngeal nerves along their course in the neck/upper mediastinum. 3. Discuss the overall role of imaging and the advantages and disadvantages of different imaging modalities (CT, MRI, and PET-CT) in the workup of patients presenting with vocal cord paralysis.

CONTENT DESCRIPTION: We will first outline the epidemiology/causes of vocal cord paralysis in the adult and pediatric populations. We will then describe the course of the vagus and recurrent laryngeal nerves and the imaging landmarks that allow us to follow the course of the nerves from the mediastinum to the skull base. We will review the most common as well as unusual etiologies of injuries to these nerves by location. We will specifically describe pathology at the level of the brainstem, skull base, suprahyoid neck, infrahyoid neck, and mediastinum and will delineate associated imaging findings on CT, MRI, and PET-CT. We will go on to discuss the overall role of different imaging modalities (CT, MRI, and PET-CT) and their respective utility in the assessment of adult and pediatric patients with vocal cord paralysis. We will provide suggested imaging protocols and algorithms and talk about potential imaging pitfalls.

(E-95) Wednesday • 7:00 AM
MR Imaging–derived Cerebrospinal Fluid Production Rate as a Marker and Risk Factor for Intracranial Hypertension in Astronauts Exposed to Microgravity

Larry A. Kramer, MD, *University of Texas Medical School-Houston, Houston, TX*; Khadr M. Hasan, PhD; Roy Riascos, MD *(Larry.A.Kramer@uth.tmc.edu)*

LEARNING OBJECTIVES: 1. Explain how to measure cerebrospinal fluid (CSF) production rate at the level of the cerebral aqueduct using a cardiac-gated CINE phase-contrast sequence. 2. Describe how to analyze phase-contrast data to only quantify true CSF flow compared to background noise, to improve measurement accuracy. 3. Explain how CSF production rate is modulated by intracranial hypertension. 4. Discuss how changes in CSF production rate before and after spaceflight are applied in astronauts to identify microgravity-induced intracranial hypertension. 5. Explain how CSF production rate data can be applied in the study of idiopathic intracranial hypertension. 6. Discuss how baseline CSF production rate preflight may predict the development of intracranial hypertension in astronauts upon exposure to microgravity.

CONTENT DESCRIPTION: 1. Describe newly observed structural abnormalities of the retina of astronauts exposed to microgravity with increasing mission duration. 2. Describe examples of alteration of the optic nerve sheath, optic nerve, pituitary gland, and posterior globe structure that have been documented with MRI in these astronauts. 3. Discuss the theories of visual abnormalities in astronauts. 4. Discuss how cerebrospinal fluid (CSF) production rate is used in studying this phenomenon and in supporting the hypothesis of microgravity-induced intracranial hypertension. 5. Describe how to measure CSF production rate accurately using phase-contrast flow analysis.

(E-96) Thursday • 7:00 AM
Subaxial Cervical Spine Trauma: What the Clinician Needs to Know

Alberto Diaz de Leon III, *University of Texas Southwestern Medical Center, Dallas, TX*; Richard Suss, MD; Marco Pinho, MD *(albertdiazdeleon@gmail.com)*

LEARNING OBJECTIVES: 1. Explain the principles behind the development and utilization of the Subaxial Injury Classification (SLIC) and Severity scale. 2. Discuss relevant terminology, including the discoligamentous complex (DLC), and appropriate descriptors of injury morphology. 3. Discuss examples for the proper application of SLIC and Severity scale.

CONTENT DESCRIPTION: By understanding and applying the SLIC, a classification scheme developed by the Spine Study Trauma Group, the radiologist has the opportunity to provide an effective, precise, and relevant report for the spine surgeon. We provide a succinct description of this system, explaining how and why the consultant uses it, and of the relevant subaxial cervical spine anatomy. A review of the three main injury morphology categories and of the means of evaluating the status of the DLC is presented through a number of cases and illustrations.

(E-97) Wednesday • 7:00 AM
Posterior Reversible Encephalopathy Syndrome: Not Always Posterior or Reversible—Review of Typical and Atypical Findings

Conor Reilly, MD, *University of Texas Southwestern Medical Center, Dallas, TX*; Thomas O'Neill, MD; Carlos L. Perez, MD, BS; Marco Pinho, MD

LEARNING OBJECTIVES: 1. Describe the pathophysiology and clinical course of posterior reversible encephalopathy syndrome (PRES). 2. Recognize the typical cross-sectional imaging characteristics, but also the varied atypical presentations and complications that may cause permanent sequelae.

CONTENT DESCRIPTION: PRES is often seen in the setting of hypertension, preeclampsia, and/or other systemic drug-induced, inflammatory, or metabolic abnormalities, which are thought to result in regional abnormal cerebral vascular autoregulation, endothelial dysfunction, and loss of the blood-brain barrier. Patients may present with headache, vision changes, and altered mental status, at which time they often undergo subsequent imaging. CT and MR imaging most commonly demonstrate areas of cortical/subcortical edema involving the parietal and occipital lobes, which usually resolve upon treatment or resolution of the inciting factor. Our presentation includes a description of the pathophysiology, associated conditions, and typical clinical presentation of PRES. We present a selection of cases of PRES collected from our institution, which highlight both typical and atypical distribution and imaging findings. A focus is given to exceptions to the syndrome descriptors, including lesion distribution without posterior predilection and imaging findings that are not reversible and associated with a worse outcome.

Pediatric Radiology

(E-98) Thursday • 7:00 AM
Ovarian Herniation in Pediatric Patients: US Findings

Mohamad H. Gharavi, MD, *Aultman/Mercy/NEOMED Radiology Residency Program, Canton, OH*

LEARNING OBJECTIVES: 1. Discuss the anatomy of the inguinal canal and the pathophysiology of inguinal hernia in women. 2. Discuss the clinical importance of diagnosis of ovarian herniation in the pediatric population and the role of imaging in this regard. 3. Discuss the ultrasonographic findings of ovarian herniation and ability to recognize the cases of ovarian herniation and possible ovarian ischemia.

CONTENT DESCRIPTION: I. Anatomy and pathophysiology of inguinal hernia and different organs that can herniate into the inguinal canal in women. II. Clinical importance of diagnosis and ultrasonographic findings of ovarian herniation in the pediatric population. III. Literature search of reported cases of female ovarian hernia. IV. Presentation of a few pediatric cases of ovarian hernia from our institution and discussion of the ultrasound findings.

(E-99) Wednesday • 7:00 AM
Overuse Injuries of the Adolescent Upper Extremity: A Multimodality Review

Allen Acomb, *Baylor Scott and White, Temple, TX*; Stephen Jones, MD; Ricardo D. Garza-Gongora, MD; Lauren D. Tribbey, MD; John N. Morelli, MD

LEARNING OBJECTIVES: 1. Discuss the unique biomechanical and physiologic conditions that predispose adolescents to overuse injury. 2. Describe the specific activities associated with overuse injuries involving the shoulder, elbow, and wrist. 3. Identify the characteristic imaging features of each injury, as depicted on radiographs and magnetic resonance imaging.

CONTENT DESCRIPTION: The rise in popularity of youth sports has led to more intense training and more frequent competition. This has caused the adolescent athlete to become more susceptible to overuse injuries, which occur as a result of repetitive microtrauma. Furthermore, today's young athlete often focuses on a single sport, which also increases the risk of injury. Unique factors related to the stage of development predispose the skeletally immature athletes to overuse injuries, which include stress fracture, apophysitis, physeal injury, and osteochondral defect. Overhead motion, particularly in baseball, is a classic cause of overuse injury in adolescents, presenting in the shoulder as a physeal injury known as "Little League shoulder." Repetitive valgus stress on the elbow in pitchers results in a spectrum of injuries collectively known as "Little League elbow," most frequently manifested as medial epicondylar apophysitis. Another common cause of overuse is gymnastics, in which repetitive trauma to the distal radial physis can lead to altered biomechanics and further injury to the wrist. These and other classic overuse injuries will be depicted in an image-rich multimodality presentation. Accurate identification of these processes by the radiologist is important, as early recognition is vital to appropriate treatment and recovery.

Women's Imaging

(E-100) Thursday • 7:00 AM
Pictorial Depiction of Breast Cancer Morphology on Contrast-enhanced Spectral Mammography, with Digital Mammography and MR Imaging Correlation

Chandni Bhimani, *Cooper University Hospital, Camden, NJ*; Roshni R. Patel; Pauline Germaine, DO; Lydia Liao, MD, PhD*; Luna Li; Kristin Brill, MD; et al *(bhimani-chandni@cooperhealth.edu)*

LEARNING OBJECTIVES: 1. Discuss contrast-enhanced spectral mammography (CESM) as a new diagnostic tool. 2. Describe variable presentations of breast cancer on CESM. 3. Identify patients who may benefit from CESM. 4. Explain how to incorporate the information in the staging assessment of patients with breast cancer.

CONTENT DESCRIPTION: CESM is a new tool in the diagnosis and staging of breast cancer. It allows lesion characterization by combining benefits of digital mammography with assessment of lesion vascularity following contrast administration. Breast cancer has a variable appearance and presentation, and this pictorial essay aims to demonstrate this diversity. Since CESM is only available at a limited number of facilities, this presentation also aims to increase awareness of this modality and its clinical applications. Morphologic features of breast cancer on CESM will be presented following the American College of Radiology Breast Imaging Reporting and Data System (ACR BI-RADS) lexicon, 5th edition. The following breast cancer presentations will be illustrated: mass (round, oval, or spiculated), nonmasslike enhancement and parenchymal asymmetry, microcalcifications without and with associated mass, and normal and abnormal lymph node morphology. Additional cases of nipple and chest wall involvement and assessment of multifocal and multicentric as well as contralateral breast involvement will be presented in assessment of breast cancer staging. These examples will be correlated with digital mammography, ultrasound, and MRI findings. A framework of findings and interpretations of the above-mentioned breast cancer morphologic features will be discussed, in addition to practical applications.

(E-101) Wednesday • 7:00 AM
Contrast-enhanced Spectral Mammography: Modality-Specific Artifacts

Chandni Bhimani; Pauline Germaine, DO, *Cooper University Hospital, Camden, NJ*; Lydia Liao, MD, PhD*; Elizabeth Tinney; Luna Li; Kristin Brill, MD

LEARNING OBJECTIVES: 1. Describe contrast-enhanced spectral mammography (CESM) as a new diagnostic tool. 2. Identify modality-specific artifacts, and recognize their appearance on CESM. 3. Discuss how to improve image quality of CESM examinations by reducing the number of artifacts.

CONTENT DESCRIPTION: CESM is a new tool in the breast imaging armamentarium. It incorporates digital mammography and intravenous contrast utilization. Modality-specific artifacts may reduce image quality, limiting evaluation and precluding accurate interpretation. This presentation aims to illustrate and classify CESM artifacts after retrospective analysis of 1000 examinations, dividing artifacts into three types based on the possible mechanisms. Frequency of each artifact is evaluated, as well as its influence on study interpretation, based on the severity of image disturbance/degradation. Possible solutions to reduce artifacts and to improve image quality are also discussed. We report 15 different types of CESM artifacts, with their associated frequency and level of image degradation. Three categories of artifacts are identified: (1) subject related, (2) machine/detector and data processing related, and (3) artifacts with unknown mechanism.

(E-102) Thursday • 7:00 AM
Contrast-enhanced Spectral Mammography: Overview of Study Technique and Procedure Indications

Danielle Senge, MD, *Cooper University Hospital, Camden, NJ*; Pauline Germaine, DO; Lydia Liao, MD, PhD*; Luna Li; Kristin Brill, MD; Elizabeth Tinney; et al *(senge-danielle@cooperhealth.edu)*

LEARNING OBJECTIVES: 1. Discuss contrast-enhanced spectral mammography (CESM) as a new diagnostic study, and recognize its advantages and disadvantages. 2. Describe the CESM technique. 3. Identify patients who may benefit from CESM, and describe how to integrate the study into diagnostic work flow.

CONTENT DESCRIPTION: Intravenous contrast material has a proven role in diagnostic imaging. These benefits have been incorporated into CESM, which provides both morphologic and physiologic information about breast lesions. This added information can help identify breast masses, highlight suspicious features, and reduce false-positive rates. At our institution, CESM serves as a valuable tool in the diagnostic assessment of suspicious lesions, breast cancer staging, and surgical planning. In this educational poster, we illustrate CESM technique and describe its indications and contraindications. Indications for CESM include high-risk screening, inconclusive diagnostic workup, and staging of biopsy-proven breast cancer. Women with dense breast tissue can especially benefit, since subtraction images remove normal background enhancement from interpretation, increasing conspicuity. CESM offers a valuable alternative to MRI in patients unable to obtain MRI due to financial constraints or contraindications to MRI. When utilized in staging, CESM has altered surgical management by more accurately estimating tumor size, nipple involvement, multifocality, and contralateral extent of involvement. With the use of iodinated contrast material, institutional protocols are followed in the same manner as for a contrast-enhanced CT scan, including considerations for allergy, renal function, and monitoring for adverse reaction. The technical protocol for CESM is the same as for standard mammography, aside from placement of a peripheral intravenous catheter and injection prior to imaging. Software modifications to standard mammography equipment enable simultaneous low- and high-energy image acquisition. CESM images are promptly reviewed by a radiologist, as additional projections or compression views may be warranted, followed by targeted ultrasound.

(E-103) Wednesday • 7:00 AM
Management of Nipple Discharge and the Associated Imaging Findings

Neda Jafarian, MD, *Moffitt Cancer Center, Tampa, FL*; Jennifer S. Drukteinis, MD; Shannon Falcon, MD, MS; Bhavika K. Patel, MD

LEARNING OBJECTIVES: ***Educational Goals/Teaching Points:*** Salient points will be highlighted in the discussion of each example. (1) Examples of different imaging modalities demonstrating the etiology for nipple discharge in each case: *(a)* mammography, *(b)* ultrasound, *(c)* ductography, *(d)* contrast-enhanced MRI, and *(e)* MR ductography. (2) Examples and description of both benign and malignant etiologies of nipple discharge: *(a)* physiologic stimulation, *(b)* galactorrhea, *(c)* apocrine glandular secretion, *(d)* intraductal papilloma, *(e)* secreting pituitary tumor, *(f)* medications, and *(g)* malignancy. (3) Algorithm for evaluation and management of nipple discharge. (4) Optimization tips and troubleshooting for each case will be illustrated utilizing interactive imaging examples. (5) The exhibit will conclude with a series of multiple-choice questions, including answers and detailed explanations. This exhibit will serve to familiarize participants with different imaging modalities involved in the workup of nipple discharge and provide practical tips for selection of the most appropriate imaging workup. In addition, the exhibit will familiarize the participant with the underlying etiologies of both physiologic and pathologic nipple discharge.

CONTENT DESCRIPTION: ***Background Information/Purpose:*** Nipple discharge is commonly encountered by health care providers, accounting for 2%–5% of medical visits by women. Because nipple discharge is the presenting symptom in 5%–12% of breast cancers, it causes considerable anxiety for both patients and providers. Furthermore, the workup and management of nipple discharge can be confusing. Fortunately, the cause of nipple discharge is usually benign, so that the primary goal of evaluation and management is separation of patients with pathologic causes of discharge from those with benign or physiologic causes. Recognition and appropriate workup of nipple discharge are important to determine the next steps in troubleshooting and in image optimization. This exhibit will demonstrate the appropriate workup and algorithm for a patient who presents with nipple discharge, with presentation of useful tips to reduce and eliminate unnecessary imaging.

(E-104) Thursday • 7:00 AM
Internal Mammary Lymph Nodes in Breast Cancer: What the Radiologist Needs to Know

Millicent Gentry, MD, *Moffitt Cancer Center, Tampa, FL*; Bhavika K. Patel, MD

LEARNING OBJECTIVES: This exhibit will review (1) breast cancer staging; (2) relevant parasternal anatomy and lymphatic drainage of the breast; (3) imaging features of internal mammary lymph nodes (IMNs) on ultrasound, positron emission tomography CT, magnetic resonance imaging, and lymphoscintigraphy; and (4) current recommendations of management of IMNs, with emphasis on teaching points relevant to the interpreting radiologist.

CONTENT DESCRIPTION: Lymph node staging is one of the most important prognostic factors in assessing the stage and prognosis of breast cancer. The internal mammary lymph node chain is the most important lymphatic drainage site outside the axilla in breast cancer patients. However, management of metastases to the internal mammary nodes remains controversial; and historically, involvement of IMNs is rarely assessed at the time of definitive surgery. Nonetheless, metastases to the IMNs are found in a significant proportion of breast cancers, including approximately 30% of medial tumors and 15% of lateral tumors. In addition, metastases to IMNs adversely affect the disease-free interval and long-term survival. Thus, preoperative detection of internal mammary nodal metastases via the use of noninvasive imaging methods is ideal. This exhibit will provide a multimodality imaging review of relevant parasternal anatomy, as well as the appearance of normal and pathologic IMNs at ultrasound, computed tomography, MRI, and lymphoscintigraphy. This exhibit will also review lymphatic drainage patterns of the breast, criteria for diagnosing suspicious internal mammary lymphadenopathy, clinical importance of IMNs, and current management of internal mammary lymphadenopathy.

(E-105) Wednesday • 7:00 AM
Breast Imaging Quality Metrics Made Ridiculously Simple

Bo Li, MD, *Mount Sinai St Luke's-Roosevelt, New York, NY*; Jennifer J. Choi, MD, BS; Hing Yee Eng, BA, MD; Nolan J. Kagetsu, MD*; Stephen Manghisi *(boli@chpnet.org)*

LEARNING OBJECTIVES: 1. Describe breast imaging quality performance metrics that can help the user undergo audits, evaluate results, and increase breast cancer detection rates. 2. Apply and integrate breast imaging quality performance metrics in order to assess one's overall performance in breast imaging interpretation and improve patient care/outcome. 3. Discuss how breast imaging quality performance metrics can be applied to breast ultrasound and breast MRI screening evaluations.

CONTENT DESCRIPTION: I. Introduction: the importance of breast imaging quality metrics. II. What are the breast imaging quality metrics? (true positives; false positives; positive predictive value 1; positive predictive value 2; cancer detection rate; percentage of invasive cancers that are node-negative; percentage of cancers that are "minimal"; percentage of cancers that are stage 0 or 1; recall rate). III. What are the indications for using breast imaging quality metrics? IV. Future uses of breast imaging quality metrics (breast ultrasound and breast screening MRI examinations).

(E-106) Thursday • 7:00 AM
Breast Density Notification Legislation: What Now and What Next?

Jennifer J. Choi, MD, BS, *Mount Sinai St Lukes-Roosevelt, New York, NY*; Bo Li, MD; Hing Yee Eng, BA, MD; Nolan J. Kagetsu, MD*; Stephen Manghisi *(jennchoi@chpnet.org)*

LEARNING OBJECTIVES: 1. Explain the difference between the masking effect of breast density and the effect of increased mammographic breast density on breast cancer risk. 2. Describe the most recent developments in breast density notification laws across the country. 3. Discuss the implications of breast density notification laws on patient care and the impact on clinical practice.

CONTENT DESCRIPTION: ***Background:*** How breast density notification legislation was initiated and enacted. ***Overview:*** I. The most recent breast density notification legislation across the country on the state and federal level. II. How it has impacted radiology practices (ie, insurance coverage, cost-effectiveness, effect on patient morbidity and mortality). III. How breast imagers in different states are approaching the legislative intent of density notification with realistic and practical practice patterns (ie, the California Breast Density Information Group). IV. Future implications (ie, overutilization of medical imaging, impact on patient anxiety).

(E-107) Wednesday • 7:00 AM
Knots and Twists of Umbilical Cord Anomalies: Pictorial Review in Evaluating the Umbilical Cord on Sonogram and Common Umbilical Cord Anomalies

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LEARNING OBJECTIVES: Many radiologists are uncomfortable with evaluating the umbilical cord on sonograms, as pregnancies beyond the first trimester are often diverted to obstetrics at tertiary care centers. However, umbilical cord anomalies are not always incidental and can be associated with other structural anomalies or growth retardation, requiring further workup. A radiologist who is able to evaluate for normal umbilical cord appearance and look for classic abnormalities will greatly contribute to patient care and management. In addition, many community/rural hospitals may not have obstetrics on call, and the radiologist plays a crucial role in evaluating pregnancies of more-advanced gestational age. This pictorial exhibit will review: (1) How does a normal umbilical cord look on sonogram? (2) Common and rare anomalies associated with the umbilical cord. (3) What does the clinician need to know? (4) Indications for further workup.

CONTENT DESCRIPTION: I. Sonographic evaluation of the normal umbilical cord. A. Anatomy. B. Sonographic landmarks. II. Common and rare anomalies of the umbilical cord. A. Single umbilical artery. B. Umbilical vein varix. C. Umbilical cord cyst. D. Velamentous insertion. E. Vasa previa. III. Indications for further workup.

(E-108) Wednesday • 7:00 AM
The Depths of DIEP: What the Radiologist Needs to Know for Perforator Flap Breast Reconstruction

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LEARNING OBJECTIVES: The introduction of the transverse rectus abdominis myocutaneous (TRAM) flap in 1982 dramatically changed the world of breast reconstruction. Since then, the TRAM procedure has evolved with advances in surgical techniques; most notably, the deep inferior epigastric perforator (DIEP) has emerged to the forefront, as this technique removes abdominal skin and fat in an entire flap with its primary blood supply (deep inferior epigastric vessels). DIEP spares the abdominal musculature while maximizing arterial blood flow to the perforator flap. As DIEP gains popularity among surgeons, radiologists need to be familiar with both the unique surgical aspects and interpreting pre- and postoperative imaging. (1) Explain key concepts of DIEP and how it differs from traditional TRAM. (2) Describe presurgical MR angiography, including identifying and characterizing abdominal perforators. (3) Recognize normal postsurgical findings and complications. (4) Discuss how to effectively communicate key findings with surgeons.

CONTENT DESCRIPTION: I. Key principles of DIEP. II. Presurgical imaging. A. Normal anatomy and variants of perforators. B. Calculating coordinates and assessing features of perforators. C. Measuring subcutaneous fat volume. D. Ancillary findings. III. Postsurgical imaging. A. Normal findings. B. Complications (ie, abscess, fat necrosis). IV. Alternatives to DIEP (ie, gluteal artery perforators [GAP]).

(E-109) Wednesday • 7:00 AM
Palpable Masses in Pregnancy and Postpartum: Imaging Workup and Diagnosis

Claudia Cotes, MD, MS, *University of Texas Medical Branch, Houston, TX*; Quan D. Nguyen; Angelica S. Robinson, MD; Uzoma Igboagi, BS; Oyintonye L. Odogwu

LEARNING OBJECTIVES: 1. Describe the primary imaging modalities utilized in the evaluation of the breast in pregnant patients. 2. Describe the primary imaging modalities utilized in the evaluation of the breast in postpartum patients. 3. Discuss pregnancy and postpartum palpable masses in terms of symptoms, imaging characteristics, imaging diagnosis, and pathology (when obtained): fibroadenoma; lactating adenoma; galactocele; lobular hyperplasia of pregnancy; mastitis and breast abscess; and breast cancer.

CONTENT DESCRIPTION: I. Introduction. II. Physiologic changes of the breast during pregnancy and postpartum. III. Imaging modalities and workup for the pregnant patient. IV. Imaging modalities and workup for the postpartum patient. V. Palpable abnormalities in pregnant and postpartum patients in our institution. VI. Review of the following findings in the pregnant and postpartum patient: fibroadenoma; lactating adenoma; galactocele; lobular hyperplasia of pregnancy; mastitis and breast abscess; and breast cancer. VII. Conclusion.

(E-110) Thursday • 7:00 AM
Hysterosalpingography: A Pictorial Review of Technique

Elizabeth V. Craig, MD, *Vanderbilt University Medical Center, Nashville, TN*; Lucy Spalluto, MD

LEARNING OBJECTIVES: Describe the indications, technique, anatomy, and potential complications of hysterosalpingography (HSG).

CONTENT DESCRIPTION: I. Review the indications for HSG. II. Illustrate the technique for HSG with detailed photographs and diagrams, to include: A. Documenting patient history and confirming appropriate indication for the procedure. B. Obtaining patient informed consent. C. Tray setup/catheter demonstration. D. Positioning patient. E. Cannulation of cervix. F. Instilling contrast. G. Obtaining necessary fluoroscopic images. H. Review of postprocedural instructions. III. Review the normal anatomy seen on HSG. IV. Review select HSG cases for different indications. V. Briefly discuss complications of HSG.

(E-111) Wednesday • 7:00 AM
Problem Solving with Fetal MR Imaging

Cara M. Bryan, MD, *West Virginia University School of Medicine, Morgantown, WV*; Jeffery Hogg, MD; Vickie Williams, MD

LEARNING OBJECTIVES: 1. Describe indications and contraindications for fetal MR imaging, 2. Explain fetal MR imaging techniques. 3. Discuss the use of MRI to further characterize abnormal morphology detected on ultrasound.

CONTENT DESCRIPTION: Content includes indications, contraindications, and a brief perspective of how fetal MRI for anomalies is accomplished. While ultrasound is the modality of choice for fetal imaging, in certain cases MRI can be helpful to further delineate sonographic abnormalities. The role of fetal MRI in the diagnosis, problem solving, prognosis, surgical planning, and counseling for non-CNS anomalies is reviewed. Case examples include, but are not limited to, conjoined twins, diaphragmatic hernia, pulmonary hypoplasia, horseshoe kidney, unilateral renal agenesis, club feet, hemimegalencephaly, and Dandy-Walker spectrum. Cases are presented with high-quality images, with emphasis on the clinical context and the impact the fetal MR imaging has on patient management.

(E-112) Thursday • 7:00 AM
Review of Radiologic Physics for the Mammographer: From Screen-Film to 3D Tomosynthesis

Swetha B. Dasari, MD, *Westchester Medical Center, Valhalla, NY*; Perry S. Gerard, MD; Jeffrey M. Gnerre, MD, MS; Julian Sanchez, MD; Zvi Lefkovitz, MD; Jasnit Makkar, MD; et al

LEARNING OBJECTIVES: 1. Explain the physics principles behind screen-film mammography, digital mammography, and 3D tomosynthesis. 2. Describe how to utilize this knowledge to optimize image quality while maintaining the lowest possible levels of radiation for screening and diagnostic breast exams. 3. Explain how to utilize this knowledge to troubleshoot poor-quality exams and commonly encountered artifacts.

CONTENT DESCRIPTION: Topics to be covered include (1) physics principles of screen-film mammography; (2) physics principles of digital mammography; (3) physics principles of 3D tomosynthesis; (4) commonly encountered artifacts seen in screen-film mammography, digital mammography, and 3D tomosynthesis, with methods for elimination; and (5) illustrations of poor-quality exams and suggestions for improvement.