



# Safety And Quality

Program subject to change until 12/16/2019.



105<sup>TH</sup> Scientific Assembly and Annual Meeting  
December 1-6 | McCormick Place, Chicago





**105<sup>TH</sup> Scientific Assembly  
and Annual Meeting**  
December 1-6 | McCormick Place, Chicago



DM100

**National Cancer Institute (NCI) Perception Research Lab**

All Day Room: Learning Center, Hall D

Printed on: 10/29/20



SSA06

## Science Session with Keynote: Emergency Radiology (Practice Management)

Sunday, Dec. 1 10:45AM - 12:15PM Room: N227B



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Scott D. Steenburg, MD, Zionsville, IN (*Moderator*) Institutional research collaboration, IBM Corporation  
Karen S. Lee, MD, Boston, MA (*Moderator*) Nothing to Disclose  
Howard P. Forman, MD, New Haven, CT (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSA06-01 Emergency Radiology Keynote Speaker: Optimizing Efficiency and Quality

Sunday, Dec. 1 10:45AM - 11:05AM Room: N227B

### Participants

Scott D. Steenburg, MD, Zionsville, IN (*Presenter*) Institutional research collaboration, IBM Corporation

#### SSA06-03 Imaging Workflow Acceleration at a Level 1 Trauma Centre after 24/7 In-house Radiologist Staff Coverage Implementation

Sunday, Dec. 1 11:05AM - 11:15AM Room: N227B

### Participants

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### PURPOSE

This study aims to evaluate the effect of 24/7 staff radiologist shifts at a Level 1 Trauma Centre on study turnaround time and final report release times as measured by relevant time frames and categorized by CTAS score, radiology shift and day of the week.

### METHOD AND MATERIALS

A retrospective chart analysis was conducted on all patients over 18 years old with scans performed at the emergency department (ED). A total of 68,846 exams from pre-24/7 period were taken (Oct 1, 2012 to Sept 30, 2013) and a total of 71,255 from post-24/7 period (Oct 1, 2013 to Sept 30, 2014). The Canadian Triage and Acuity Score (CTAS) was recorded for each patient, categorizing them from most to least acute: CTAS 1 (Resuscitation), 2 (Emergent), 3 (Urgent), 4 (Less Urgent) and 5 (Non-Urgent). The time between imaging request and end of imaging (Time A) and between end of imaging and final report (Time B) were calculated. The Student's t-test and Mann-Whitney test were used to determine statistical significance between pre- and post-24/7 staff radiologist time lengths, where  $p < 0.05$  was considered statistically significant.

### RESULTS

Time A significantly decreased between pre and post-24/7 by 87 min on average for patients with CTAS 3, 71 min for patients with CTAS 4 and 29 min for patients with CTAS 2. Time B was significantly shortened by 332 min on average for patients with CTAS 2, 316 min for patients with CTAS 1 and 3 and 259 min for patients with CTAS 4. The largest decrease in Time B was observed for patients with CTAS 2, with reductions over the shifts that were newly covered by 24/7 Radiology staff, by an average of 626.6 mins during overnight shifts and weekends.

### CONCLUSION

The implementation of around-the-clock attending radiologist coverage at our Level 1 Trauma Centre significantly decreased time between image request and imaging completion for patients with CTAS 2 to 4, and between imaging completion and final report release for patients with CTAS 1 to 4. Patients with CTAS 2 benefitted from the largest decrease in time for this time frame.

### CLINICAL RELEVANCE/APPLICATION

The presence of 24/7 staff radiologists can significantly reduce imaging time and report finalization times for CTAS 2 and 3 patients, respectively, which in turn may contribute to faster disposition of ED patients and therefore facilitate faster care for incoming critically ill patients.

## **SSA06-04 Improving ED Efficiency and Patient Safety: Impact of Overnight In-house Radiology Staff Coverage on Imaging-related ED Recalls**

Sunday, Dec. 1 11:15AM - 11:25AM Room: N227B

### Participants

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### PURPOSE

In-house overnight staff radiologist coverage significantly reduces the overall turnaround time (TAT) for imaging studies. Although TAT is a useful metric for performance, the impact of overnight staff coverage on the quality of acute patient care is still questioned, largely due to published low discrepancy rates between radiology residents and staff. One of the more significant management changes related to discrepancies is the call back of patients after discharge from ED, caused by ED physicians acting on preliminary resident reports. This study analyzes how the number of ED patients being called back due to discrepant prelim and final imaging reports changed after implementing an overnight staff coverage model at a major Level 1 trauma center with over 675 acute care beds.

### METHOD AND MATERIALS

Using ED visit information of two years prior (2016 and 2017) and one year after (2018) rollout of overnight radiology staff coverage, all patients were identified who had overnight imaging performed during their ED visit and who returned to the ED within 48 hours. Visit notes were assessed by two independent scorers who determined if the patient's return was due to an imaging report related recall or not. Discrepant scorers' opinions were assessed by a senior third scorer performing chart review. Logistic regression was used to determine if the new coverage model had a significant impact on the number of ED recalls related to imaging report discrepancies.

### RESULTS

ED patient visits with overnight imaging were 9,412 in 2016; 9,736 in 2017; and 10,254 in 2018. Number of imaging related recalls were 51, 57 and 7 (in 2016, 2017, and 2018 respectively). Coverage model was a statistically significant predictor of recalls ( $b = 2.11$ ,  $z = 5.42$ ,  $p < 0.001$ ), before the new overnight staff coverage patients were 8.30 95%CI[4.16, 19.68] times more likely to get a recall related to discrepancy in prelim and final read. Despite an increase of ED visits with overnight imaging of almost 9% in 3 years, imaging related absolute number of recalls dropped by 90%.

### CONCLUSION

Despite increasing ED visits, overnight attending coverage has significantly reduced ED recalls related to imaging, improving ED patient safety and ED efficiency.

### CLINICAL RELEVANCE/APPLICATION

Overnight final imaging interpretation by in-house staff radiology coverage significantly reduces callback rate in ED patients requiring acute care, improving ED efficiency and patient safety.

## **SSA06-05 Imaging Information Overload: Quantifying the Burden of Interpretive and Non-Interpretive Tasks for CT Angiography for Aortic Pathologies in the ED**

Sunday, Dec. 1 11:25AM - 11:35AM Room: N227B

### Participants

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### PURPOSE

Advances in CT imaging has allowed for improved resolution and the ability to create high quality reformations. The unintended consequences is an increase in the volume of images that the radiologist must interpret. With improved imaging, more incidental findings are found, leading to recommendations for follow-up imaging. CT angiography of the chest (CTA) is the study of choice to evaluate aortic pathologies, but over-utilization in the emergency department (ED) can increase the cognitive burden on the radiologist. The purpose is to quantify the complexity of CTA chest exams performed in the ED over a 10 year period.

### METHOD AND MATERIALS

This is a retrospective analysis of adults patients ( $\geq 18$  years) presenting to the ED at a single Level 1 tertiary care hospital for

the evaluation of acute aortic pathology with CTA Chest from Jan 1, 2005 to Dec 31, 2015. The number of images and reformats per study were obtained from PACS. Aortic findings, including aortic dissection, aneurysm, and post-operative aortic repair, were determined from the radiology report. Imaging recommendations and verbal communication were evaluated. Descriptive statistics and partial correlation analysis were performed with correlation coefficients (CC) calculated.

## RESULTS

A total of 4368 studies were performed over 10 years. The mean age was 64 years, with 56.8% male patients. Studies per year increased 163% over the study period. The number of images and reformats per scan increased from 487 to 2918 images and 6.4 to 13.7 reformats (CC = 0.93 and 0.96, respectively, both  $p < 0.0001$ ). The proportions of exams requiring verbal communication increased from 9.3% to 24.7% (CC=0.77,  $p=0.008$ ) and recommendations from 1.8% to 28.9% (CC=0.66,  $p=0.03$ ). Overall proportion of cases with aortic findings was 27.3%. However, the proportion of exams with aortic findings did not significantly change over the study period (CC= 0.12,  $p=0.73$ ).

## CONCLUSION

This study demonstrates the increasing complexity of CTA exams as seen by the increase in the number of images and reformats per study. Non-interpretive tasks also increased accordingly. Although the number of CTA exams increased over time, the proportion of studies with aortic pathology remained constant.

## CLINICAL RELEVANCE/APPLICATION

More compliant adherence to appropriateness criteria and careful thought in determining necessary reformats in CTA protocols should be considered in order to prevent radiologist burn out.

### SSA06-06 Value of a 24-hour Teleradiology Service for Cruise Ships in Detecting Previously Missed Pathologies

Sunday, Dec. 1 11:35AM - 11:45AM Room: N227B

#### Participants

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## PURPOSE

The introduction of a round the clock teleradiology service for a cruise ship as a novel concept in maritime telemedicine. Using a VPN tunnel we implemented a workflow with a routine high standard interpretation of x-rays that were imaged on board and read by experienced radiologists in a tertiary hospital.

## METHOD AND MATERIALS

This study was conducted between February 2017 and September 2018 and four cruise ships were involved in total. The ships were equipped with a mobile digital x-ray unit using digital storage imaging plates (SIEMENS Polymobil). The digital x-ray images were transmitted in a standardized fashion from the cruise ships to the hospital via satellite internet. Using VPN secured data transfer of images was managed together with patient data and integrated to the PACS (GE Healthcare, Centricity Universal Viewer). In the tertiary hospital images were analyzed by the radiologist on-call and reports were immediately sent back via VPN.

## RESULTS

Overall 410 x-rays of 355 patients were acquired on board and successfully transmitted via satellite from the cruise ships to the tertiary hospital. The vast majority were skeletal x-rays (n=349) with fracture after a trauma being the most frequent query (n=259). The remaining cases were chest x-rays (n=52) with pneumonia (n=36) being the most frequent query and abdominal x-rays (n=9). In 246 cases no pathologies were seen. Common pathologies were as follows: fracture or dislocation (n=77), osteoligamentary injury (n=11), arthrosis (n=16) and others (n=49). In 86% of cases the initial report by the physician on board matched the report in the tertiary hospital. However, in 14% of the cases the radiologist in the tertiary hospital detected pathologies, which were previously missed by the physician on board.

## CONCLUSION

Using a VPN tunnel we were able to demonstrate a robust and well-functioning workflow allowing a routine high standard interpretation of x-rays that were imaged on board by experienced radiologists in a tertiary hospital. The radiologists in the tertiary hospital detected pathologies in 14% of the cases, which were previously overlooked and potentially would not have been treated.

## CLINICAL RELEVANCE/APPLICATION

A 24-hour teleradiology service for cruise ships has the potential to improve immediate patient care in emergencies on board of cruise ships by making use of the expertise of a radiologist.

### SSA06-07 Urgency Emergency Radiology: Imaging at Urgent Care Centers

Sunday, Dec. 1 11:45AM - 11:55AM Room: N227B

#### Participants

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#### **PURPOSE**

Urgent care centers are facilities that provide ambulatory care outside of the emergency department. The incorporation of radiography capabilities within these practices make imaging accessible and can serve as screening tests for various conditions. The purpose of this study is to examine the image utilization patterns and to quantify positive cases. In addition, the frequency of radiologist recommendations and documented verbal communication will be examined.

#### **METHOD AND MATERIALS**

This retrospective study evaluated radiographs performed for both pediatric and adult patients visiting one of 10 urgent care centers within a large metropolitan city from January 1, 2019 to March 31, 2019. All imaging was interpreted by emergency radiologists at an academic Level 1 trauma center. The number of exams were evaluated by body systems. The number of positive findings, radiologist recommendations, and documented verbal communication were quantified.

#### **RESULTS**

A total of 3289 patients were identified over the 3 month period. The average age was 38.4 years (range between 1 to 103) with 61% of patients female. Chest radiographs were the most commonly ordered study accounting for 37.4% of all exams with a positive findings rate of 16.3%. Lower extremity exams comprised of 30.0% of exams with a positivity rate of 27.6%. Upper extremity radiographs accounted for 23.6% of exams with a positivity rate of 33.0%. Imaging of the spine and ribs accounted for 7.2% of exams with 16.4% cases being positive. Abdominal and facial bone radiographs were not commonly ordered, accounting for 0.8% and 1% of all exams respectively, with 7.4% and 27.3% of cases having positive findings. Accounting for all studies, the positivity rate was 23.7%, in which 5.4% had radiologists making recommendations for further imaging or follow-up. Only 1.4% of exams required verbal communication of findings.

#### **CONCLUSION**

This study demonstrates the utilization of onsite radiography at a network of urgent care centers within a large metropolitan city, with studies interpreted by emergency radiologists at an academic teaching hospital. Chest and extremity radiographs were commonly ordered exams. Almost a quarter of studies had positive findings, although the rate of recommendations and verbal communication was low.

#### **CLINICAL RELEVANCE/APPLICATION**

This study provides insight into the workflow of incorporating ambulatory care imaging within the context of an ED radiology practice.

#### **SSA06-08 Does Intravenous Contrast Utilization Affect CT Scan Operation in Emergency Department? A Large Urban Tertiary Academic Center Experience**

Sunday, Dec. 1 11:55AM - 12:05PM Room: N227B

#### **Participants**

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#### **PURPOSE**

Rapid turnaround times in computed tomography (CT) department is essential for efficient management of high patient volumes in a busy urban emergency department. There have been a number of published studies showing prolonged emergency department (ED) stays secondary to use of oral contrast media in CT. However, there is a paucity of quantitative data on the effect of intravenous contrast media on CT workflow in ED. We analyzed the potential effect of intravenous contrast administration in CT studies on the ED workflow.

#### **METHOD AND MATERIALS**

In this retrospective study, database of CT acquisitions from April 2018 to April 2019 were retrospectively reviewed at a tertiary-level academic hospital. The non-contrast and contrast enhanced CT studies ordered by emergency department were extracted and compared. CT studies ordered for evaluation of stroke, high-energy trauma and aortic emergencies were excluded. Time intervals between order time and start of the scans were compared. For statistical analysis Mann-Whitney-U test was used. Significance was set at 0.05.

#### **RESULTS**

18951 CT scans were evaluated (13872 non-contrast CT vs 5079 contrast enhanced CT). The overall average time intervals for non-contrast CT and contrast enhanced CT were 48 minutes 38 seconds and 1 hour 17 minutes 10 seconds, respectively ( $p < 0.001$ ). Similar pattern was observed regardless of the type of CT study performed.

#### **CONCLUSION**

The use of intravenous iodinated contrast media can cause about a half-hour delay in emergency department workflow at a large

academic institution.

#### **CLINICAL RELEVANCE/APPLICATION**

At large institutions, the use of iodinated intravenous contrast media may prolong order to image acquisition time significantly. Physicians and radiologists must take the time interval difference into consideration when planning for improved operational efficiency and CT turnaround time reductions.

#### **SSA06-09 Increasing Timely Access to Emergency CTs via Discrete Event Simulation**

Sunday, Dec. 1 12:05PM - 12:15PM Room: N227B

#### **Participants**

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Michael Carter, PhD, Toronto, ON (*Abstract Co-Author*) Nothing to Disclose  
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#### **PURPOSE**

This study aims to investigate ways of reducing turnaround times (TAT) for urgent computed tomography (CT) studies completed at the emergency department (ED) of a major urban Academic Level 1 Trauma Center.

#### **METHOD AND MATERIALS**

To model the complex dynamics of the workflow for urgent ED patient CTs, a discrete event simulation model (DES) was developed using the software Simul8 version 24.0. The model was built using a year worth of historical data, and the base model results were validated against current performance metrics. The model was then used to explore the effects of several scenarios on emergency CT TAT, including: 1) decreasing the need for protocols assigned by radiologists, 2) increasing the number of CT technologists as well as reallocating some of their existing shifts, 3) reducing appointment booking delays, and 4) increasing overall demand for emergency CTs.

#### **RESULTS**

Scenario results were as follows: 1) reducing the number of protocols will have mild impacts on TAT (e.g. reducing the number of protocols by 30% will reduce TAT by 6.3%). 2) Reallocating one of the technologists shifts from day-time to night-time can reduce TAT by as much as 12.8%, and adding new shifts so that two CT technologists are available at all times can produce a TAT reduction of 18%. 3) Reducing booking delays by 50% will reduce TAT by 15.2%, and investing in an automated booking system for emergency cases would reduce it by 25.9%. Finally, 4) increasing demand by 5% next year and 10% the following year, will produce an increase in TAT by 3% and 11%, respectively.

#### **CONCLUSION**

This study highlights the benefits of predictive modeling the uncertainties and the dynamic behavior of complex systems such as the imaging workflow for ED patients. DES is a powerful tool that can be used to test different scenarios before committing any resources to implement process changes. The use of DES has provided insightful information of what process changes will have the most impact on TAT, and so it allows hospital leadership to focus on implementing the changes that will provide the best return.

#### **CLINICAL RELEVANCE/APPLICATION**

Modeling ED imaging workflow helps to improve operational efficiency because it provides the quantitative evidence necessary to guide decisions that aim to maximize resource investments.

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SSA20

## Physics (Radiation Dose - Radiography/Fluoroscopy)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E351

PH SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Virgina Tsapaki, PHD, Nea Ionia, Greece (*Moderator*) Nothing to Disclose  
Adam S. Wang, PhD, Baltimore, MD (*Moderator*) Research support, General Electric Company; Research support, Siemens AG; Research collaboration, Varex Imaging Corporation; Stockholder, Varian Medical Systems, Inc

### Sub-Events

#### SSA20-01 Cohort Study of Patients Receiving Substantial Cumulative Doses from Fluoroscopically-Guided Interventional Medical Procedures Over 9 Years

Sunday, Dec. 1 10:45AM - 10:55AM Room: E351

### Participants

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### PURPOSE

Fluoroscopically-guided interventional (FGI) procedures deliver the highest radiation dose among all imaging procedures. This study is to explore the medical conditions of patients receiving 1-year cumulative  $K_{a,r}$  (air kerma at the reference point)  $\geq 5$  Gy or effective dose  $\geq 100$  mSv from FGI procedures over 9 years.

### METHOD AND MATERIALS

With IRB approval, this retrospective study examined 25253 patients (average age  $58.2 \pm 17.0$  years, 50.6% male) who underwent 46491 FGI procedures at a tertiary referral center from January 2010 to January 2019. Data was retrieved from an in-house semi-automated dose tracking system by setting the above dose thresholds. Identified patients were characterized by medical conditions documented in longitudinal medical records. Statistical software (R, version 3.5.1) was used to determine 5 percentiles (10th, 25th, 50th, 75th, 95th) and interquartile range (IQR) of age and dose distributions.

### RESULTS

Among 411 (1.6%) patients (68.6% male) with 1-year cumulative  $K_{a,r} \geq 5$  Gy, median number of FGI procedures was 3 (range 1-34), median age at the first procedure was 59 (IQR 48-68) years, median value of 1-year cumulative  $K_{a,r}$  was 7047 (IQR 5755-9066) mGy, and median effective dose was 260 (IQR 142-369) mSv. Among 1011 (4.0%) patients (69.6% male) with effective dose  $\geq 100$  mSv, median number of FGI procedures was 2 (range 1-38), median age at the first procedure was 60 (IQR 51-69) years, median value of 1-year cumulative  $K_{a,r}$  was 3899 (IQR 2785-5727) mGy, and median effective dose was 177 (IQR 132-261) mSv. Patient medical conditions included trauma, stroke/brain aneurysm, medical bleeding in torso, organ transplant, cancer, benign tumor, and chronic disease. Five of 22 patients with 1-year cumulative  $K_{a,r} \geq 15$  Gy deceased as of March 2019.

### CONCLUSION

This is a first cohort study of patients receiving substantial cumulative doses from FGI procedures over a long period, revealing the use of substantial dose in the critical care of a sizeable fraction of patients under serious medical conditions. The provided cumulative dose distributions can serve purpose for dose management.

### CLINICAL RELEVANCE/APPLICATION

X-ray fluoroscopy guidance can save lives in urgent or critical care of patients under serious medical conditions, and the care of 1.6%-4.0% patients may use substantial dose (1-year cumulative  $K_{a,r} \geq 5$  Gy, or effective dose  $\geq 100$  mSv).

#### SSA20-02 Source of Errors in Indirect Fluoroscopy Skin Dose Estimation and Peak Skin Dose Position

Sunday, Dec. 1 10:55AM - 11:05AM Room: E351

## Participants

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Jie Zhang, PhD, Lexington, KY (*Presenter*) Nothing to Disclose

## PURPOSE

There has been an increasing shift to using dose monitoring software for tracking skin exposure during fluoroscopically-guided interventions. It was reported that indirect skin dosimetry is unlikely to be more accurate than +/-50%, while others reported that compared to direct measurements, the error can be within +/-20%. This study is to identify the source of errors and demonstrate their potential influence on the accuracy of indirect dose estimation.

## METHOD AND MATERIALS

We analyzed available indirect skin dose methods using varying levels of procedural details in the patient protocol and identified potential source of errors, including but not limited to gantry angle, source-surface-distance (SSD), table-pad attenuation, and backscatter. Simple algebraic approach was applied to analyze the effects of those such as distance and attenuation, while Monte Carlo was used to simulate the effects of gantry angles (primary & secondary) combining with various field of view (FOV). We also did direct distance and attenuation measurements from a Philips Allura Xper FD10 for quantitative analysis.

## RESULTS

Gantry angle shows the largest impact on the magnitude and position of peak skin dose (PSD). Simulation shows that PSD location shifts ~18cm from center with the gantry angle from 0° to 50°, independent of FOV. The ratio of PSD to reference air kerma increases from 1.2 to 1.6 (for gantry angle 0°) and from 1.38 to 1.90 (for gantry angle 40°), with the increased FOV from 5 cm to 40 cm. Both the magnitude and position of PSD with gantry angle show non-linear relationship, which increases the difficulty to accurately estimate skin dose. The simple SSD increase due to the use of the pad (in general not considered) may add up to 18% error in dose, based on its thickness and patient weight. The ratio of the exposure with pad-table to air kerma varies up to 15% as kV increase from 50 to 120 kV due to attenuation, plus about 20% backscatter changes (depending on FOV) due to increased beam energy. The use of an additional Cu filter will aggravate the results, i.e., an additional 0.2mm Cu filter can add ~5% more error in PSD estimate. .

## CONCLUSION

Understanding the source of errors in indirect skin dose estimates will improve accuracy of the PSD estimation which determines notification level.

## CLINICAL RELEVANCE/APPLICATION

Improving the accuracy of PSD estimation can potentially reduce unnecessary notifications or avoid missing notifications.

## SSA20-03 Comparison and Image Evaluation of Mini C-Arm Fluoroscopy System Based on Cold Cathode and Hot Cathode

Sunday, Dec. 1 11:05AM - 11:15AM Room: E351

## Participants

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## PURPOSE

In this study, we qualitatively and quantitatively compared and analyzed the X-ray images obtained from the carbon nanotube (CNT) based cold cathode and tungsten based hot cathode ceramic tubes integrated together in mini C-arm fluoroscopy system.

## METHOD AND MATERIALS

A commercialized portable type mini C-arm fluoroscopy system (figure a) was constructed with sealed ceramic type cold cathode and hot cathode X-ray tubes (figure c) and a flat panel detector (RAD icon, 0889, Teledyne Rad-icon Imaging Corp., CA, USA). We developed the CNT emitter and the brazed X-ray tubes at our own lab which can work at high anode voltage without arcing. We demonstrated the superiority of CNT based cold cathode (figure e) X-ray sources over thermionic (figure d) counterpart in terms of producing high resolution X-ray images, pulse based active control switching and quantity of radiation dose. X-ray images of alive rat (figure f) and resolution phantom was taken to compare and evaluate the images from both X-ray sources. Herceptin drug was inserted into a live rat to produce cancer cells and detect it through X-ray images from different sources. Imaging was done at various pulses to evaluate the efficiency of converting the digital signals for switching and calculate the radiation dose.

## RESULTS

CNT based cold cathode X-ray source showed the 20% less radiation to produce the same quality image with the same exposure time. Cold cathode source had 40% smaller focal spot size compared to hot counterpart. The response to digital pulses was 3 times faster in CNT based cold cathode than hot cathode X-ray sources. Finally, the X-ray images obtained at 80 kV with 1mA anode current exposed, the optimal voltage to take high quality image of rat to detect cancer cells from normal tissue.

## CONCLUSION

CNT based cold cathode source in Mini C-arm fluoroscopy system showed better functions, superior quality X-ray Image and safer (reduced radiation dose) compared to the hot cathode X-ray source.

## CLINICAL RELEVANCE/APPLICATION

Imaging quality can be greatly improved by CNT based cold cathode source with lower radiation dose and greatly improved the imaging techniques by integrating the digital signals.

### SSA20-04 The Effect on the Scattered Radiation Distribution of Moving the Centerline of the Patient Lateral to the X-Ray Beam Isocenter During Fluoroscopic Procedures

Sunday, Dec. 1 11:15AM - 11:25AM Room: E351

#### Participants

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## PURPOSE

The scattered radiation from the patient reaching the interventionalist changes as the patient table is moved left and right of the c-arm gantry isocenter. This study investigates and quantifies the change in the scattered radiation dose distribution as the patient is moved laterally.

## METHOD AND MATERIALS

EGSnrc (DOSXYZnrc) Monte-Carlo software was used to calculate the scattered radiation distribution around the Zubal anthropomorphic computational phantom of an average adult male for beams imaging the head, the chest and the abdominal regions. The distributions were calculated as a function of the lateral shift of the phantom from the c-arm isocenter for x-ray beams with different gantry angulation. All comparisons were made with the same exposure factors and each MC simulation used 3E9 primary beam photon histories.

## RESULTS

For staff at a fixed distance from the isocenter, the scatter was generally reduced as the patient was moved toward the staff, since in this case the body attenuates more of the scatter, and it conversely increased as the patient is moved away from the staff. The percent differences from the centered patient when averaged over distance from the floor with a PA projection for staff on the right side were: Head, 2.4 cm shift to left, 48% increase; 2.4 cm shift to right, 37% decrease; Chest, 5 cm shift to left, 133% increase; 5 cm shift to right, 54% decrease; Abdomen, 2.5 cm shift to left, 127% increase; 2.5 cm shift to right 47% decrease. The change in scatter with shift for different LAO/RAO and CRA/CAU angles was similar. For zero degrees RAO/LAO chest projections with the patient centered, the scattered dose on the left side was lower than the right side due to differences in internal organ attenuation.

## CONCLUSION

During Interventional procedures, only small table lateral movement can substantially impact the scattered dose to the staff in the room. Such changes in scatter is dependent on height from the floor and will have an effect which is dependent on where the staff is located in the room. The information from this study provides a better understanding of the changes in scattered dose distribution and facilitates improved staff dose management.

## CLINICAL RELEVANCE/APPLICATION

The position of the x-ray beam relative to the patient centerline has a substantial effect on the room scatter distribution and this information can help staff manage their dose.

### SSA20-05 Radiation Doses to Patients from Fluoroscopically-Guided Liver Procedures

Sunday, Dec. 1 11:25AM - 11:35AM Room: E351

#### Participants

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## PURPOSE

To present procedure-specific distributions of air kerma at the reference point ( $K_{a,r}$ ) and effective dose for fluoroscopically-guided liver procedures.

## METHOD AND MATERIALS

With IRB approval, this retrospective study included 1090 consecutive liver cases (61.6% male) performed from May 2016 to October 2018 in adults. Patient age at the procedure time was  $60.8 \pm 13.0$  years for the men (median 63 years, range 22-93 years, 17.4% in 22-50 years) and  $58.7 \pm 15.3$  years for the women (median 62 years, range 20-90 years, 27.4% in 20-50 years).  $K_a,r$  and dose-area product (KAP) were retrieved from an in-house semiautomated dose monitoring system. Effective dose was calculated using KAP and a conversion coefficient [ $0.26 \text{ mSv}/(\text{Gy}\cdot\text{cm}^2)$ ] from NCRP Report No. 160. Statistical software (R, version 3.5.1) was used to determine 5 percentiles (10th, 25th, 50th, 75th, 95th) for 9 procedures - endovascular liver biopsy, transjugular intrahepatic portosystemic shunt (TIPS) creation, TIPS revision, pre-selective internal radiation therapy (SIRT), SIRT, hepatic artery embolization, transarterial chemoembolization, portogram, and portal vein embolization.

## RESULTS

Number of procedures was 239, 120, 79, 184, 187, 37, 186, 32 and 26; Median  $K_a,r$  was 102, 886, 317, 615, 245, 1202, 907, 502 and 1009 mGy; median effective dose was 5.44, 56.1, 19.1, 37.2, 13.3, 48.1, 49.7, 26.9 and 47.1 mSv; ultrasound guidance usage was 99.6%, 97.5%, 91.1%, 17.4%, 19.3%, 56.8%, 22.0%, 87.5% and 96.2% for 9 procedures (in the above order), respectively. Among all cases, the lowest  $K_a,r$  was 8 mGy for a male (age 63 years, weight 73 kg) from endovascular liver biopsy under both ultrasound guidance and x-ray fluoroscopic guidance. The highest  $K_a,r$  was 11121 mGy for a male (age 65 years, weight 79 kg) from hepatic artery embolization. Effective dose range was 0.4-303 mSv.

## CONCLUSION

In interventional liver procedures, ultrasound guidance is used when feasible to reduce patient dose. This is a first study to provide both  $K_a,r$  and effective dose for comprehensive liver procedures under fluoroscopy and/or ultrasound guidance.

## CLINICAL RELEVANCE/APPLICATION

With the Joint Commission's standard of fluoroscopy dose review, 5 percentiles of  $K_a,r$  and effective dose provided in this study for 9 liver procedures can be used to set baselines in dose management.

## SSA20-06 Radiation Exposure to Pediatric Patients and Staff During Retrograde Wedge Portography

Sunday, Dec. 1 11:35AM - 11:45AM Room: E351

### Participants

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## PURPOSE

Most recent surgical procedures such as the meso-Rex bypass shunt requires wedged hepatic venous portography via the transjugular approach for the assessment of the surgical patient. Retrograde Wedge Portography (RWP) is an interventional procedures performed on patients with portal vein cavernoma in cases where the Rex Recessus is not well delineated with the other non-invasive imaging techniques. Usually staff radiation doses during pediatric interventional procedures are associated with a lower occupational radiation risk because the patients are small. However patient radiation doses may be high particularly when the abdominal region is involved; pediatric procedures require the operators to be physically close and, as when transjugular approach occurs, it is often not possible to use protective screens and some more complex case also can result in a longer fluoroscopic time. These can result in increased operator doses. It is well known that a good radiation protection program in daily practice for all procedures reduces radiation risks to patients and staff and electronic dosimeters have proven to be useful for optimization purposes, for studies of radiation exposure by type of procedure or for specific aspects of a procedure. Our study aim is to provide data on radiation exposure to pediatric patients undergoing RWP and effective dose (E) of each operator performing them in a single center using a pediatric adjusted fluoroscopy protocol in a flat-panel detector based system (FPDS).

## RESULTS

Tube voltage range was 60-84 kV; Tube current range was 0.1-9.5 mA; Spectral filtration was 0.3 mmCu. Patients: mean DAP was  $11.2 \pm 12.9 \text{ Gy}\cdot\text{cm}^2$  (3rd quartile  $11.9 \text{ Gy}\cdot\text{cm}^2$ ); mean KA was  $0.16 \pm 0.09 \text{ Gy}$  (3rd quartile 0.2Gy); mean FT was  $357 \pm 181 \text{ sec}$  (3rd quartile 420sec). Staff: mean E for the radiologist was  $0.50 \pm 0.46 \mu\text{Sv}$  (3rd quartile  $0.75 \mu\text{Sv}$ ); for the radiographer  $0.12 \pm 0.11 \mu\text{Sv}$  (3rd quartile  $0.18 \mu\text{Sv}$ ); for the anesthesia nurse  $0.08 \pm 0.17 \mu\text{Sv}$  (3rd quartile  $0.03 \mu\text{Sv}$ ). Figure 1 shows the mean E for all operators. Figure 2 shows the operators' positions within the angiosuite during hepatic RWP.

## CONCLUSION

In conclusion, this study demonstrated that the radiation doses to the operators in RWP can be very low, remaining well within limits established by the ICRP. The difference in dose among all operators, is related to their position within the angiosuite in relation to the angiographic equipment. Operators performing RWP should be aware of the potential high radiation exposure for themselves and for patients too. Good radiation protection policies and training are necessary in interventional radiology to reduce radiation risks to both patients and staff. No other data about radiation exposure to pediatric patients and staff performing RWP are in the available literature to compare our results. However, in our experience, close liaison between radiologist and radiographer allowed us to vary technical parameters and to select a different fluoroscopy protocol from the pre-set provided by the manufacturer. Although this may have resulted in a small variation in image quality, procedures included in this study were performed safely. New technologies and in-depth knowledge of angiographic equipment can help us to achieve a low radiation dose to patients and staff according to the RWP procedure complexity.

## METHODS

Between September 2016 and December 2018, 19 consecutive RWP were performed on 19 children (mean age  $7 \pm 5$  years, 3rd quartile 11.5 years). Two Radiologist, six radiographers and six anesthesia nurses were involved in this study. A pediatric fluoroscopy protocol optimized to produce high contrast images using 50% as threshold dose with modified parameters adjusted on

pediatric patients, 7.5 frame/sec and low image detail level was routinely employed. Magnification and normal image detail level was only used when absolutely necessary in technically challenging cases. Digital Subtraction Angiographic acquisition (DSA) was used during which all operators left the angiographic suite and went into the control room while images were acquired. Electronic personal dosimeters, placed outside the lead apron at the left upper chest position, were used to measure radiation doses to radiologist, anesthesia nurse and radiographer. Due to the transjugular access, no additional shielding was used for the interventional radiologist. The Hp(10), the personal dose equivalent at a depth of 10 mm of tissue, registered by the detectors at the end of every procedure was systematically recorded. Effective operator dose (E) was then calculated using a modified Niklason algorithm, by multiplying the Hp(10) value by 0.03, and given in  $\mu\text{Sv}$ . Patients' radiation exposure was measured with Dose Area Product (DAP) and fluoroscopy time (FT). Descriptive statistics (mean  $\pm$  SD and third quartile) of the dose area product (DAP, given in  $\text{Gy}\cdot\text{cm}^2$ ), air kerma (KA, given in Gy) and fluoroscopy time (FT, given in seconds) for each procedure were recorded

### **SSA20-07 Clinical Evaluation of a Dose Management System-Integrated 3D Skin Dose Map by Comparison with XR-RV3 Gafchromic® Films**

Sunday, Dec. 1 11:45AM - 11:55AM Room: E351

#### **Participants**

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#### **PURPOSE**

Validate the performance of peak skin dose (PSD) and skin dose map (SDM) estimation from a radiation dose management system (RDMS) (DoseWatch™, GE Healthcare) versus the gold standard of XR-RV3 Gafchromic film in interventional vascular and cardiology procedures.

#### **METHOD AND MATERIALS**

The study was conducted on a total of 38 cardiac procedures and 60 vascular embolizations between June 2018 to March 2019 on three Philips systems (two Allura Xper FD10 and one Allura Xper FD20). 'Ground truth' PSD measurements (PSDFilm) and spatial dose distributions were obtained from XR-RV3 Gafchromic film, positioned underneath patients' backs for each procedure. These were compared against PSDRDMS and SDMRDMS estimates provided by the dose management system using a triangle mesh of 0.055cm<sup>2</sup> resolution on ICRP 110 anthropomorphic phantoms, as well as on a planar phantom with a square ROI of 1cm<sup>2</sup>. The RDMS used Radiation Dose Structured Report (RDSR) data to model exposure events, calculating PSD following the methodology described by K. Jones, et al. Statistical analyses were carried out to compare PSDFilm and PSDRDMS.

#### **RESULTS**

Preliminary results show that the PSDFilm median (1st quartile; 3rd quartile) was 0.573(0.411; 0.981) Gy for vascular procedures and 0.443(0.297; 0.700) Gy for cardiac procedures. For a flat phantom, the PSDRDMS was 0.553(0.375; 1.031) Gy for vascular procedures and 0.467 (0.311; 0.708) Gy for cardiac procedures, and 0.583(0.388; 1.097) Gy and 0.440 (0.305; 0.750) Gy for anthropomorphic phantom, respectively. For both phantoms, the correlation between PSDFilm and PSDRDMS was strong. For vascular procedures, the mean deviation between PSDFilm and PSDRDMS was 1  $\pm$  16% for flat phantom and 2%  $\pm$  19% for anthropomorphic phantom and 5  $\pm$  19% and 2  $\pm$  18% for cardiac procedures, respectively. Dose map representations matched for most patients. Gaps identified are related to the table displacement during fluoroscopy events and the use of a wedge filter.

#### **CONCLUSION**

The results found in this patient study show that SDM tool is a suitable alternative to Gafchromic® film to calculate PSD and visualize the skin dose distribution.

#### **CLINICAL RELEVANCE/APPLICATION**

The RDMS tool can be used routinely to compute the PSD for all patients with an accuracy close to the one of Gafchromic films, effectively reducing costs and complexity of patient follow-up

### **SSA20-08 Radiation Dose Audit for Fluoroscopy Procedures Performed with Mobile C-Arms or Performed in Radiography/Fluoroscopy (R/F) Suites: Data From a Tertiary and Quaternary Care Hospital**

Sunday, Dec. 1 11:55AM - 12:05PM Room: E351

#### **Participants**

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#### **CONCLUSION**

Data indicates that with mobile C-Arms or R/F suite, radiation utilization for routine procedures is an order of magnitude lower relative to threshold radiation dose values recommended for patient follow-up. Monitoring such low radiation dose values may not be optimal use of healthcare resources. Alternately, evidence-based exemption should be granted from the requirement of tracking

fluoroscopy doses for such low dose procedures.

## Background

Accreditation agencies necessitate documenting radiation doses for fluoroscopy procedures. Our hypothesis was that procedures performed with mobile C-Arms or in R/F suites utilize radiation dose levels considerably below the recommended threshold for patient follow-up based on possibility of tissue reactions.

## Evaluation

IRB waiver was obtained. All fluoroscopy procedures performed with any one of the 14 mobile C-Arms (GE:OECs, Philips:Veradius, Ziehm:Vision-R) or in an R/F suite (Siemens:Axiom-Iconos-200) from July-2017 till June-2018 were reviewed. Mobile C-Arms were used for surgical, orthopedic, pain-management, gastroenterology and urology procedures. All cases with system-reported cumulative air kerma (CAK) were included in the study. Descriptive statistics were computed from this data-set to characterize radiation utilization.

## Discussion

Data from 1122 cases were included (53% female/47% male; age:53.9±17.9years; BMI:28.4±6.7). The mean (±standard deviation) and median CAK values for radiology procedures (n=102; e.g., arthrograms, aspirations, etc.) performed with mobile C-Arms were 16.5(±54.4)mGy and 2.39mGy, respectively. For surgical procedures performed in the operating room (n=549) the mean and median CAK values were 36.8(±79.6)mGy and 11.4mGy, respectively. Mean and median CAK values were 65.2(±90.2)mGy and 32.7mGy for gastroenterology procedures (n=98), 16.1(±14.6)mGy and 12.4mGy for urology procedures (n=24), and 46.3(±84.0)mGy and 28.8mGy for pain-management procedures (n=146) performed in neurosurgery department. For procedures performed in the R/F suite (n=203), the mean and median CAK values were 168.2(±262.1)mGy and 72.6mGy. Depending upon the type of procedure, the mean fluoroscopy time ranged from 71 to 497 secs.

## SSA20-09 Experimental Validation of Calculated Skin Dose Variation with Incident X-Ray Beam Angle

Sunday, Dec. 1 12:05PM - 12:15PM Room: E351

### Participants

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## PURPOSE

The incident angle of the x-ray beam on the patient's skin varies during fluoroscopically-guided procedures and accurate estimation of skin dose is important to evaluate the risk of deterministic skin effects. Radiochromic film measurements of skin dose were made as a function of the angle of x-ray beam incidence on a phantom to validate the results of Monte-Carlo calculations.

## METHOD AND MATERIALS

To estimate the dose to the skin, a sheet of Gaf-chromic XR-QA2 film was placed on the surface of a 30 cm x 30 cm block of solid water 20 cm thick. To simulate the attenuation of the overlying epidermis, a 1.25 mm thick sheet of PMMA, which is equivalent to 1.5 mm water, was placed over the film. The primary and the scatter dose was measured for incident angles from 90 to 10 degrees at 80 kVp for a field size of 10 cm x 10 cm and the primary entrance air kerma was measured without the phantom. EGSnrc Monte-Carlo (MC) software was used to calculate the skin dose as a function of incident x-ray beam angle for different beam energies and different field sizes. The incident primary dose was calculated in air at the field center and the primary and scatter dose was calculated averaged over various thicknesses of 'skin' to determine the effect on primary attenuation and scatter. All MC simulations used 5x10<sup>10</sup> photons incident on the phantom.

## RESULTS

The measured skin dose agreed with that calculated by MC with an average difference of about 3 percent over the angular range from 90 to 10 degrees. Both calculated and measured skin dose values decreased with decreasing angle of incidence due primarily to the increased path length and thus increased attenuation of the primary x-rays. In both cases, the total scatter plus primary decreased to about 40% of the primary at an angle of 10 degrees at 80 kVp.

## CONCLUSION

Good agreement was obtained between the measured and calculated variation of skin dose with angle of incidence. The skin dose decreases substantially with decreasing incident angle and thus correction factors for angle of incidence should be applied when estimating skin dose for fluoroscopically-guided procedures.

## CLINICAL RELEVANCE/APPLICATION

Radiochromic film measurements verified the skin dose dependence on incident angle as calculated with Monte Carlo software so skin dose from fluoroscopic procedures can be more accurately estimated.

Printed on: 10/29/20



SSA22

## Physics (MRI - New Techniques and Image Quality)

Sunday, Dec. 1 10:45AM - 12:15PM Room: E353A

MR PH SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

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Baowei Fei, PhD, Cleveland, OH (*Moderator*) Nothing to Disclose  
R. Jason Stafford, PhD, Houston, TX (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSA22-01 Hybrid MR-OR Siting and Safety

Sunday, Dec. 1 10:45AM - 10:55AM Room: E353A

### Participants

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### CONCLUSION

The hybrid MR-OR environment provides many clinical advantages but is not free of a certain degree of risk. The risk is further compounded with lack of consistent safety standards. Engineering MR safety into the practice design and strict adherence to MRI safety checklists, policy enforcement and regular personnel training is critical to maintaining MR safety in this complex multidisciplinary procedural environment.

### Background

Hybrid MR-OR for interventional and intraoperative procedures has emerged from its infancy to a standard setup at major academic medical centers. The American College of Radiology (ACR) white paper on MR Safety is a primary reference used by most sites for designing MR safety best practices; unfortunately, it is lacking specific guidance on hybrid MR-OR siting and safety. We attempt to provide a template for hybrid MR-OR siting and safety that builds on the ACR white paper terminology and covers unique considerations regarding design, layout, access, training, screening, infection control and procedural considerations when developing hybrid MR-OR siting and safety practices.

### Evaluation

A key challenge of hybrid MR-OR environment is its multidisciplinary, interdepartmental nature, and as such requiring a strong collaborative approach in the design of the hybrid environment and implementation of education and safety protocols. Safety not only has to be forefront in awareness, but also engineered into the workflow. We highlight three key elements of engineering safety into the practice design through 1) siting considerations 2) workflow and training considerations and 3) procedural safety considerations.

### Discussion

Siting considerations should include architectural layout, scanner choice (on rails vs stationary), zone designs, and screening equipment. Workflow and training consideration should include staff training (with emphasis on hands-on training), access control, and patient/staff movement. Procedural safety considerations should include level 2 personnel staffing, patient screening, procedural pause, surgical equipment screening, and infection control. Ongoing evaluation of procedural process is critical as new procedures are added.

#### SSA22-02 Lower Risk of Hearing Loss Without Sacrificing Image Quality in Fetal MR Imaging: A Feasibility Study Using Acoustic Reduction Technique

Sunday, Dec. 1 10:55AM - 11:05AM Room: E353A

### Participants

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## PURPOSE

The purpose of this study was to evaluate whether ART is reliable and applicable in fetus brain imaging.

## METHOD AND MATERIALS

We collected from September 2017 to October 2018 using 3.0T MR scanner for fetal head exams. 10 subjects underwent ART sequences (group A), the matched 10 subjects underwent traditional sequences (group B). The protocol of traditional sequences includes T2 single short fast spin echo (SSFSE) (axial, sagittal, coronal); while the ART sequences contains ART T2 SSFSE (axial, sagittal, coronal) (Table 1). A quantitative assessment by the ROI of 1 mm was manually placed on the different layers of the brain (Fig 1A). A qualitative evaluation including eight criteria (1. Delineation of germinal zone and gray matter, 2. Delineation of white matter, 3. Delineation of internal and external CSF spaces, 4. Delineation of amniotic fluid adjacent to the skull, 5. Delineation of brain stem, 6. Delineation of cerebellum, 7. Severity of motion artifacts, 8. Overall image quality) were evaluated on an ordinal scale regarding signal characteristics, potential dysmorphism and developmental anomalies (5= optimal diagnostic quality; 4= very good image quality; 3= diagnostic image quality, 2= image quality below diagnostic standards; 1= image quality too poor to correctly identify anatomy).

## RESULTS

The maximum differences of peak and equivalent sound pressure between the two groups are 18.1dBA and 16.1dBA respectively, indicating the ART sequences have lower noise than traditional sequences. Comparative ratios calculated between germinal matrix/air, periventricular layer/air, subplate layer/air, and cortical layer/air for group A (33.97±17.52, 42.45±16.65, 46.37±22.46, 43.03±20.89) were lower than that of group B (52.54±25.61, 33.39±12.91, 69.17±35.21, 64.76±32.53), but with no significant difference ( $P=0.09, 0.20, 0.12, 0.11$ ). The qualitative results showed that the image quality of group B and group A scored 4.42 + 0.37 and 4.36 + 0.49 respectively. There was no significant difference in image quality score between the two groups.

## CONCLUSION

Acoustic reduction sequence can acquire high quality images in 3.0T scanner, meanwhile decrease hearing loss risk in fetal head examinations compared with the conventional method.

## CLINICAL RELEVANCE/APPLICATION

Acoustic reduction sequence can acquire high quality images in 3.0T scanner, meanwhile decrease hearing loss risk in fetal head examinations compared with the conventional method.

## SSA22-03 Multi-Site, Multi-Vendor, and Multi-Platform Assessment of Accuracy of Quantitative Proton-Density Fat Fraction (PDFF) at 1.5 and 3 Tesla with a Standardized Spherical Phantom: Results from a Study by the RSNA QIBA PDFF Committee

Sunday, Dec. 1 11:05AM - 11:15AM Room: E353A

### Participants

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#### PURPOSE

Proton Density Fat Fraction (PDFF) is a popular MRI/S biomarker of hepatic steatosis. The QIBA PDFF Committee was formed in 2015. In this work, the committee conducted a multi-center and multi-vendor phantom study. The objective was to characterize the accuracy of PDFF as a robust biomarker, as measured by various SPGR chemical-shift-encoded sequences against a standardized phantom with known PDFF values.

#### METHOD AND MATERIALS

9 sites with multiple commercial 1.5T and 3T systems were involved. The phantom contained 12 vials of known PDFF. Sites were asked to test several protocols, to their best capability. P1: a vendor-sourced 'out-of-the-box' liver PDFF protocol. Each site ran P1 'as is', using default parameters for GE's IDEAL-IQ, Siemens' LiverLab, and Philips' mDIXON-Quant. P2: a complex-based QIBA recommended protocol. P3: a magnitude-based Liver Imaging of Phase-interference signal Oscillation and Quantification protocol. Each site acquired P1-P3 data, which were reviewed by an independent reader. For P1 and P2, each vendor's online multi-fat-peak complex-based data reconstruction algorithm and software was used for PDFF generation, with no modifications to reconstruction parameters. No work-in-progress software was used. For P3, data were sent to an additional independent site for multi-fat-peak magnitude-based reconstruction. A single analyst made all PDFF measurements. Linear regression was performed against reference values.

#### RESULTS

149 scans of the phantom were performed, 45 on 1.5T (15xP1, 12xP2, 18xP3), and 104 on 3T (33xP1, 24xP2, and 47xP3). Pooled P1 data for 1.5T: (slope=0.97, bias=0.15, r2=0.99), for 3T: (slope=0.99, bias=-0.69, r2=0.99); pooled P2 data for 1.5T: (slope=0.99, bias=-0.35, r2=1.0), for 3T: (slope=1.0, bias=-1.01, r2=0.99); pooled P3 data for 1.5T: (slope=0.96, bias=-0.25, r2=1.0), for 3T: (slope=0.97, bias=-0.02, r2=0.99). Lin's concordance correlation coefficient for all 1.5T data was 0.9973 and 0.9972 for all 3T data.

#### CONCLUSION

Quantitative PDFF data collected in a standardized phantom are accurate using vendor-source and QIBA-recommended complex-based water-fat separation protocols and an independent magnitude-based protocol.

#### CLINICAL RELEVANCE/APPLICATION

The PDFF from MRI and MRS is a robust and accurate quantitative imaging biomarker of hepatic steatosis across different magnet field strengths, imager manufacturers, and reconstruction methods.

#### SSA22-04 Effect of Post Labelling Delay on Arterial Spin Labelling

Sunday, Dec. 1 11:15AM - 11:25AM Room: E353A

#### Participants

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#### CONCLUSION

Single PLD ASL is a robust technique in obtaining CBF values but the accuracy is still confounded by the PLD settings. This study showed that CBF values at different PLD could be significantly different. 2000ms was the most appropriate settings (27/29 cases) which agreed well with the white paper. We also noticed that ATA signs could present after 2000ms. Radiographers should take up the role in real time image interpretation. If ATA were spotted, repeated examination with a longer PLD would be necessary.

#### Background

Arterial Spin Labelling (ASL) is a MRI perfusion technique utilizing magnetically labelled blood as endogenous tracers. Post Labelling Delay (PLD) is applied to ensure an equilibrium state is reached. However, a short PLD could not ensure an equilibrium state while a long PLD could lead to reduced SNR. Failure to account for could compromise the accuracy.

#### Evaluation

29 dementia patients in December 2018 were prospectively recruited. Pseudo-continuous ASL was acquired in a 3T scanner (Achieva, Philips Healthcare) with 3 PLD settings (TR=4000ms, TE=11ms, labeling-duration=1600ms, PLD=1800/2000/2500ms). Data analysis were done by MRIcloud online.

#### Discussion

Recommended single compartment model should give the same CBF values regardless of the PLD settings but our data showed that CBF values at each PLD were significantly different (Repeated measures ANOVA, p=0.000). After referencing with the buxton's kinetic model, 5 conditions were recognized and summarized in the figure. 2 cases showed 'steady state' in which CBF values were similar at each PLD. 10 cases showed 'ATA effects' in which equilibrium was reached after 2000ms. CBF values at 1800ms was erroneous as it violated the model assumption. 9 cases showed 'SNR penalty' in which there might be measurement errors due to reduced SNR at 2500ms leading to abnormally low CBF values. CBF values could not converge in the remaining 8 cases. 'Mixed effects' (n=6) might be due to a combination of 'ATA effects' and 'SNR penalty' where 2000ms, theoretically, would be the acceptable setting. In 'severe ATA effects' (n=2), CBF values at 2000ms were abnormally high due to an incorrect model inversion. 2500ms would be the appropriate choice.

## SSA22-05 Using Water-In-Oil Emulsions in Phantom for Quality Control of Diffusion-Weighted Magnetic Resonance Imaging

Sunday, Dec. 1 11:25AM - 11:35AM Room: E353A

### Participants

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### CONCLUSION

We developed a phantom containing control substances with predefined apparent diffusion coefficients ranging from normal tissue to benign and malignant lesions. The use of W/O emulsions as a part of the phantom allowed modeling a restricted diffusion represented in the image by a high-intensity signal in a wide range of the b-value. The proposed substances also allow evaluating the effectiveness of fat suppression.

### Background

To control the quality of diffusion-weighted magnetic resonance imaging (DWI), phantoms with control substances (with stable physical characteristics and known diffusion coefficients) are used. According to literature, aqueous solutions of polymer are used to achieve different diffusion coefficients. These materials model only hindered diffusion, while the diffusion of water molecule inside the cell is restricted. In this work we give results of combination water-in-oil (W/O) emulsions and polymer solutions to model not only restricted, but also hindered diffusion.

### Evaluation

As a hindered diffusion model, we used aqueous solutions of polyvinylpyrrolidone (PVP) with concentrations of 0-50%. We created W/O emulsions to simulate a restricted diffusion based on substances with high time T2 - siloxanes: cyclomethicone (Cycl) and caprylyl methicone (Cap). We chose emulsions with equal proportions of water/fatty phases: 1:1 Cap:Water and 1:1 Cycl:Water. According to the dispersion analysis, the size of micelles in the emulsions was  $4.8 \pm 1.8 \mu\text{m}$ . The apparent diffusion coefficient (ADC) of emulsion depends on the true diffusion coefficient inside micelles and the time interval between diffusion gradients  $\Delta$ . We also included silicon oil in phantom to control fat suppression. To estimate the effectiveness of phantom, we scanned it on different MR scanners.

### Discussion

With the increase of  $\Delta$  from 44.4 ms to 60 ms, we restated the decrease of ADC of emulsion by  $0.02 \mu\text{m}^2/\text{ms}$ , whereas this effect wasn't observed for water and Cap. True diffusion coefficients of material were determined with the accuracy of 4%. When comparing the ADC results of different MR scanners, the mean variation reached 5.1%, and the relative error was 9.3%. The use of correction factor allow decreasing the error to 2.5 %.

## SSA22-06 Improvement of Late Gadolinium Enhancement Image Quality Using a Novel, Deep Learning Based, Reconstruction Algorithm and Its Influence on Myocardial Scar Quantification

Sunday, Dec. 1 11:35AM - 11:45AM Room: E353A

### Participants

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### PURPOSE

The aim of this study was 1) to evaluate myocardial late gadolinium enhancement (LGE) image quality using a deep learning (DL) based magnetic resonance image reconstruction algorithm and 2) to assess its effect on the quantification of myocardial scar.

### METHOD AND MATERIALS

Thirty-five patients ( $46 \pm 17$ y, 51% male) with suspected ischemic or non-ischemic cardiomyopathy underwent cardiovascular magnetic resonance imaging (CMR) with gadolinium contrast (0.15 to 0.2 mmol/kg; Gadovist) on a 1.5T scanner (SIGNA Artist, GE Healthcare). Short axis 2D LGE images were reconstructed twice: once with the vendor standard reconstruction, and once with vendor supplied DLRecon prototype. The DL reconstruction is based on a deep convolutional residual encoder network trained from a database of over 10,000 images to reconstruct images with high signal-to-noise ratio (SNR) and high spatial resolution. The

network offered tunable noise reduction (NR) factors from 0-100% to accommodate user preference. Two observers scored image quality and myocardial nulling of both original images and reconstructed images with 75% NR level using a 5 point scale (1=poor to 5=excellent). SNR and contrast-to-noise ratio (CNR) were measured. In 20 patients with LGE, scar size was quantified using thresholding by 2, 4, and 6 standard deviation (SD) above remote myocardium, and using full width at half maximum (FWHM) technique in images with 25%, 50%, 75% and 100% NR levels.

## RESULTS

Both image quality and myocardial nulling improved by DLRecon method ( $3.3\pm 0.6$  vs.  $3.7\pm 0.6$ ,  $p<0.001$  and  $3.3\pm 0.6$  vs.  $3.4\pm 0.6$ ,  $p=0.03$ ). SNRscar and CNRscar-remote increased significantly with 150% and 158%, respectively at a NR level of 75% (both  $p<0.001$ ). Due to reduction in noise, scar size increased significantly with increasing NR levels using SD methods, however with the FWHM method no difference in scar size was found (figure).

## CONCLUSION

Using a novel, deep learning based, reconstruction algorithm myocardial LGE image quality improved significantly. However, these algorithms have important impact on scar size quantification depending on technique used. The FWHM method is preferred because it is independent of the level of noise.

## CLINICAL RELEVANCE/APPLICATION

LGE by CMR is the gold-standard technique for assessing myocardial scar and by using a novel, deep learning based, image reconstruction algorithm image quality can be improved.

### SSA22-07 Comparison Between Readout Segmented Diffusion Weighted Imaging and Single Shot Echo Planar Imaging in Image Quality

Sunday, Dec. 1 11:45AM - 11:55AM Room: E353A

#### Participants

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## PURPOSE

To compare difference of readout segmented diffusion weighted imaging (RS-EPI) and single shot echo planar imaging (SS-EPI) on image quality with ultra-high b value for prostate cancer detection.

## METHOD AND MATERIALS

37 patients with prostate disease who underwent both RS-EPI and SS-EPI were enrolled in this study. All data were collected on a 3T MR scanner (MAGNETOM Skyra, Siemens Healthcare, Erlangen, Germany) with the b value of 0, 1000, 2000, 3000s/mm<sup>2</sup>. The image quality including lesions clarity, anatomical distortion, image sharpness, detail display based on diffusion weighted imaging (DWI) were classified according to Likert score into 1 to 5 grade. (Grade 1: cannot be used for diagnosis; Grade 2: poor; Grade 3: acceptable; Grade 4: good; Grade 5: very good.) All the images were analyzed by two experienced radiologists blinded to any clinical information as well as MR sequence type. The classification was provided from two radiologists separately. The signal-to-noise ratio (SNR), and contrast ratio, and contrast to noise ratio (CNR) were also measured on workstations by the radiologist.

## RESULTS

The scores concluded by the two radiologists have good consistency, Kappa value  $>0.80$ . The image quality including lesions clarity, anatomical distortion, image sharpness, detail display obtained from RS-EPI sequences were higher than those obtained from SS-EPI regardless of 1000, 2000, 3000s/mm<sup>2</sup> ( $P<0.001$ ). The signal-to-noise ratio (SNR), and contrast ratio, and contrast to noise ratio (CNR) measured on RS-EPI sequences were also higher than those measured on SS-EPI ( $P<0.001$ ) (table1).

## CONCLUSION

Compared with the SS-EPI sequence, ultra-high b value RS-EPI sequence significantly improves the image quality, which is more conducive to the detection of prostate lesions.

## CLINICAL RELEVANCE/APPLICATION

Compared with the SS-EPI sequence, ultra-high b value RS-EPI sequence significantly improves the image quality, which is more conducive to the detection of prostate lesions.

### SSA22-08 Radiologic Technologists' Decision-Making for Protocol Repetition in Whole-Body MR Imaging and the Potential for Automated Image Quality Assessment: A Large Population-Based Cohort Study

Sunday, Dec. 1 11:55AM - 12:05PM Room: E353A

#### Participants

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## PURPOSE

Cost-effectiveness in health care delivery and diagnostic medical imaging have become increasingly important. Such considerations are relevant when repeating protocols in Whole-Body MR imaging, especially when conducting large cohort studies. We studied the frequency of protocol repetition by radiologic technologists who performed whole-body MR imaging protocols in the multi-center German National Cohort (GNC), and the impact of automation on the need for protocol repetition, considering the local, staffing, and technical factors involved. Additionally, we studied its impact on scan time, automated image quality assessment, and protocol repetition.

## METHOD AND MATERIALS

A total of 11,347 subjects underwent whole-body MRI as part of the MR sub-study of the GNC cohort (2014-2016). Whole-body imaging was conducted at five sites using a uniform set of twelve protocols. Image acquisitions were independently conducted by radiologic technologists (RT), whose decisions for protocol repetition was compared with image quality parameters that were automatically derived.

## RESULTS

At least one repeat protocol by the RT occurred in 12% (n=1,365) of subjects. The frequency of repetition differed across protocols ( $p < 0.0001$ ), and across sites (range: 5.28%-24.34%,  $p < 0.0001$ ), and varied over time ( $p < 0.0001$ ). Mean total scan time of 62.6min increased by 4.8min (95%CI: 4.5-5.2min) in subjects needing protocol repetition. The automatically-derived image quality parameters that retrospectively predicted the need for protocol repetition included image sharpness and signal-to-noise ratio. However, their predictive value was not uniform across all protocols.

## CONCLUSION

The need to repeat MR protocols, even in highly standardized settings such as population study cohorts, is highly prevalent. Our findings indicate that automated image quality assessment has predictive value, and reduces the need for protocol repetition, thereby improving workflow efficiency and cost-effectiveness in the conduct of such studies.

## CLINICAL RELEVANCE/APPLICATION

Patients find MRI studies daunting, hence MRI protocol repetition by radiologic technologists increase not only costs, but also patient discomfort. Automation of MRI image workflow has the potential to improve both.

## SSA22-09 An Experimental Study of MRI Induced Heating in Conductive Loops

Sunday, Dec. 1 12:05PM - 12:15PM Room: E353A

### Participants

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## CONCLUSION

This work indicates that size and presence of a gap are factors to consider in the risk assessment of piercings. It has important implication for dermal piercings since there may be unknown gap in the piercing under the skin.

## Background

Patients who are unable or reluctant to remove metallic piercings before MRI are at risk of injuries due to magnetic force and radiofrequency (RF) heating. While magnetic force risk can be reduced by screening with a ferromagnetic detector, it is harder to assess the risk of RF burn from piercing. The purpose of this investigation is to conduct experiments to evaluate the relationship of RF heating with the size and configuration of conductive loops to provide a better understanding of the factors related to RF heating in piercings.

## Evaluation

The study was conducted on a GE 3T MR system. Circular loops of diameter 5cm, 8cm and 11cm with an air gap of 0, 0.3mm or 2.5mm for each diameter were constructed from copper wire (gauge 10). They were placed one at a time horizontally in a container with the loop touching the skin of a pig knuckle specimen at the loop gap position. The setup was mounted on top of a 27cm spherical phantom and scanned using a fast spin echo sequence for 10:33 minutes. Temperature at the contact point between each loop and the specimen skin was measured with a Philips patient monitor temperature sensor. The results show temperature rise of 1.4 and 1.8 deg C in the 8cm loops with a gap of 0.3mm and 2.5mm respectively, and temperature rise of 5.0 and 5.2 deg C in the 11cm loops with a gap of 0.3mm and 2.5mm respectively. There was no measured temperature increase in all loops with zero gap and in the 5cm loops with a gap.

## Discussion

This study shows that RF heating risk increases with the size of conducting loops and with the presence of a gap. The result indicates high induced electric field at the gap of the larger loops causes current to flow in the skin with high resistance leading to the heating. However, this study does not imply MRI safety for piercings smaller than a certain size or without a gap since RF heating depends also on other factors and settings not covered in this study.



SSA24

## Vascular/Interventional (Liver Cancer Science)

Sunday, Dec. 1 10:45AM - 12:15PM Room: S404CD

CH CT IR SQ VA

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

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### Sub-Events

#### SSA24-01 Safety of Shortened Observation Time Without Radiographic Follow-Up for Patients After CT-Guided Lung Biopsy

Sunday, Dec. 1 10:45AM - 10:55AM Room: S404CD

### Participants

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### PURPOSE

To determine safety of shortened observation without follow up chest X-ray (CXR) after CT-guided lung biopsy in patients without immediate post-procedure pneumothorax (PTX).

### METHOD AND MATERIALS

Consecutive patients that underwent CT-guided lung biopsies under moderate sedation between 01/05/2015 and 06/19/2017 in a tertiary academic center were included in this IRB-approved HIPAA-compliant study. "Immediate post-procedure PTX" was defined as one detected by CT at the end of the biopsy; "observation PTX" and "delayed PTX" defined as pneumothorax detected by CXR during and after the post-procedural monitoring period, respectively.

### RESULTS

441 lung biopsies for 409 patients (average age  $68 \pm 11$  yrs, 231 (56%) female patients) were performed; 76 biopsies were excluded due to immediate post-procedure PTX, 6 due to insufficient documentation in the electronic medical records and 6 due to lack of follow up after biopsy. Average duration of monitoring for outpatients (n=293) was  $2.01 \pm 0.74$  hrs. In 20/353 (5.7%) biopsies, the patient became symptomatic (chest pain, shortness of breath) during post-procedural observation with 1/20 (5%) developing PTX. In 313/333 biopsies, the asymptomatic patients did not undergo CXR after the procedure, with 7/309 of these patients (2.3%) developing delayed PTX 2-10 days after the procedure (average  $4.9 \pm 4.0$  days). In 24/333 biopsies (7.2%), the asymptomatic patients underwent CXR within 4 hours with no PTX detected and despite that 1/24 of these patients (4.2%) presented with delayed PTX 7 days after the procedure. When no immediate post procedural PTX was present, the rate of observation PTX and delayed PTX was 1/353 (0.3%) and 8/353 (2.3%), respectively.

### CONCLUSION

Obtaining routine post-procedure CXRs in patients without immediate post-procedural PTX after CT-guided lung biopsies is not necessary given the low likelihood of PTX. Furthermore, shortening monitoring to 2 hour appears to be safe for these patients.

### CLINICAL RELEVANCE/APPLICATION

A decrease in observation time for these subset of patients will allow improved utilization of hospital resources.

#### SSA24-02 Transthoracic Ultrasound Guided Lung Biopsy: Accuracy and Safety

Sunday, Dec. 1 10:55AM - 11:05AM Room: S404CD

### Participants

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**PURPOSE**

Variables affecting performance of ultrasound-guided transthoracic needle biopsy (USG-TTNB) are not well established. The aim is to determine the clinical and imagery variables affecting sensitivity and rate of complications with USG-TTNB.

**METHOD AND MATERIALS**

From 2008 to 2017, a total of 542 consecutive USG-TTNB were reviewed. Mediastinal and chest wall lesions were excluded. 14 patients had incomplete data. Cubic splines were used to test the functional relationship between pleural contact length with sensitivity and complications. Multivariate logistic regression was used to account for possible confounding variables on that relationship.

**RESULTS**

Of the 528 biopsies, 312 diagnosis were obtained by USG-TTNB, including 285 malignant and 27 specific benign diagnosis, yielding a diagnostic accuracy of 59.2% (95%CI 54-62%) and sensitivity of 72.5% (95%CI 68-77%), respectively. Positive biopsies were associated with lesion size ( $p < 0.001$ ), pleural contact length ( $p < 0.006$ ), absence of pneumothorax ( $p = 0.001$ ), chest wall invasion ( $p = 0.005$ ) and core biopsy needle  $\leq 18G$  versus  $> 18G$  ( $p = 0.024$ ). Graphical inspection of a cubic spline showed that the probability of positive biopsies rose sharply for increasing pleural contact length up to 30 mm, then a flattening of risk. A similar reverse relationship was observed for pneumothorax. After adjusting for lesion size, chest wall invasion, and core biopsy needle, there was a significant effect of increasing pleural contact length up to 30 mm predicting positive biopsy (HR 1.07 {1.02, 1.12},  $p = 0.002$  per 1mm) with a non-significant effect of pleural contact size past 30 mm. Pneumothorax occurred in 14.6% (95%CI 11.7-17.9%) and chest tube was placed in 1.7% (95%CI 0.8-3.2). Variables associated with pneumothorax were lesion size ( $p < 0.001$ ), pleural contact length ( $p < 0.001$ ) and upper/middle lobes ( $p = 0.002$ ). On multivariate analysis, none of the above were significant at 5% level. No variables were associated with hemorrhagic complications, which occurred in 3.3% (95%CI 1.8-4.8).

**CONCLUSION**

Pleural contact length and target lesion size were the key variables predicting diagnostic accuracy and pneumothorax rate.

**CLINICAL RELEVANCE/APPLICATION**

Efficacy and safety outcomes are both affected by pleural contact length and lesion size. Therefore, choosing US-TTNB as a diagnostic procedure must consider these variables.

**SSA24-03 Ultrasound- versus CT-Guided Peripheral Lung Biopsies: A Comparison of Safety, Effectiveness, and Wait Times**

Sunday, Dec. 1 11:05AM - 11:15AM Room: S404CD

**Participants**

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**PURPOSE**

To compare the safety, effectiveness and wait times of CT-guided percutaneous lung biopsies with ultrasound (US) guidance for peripheral lung lesions that abut or arise from the pleura.

**METHOD AND MATERIALS**

Consecutive CT- and US-guided biopsies performed at our institution between January 2017-January 2019 were retrospectively reviewed. Lesion size, the degree of pleural contact, wait time for the procedure, the number of needle passes, procedure duration, complications and final pathology diagnosis were recorded. Chi-square and Mann-Whitney U tests were used for statistical analysis. Research ethics board approval was obtained.

**RESULTS**

A total of 228 imaging-guided lung biopsies were performed by 5 interventional radiologists. Of these, 117 were for peripheral or pleural-based lesions. US guidance was used for 38 cases (20 men, 18 women, mean age 71.1). CT guidance was used for 70 cases (39 men, 40 women, mean age 69.9). Overall, the mean maximum axial diameter of pulmonary lesions sampled under US guidance was greater than for CT (4.8±2.5 cm vs 3.7±1.8 cm,  $p = 0.007$ ). Similarly, the length of pleural contact was also greater for US (4.1±2.4 cm) than CT (2.6±1.7 cm,  $p < 0.001$ ). Procedure time was shorter for lesions localized with US than CT (28.7±16.9 min vs 36.6±20.2 min,  $p = 0.017$ ). In contrast, the mean number of needle passes per lesion was less for CT than US (3.1±0.9 vs 3.5±1.1,  $p = 0.019$ ). The adequacy of biopsy samples was determined to be equivalent for both modalities (97.4% for US and 97.5% for CT). The wait time for both procedures was not significantly different (11.7±8.3 days for US vs 14.9±8.0 days for CT,  $p = 0.059$ ). Finally, the frequency of significant complications requiring chest tube insertion and/or hospital admission was similar between US and CT (2.6% vs 3.8%).

**CONCLUSION**

US-guided peripheral lung biopsies are safe and reliable with comparable results to CT-guided biopsies and similar wait times, but

US-guided peripheral lung biopsies are safe and reliable with comparable results to CT-guided biopsies and similar wait times, but shorter procedure times.

#### **CLINICAL RELEVANCE/APPLICATION**

US is relatively low cost, does not require ionizing radiation and allows for real-time needle visualization, making it a viable alternative to CT guidance for biopsy of peripheral lung lesions.

#### **SSA24-04 CT-Guided Percutaneous Biopsy of Ever Smaller Lung Nodules: Diagnostic Yield and Complication Rate as a Function of Nodule Size**

Sunday, Dec. 1 11:15AM - 11:25AM Room: S404CD

##### **Participants**

David J. Grand, MD, Barrington, RI (*Abstract Co-Author*) Nothing to Disclose  
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Jason I. Halpern, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
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##### **PURPOSE**

The number of CT-guided percutaneous lung biopsies performed is rapidly growing, in part due to the advent of lung cancer screening CT. However, not only are we performing more lung biopsies, but we are biopsying ever smaller nodules. Given that subcentimeter nodules have not routinely been biopsied, the diagnostic yield and complication rates are not known. The purpose of this project was to evaluate the diagnostic yield and complication rate of percutaneous lung biopsy as a function of nodule size.

##### **METHOD AND MATERIALS**

This IRB approved study involved retrospective review of 625 patients who underwent percutaneous, CT-guided lung biopsy. Patients were identified via search of our electronic medical records system (Montage). Biopsies were performed by one of fifteen attending radiologists specializing either in interventional radiology or body imaging. Data recorded included nodule size, distance from the pleura, needle type, number of passes performed, pneumothorax rate, chest tube rate, hospital admission rate, diagnostic yield as well as history of smoking or prior malignancy.

##### **RESULTS**

Overall, a diagnostic specimen was obtained in 91.5% of patients (572/625). However, diagnostic yield for lesions <1 cm was 80% compared to 92.1% for nodules > 1 cm ( $p < 0.05$ ). For every 1 cm increase in lesion size, the odds of achieving a diagnostic specimen increased 21% ( $p < 0.05$ ). Pneumothorax complicated 11% of biopsies (69/625) and 5.6% of patients (35/625) required chest tube placement. However, 22.5% of procedures were complicated by pneumothorax when lesions were <1 cm, compared to 10.3% of procedures when the nodule was >1 cm ( $p < 0.05$ ). For every 1 cm increase in nodule size, the odds of pneumothorax decreased 24% ( $p < 0.05$ ). Although there was no statistically significant difference in patients requiring chest tubes in the two groups, the odds of requiring a chest tube decreased 21% for every 1 cm increase in lesion size ( $p < 0.05$ ).

##### **CONCLUSION**

Percutaneous CT-guided lung biopsy is a safe and effective procedure, however the diagnostic yield decreases and the complication rate increases as the size of the biopsy target decreases.

#### **CLINICAL RELEVANCE/APPLICATION**

As the number of CT-guided lung biopsies increases across the country it is crucial that physicians and patients understand that diagnostic yield and complication rates are directly related to nodule size.

#### **SSA24-05 Efficacy of Thermal Ablation versus Stereotactic Radiotherapy for Stage I Lung Cancer: Subgroup Analyses Based on Tumor Histology**

Sunday, Dec. 1 11:25AM - 11:35AM Room: S404CD

##### **Participants**

Johannes Uhlig, Goettingen, Germany (*Presenter*) Nothing to Disclose  
Meaghan Dendy, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Anne Chiang, MD, PhD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
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##### **For information about this presentation, contact:**

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##### **PURPOSE**

To assess the effectiveness of thermal ablation (TA) versus stereotactic body radiotherapy (SBRT) for stage I lung cancer depending on histology.

##### **METHOD AND MATERIALS**

The National Cancer Database was queried for patients with AJCC stage I lung cancer diagnosed from 2004-2015. Adenocarcinoma, squamous cell carcinoma (SCC), unspecified non-small cell lung cancer (NSCLC) and other histology (except carcinoid) were included. Treatment was stratified as TA (radiofrequency ablation, or grouped laser/cryo ablation) and SBRT (beam-based radiation of the lung). Patients age < 18yo, chemotherapy, and unknown survival /follow up were excluded. SBRT and TA patients were 5:1 propensity score matched to account for confounders, separately for each histology. Overall survival (OS) was compared in the matched cohort.

## RESULTS

55,336 patients were included: n=68,693 receiving SBRT (97.3%) and n=1,836 receiving TA (2.7%). Histology was adenocarcinoma n=24,085 (35.1%), SCC n=20,736 (30.2%), NSCLC n=10,515 (15.3%), and other histology n=13,357 (19.4%). TA patients were more likely to be younger Caucasians with private insurance and more comorbidities and treated at academic centers in New England states for smaller adenocarcinomas. For each histology, a matched cohort was obtained with balanced distribution of confounders. TA and SBRT demonstrated comparable OS in all subgroups: adenocarcinoma (p=0.297; 1-year OS: 86 vs 86%; 3-year OS: 49 vs 52%), SCC (p=0.086; 1-year OS: 67 vs 67%; 3-year OS: 27 vs 30%), NSCLC (p=0.732; 1-year OS: 83 vs 83%; 3-year OS: 49 vs 47%), and other histologies (p=0.094; 1-year OS: 85 vs 83%; 3-year OS: 59 vs 50%).

## CONCLUSION

Utilization of thermal ablation techniques for stage 1 lung cancer varies with tumor and patient variables. For adenocarcinomas, squamous cell carcinomas and tumors classified as unspecified NSCLC, overall survival was comparable for TA and SBRT. Future studies should prospectively evaluate optimal patient selection criteria in stage I lung cancer to offer individualized treatment approaches.

## CLINICAL RELEVANCE/APPLICATION

Thermal ablation shows comparable OS to SBRT in stage I lung cancer and should be considered as an alternative treatment option, independent of histological subtype.

### SSA24-06 Percutaneous Cryoablation of Lung Metastasis: 15 Year Experience of Feasibility, Safety and Recurrence Parameters

Sunday, Dec. 1 11:35AM - 11:45AM Room: S404CD

#### Participants

Hussein D. Aoun, MD, Dearborn, MI (*Abstract Co-Author*) Reviewer, Galil Medical Ltd  
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Hakob Kocharyan, MD, Detroit, MI (*Presenter*) Nothing to Disclose  
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## PURPOSE

To report our long-term experience with CT guided percutaneous cryoablation using intensive freeze parameters for lung metastasis, including factors affecting complications and local recurrence rates.

## METHOD AND MATERIALS

Following IRB approval under HIPAA compliance, 192 CT fluoroscopic-guided, percutaneous cryoablation procedures were performed for 262 masses in 107 outpatients. Primary sites of lung metastasis included colorectal (N=57), renal cell carcinoma (N=38), sarcoma (N=103), gynecologic (N=17), hepatobiliary (N=8) and other (N=24). Tumor size and location (central vs peripheral) with relationship to major vasculature. Hydrodissection and/or were utilized for protection of adjacent structures (ie: esophagus). All complications were graded according to standardized CTCAE criteria. Patients were followed by CT and/or MRI at 1, 3, 6, 12, 18, 24 months and yearly thereafter.

## RESULTS

Average tumor diameter of 2.0 cm was treated by average cryoprobe number of 3.1, which produced CT-visible ice ablation zone diameters averaging 4.1 cm. Grade >3 complications were 3.6% [N=7/192]. There were greater complications in tumors greater/less than 3 cm [9.8% (4/41) vs. 2.0%(3/151)], p<0.025). No deaths occurred in our series for ablation of metastatic lesions. Hydrodissection and/or warming catheter utilization was used in 7.8% (15/192). At a mean follow-up of 24 months, overall local tumor recurrence was 5.7%(15/262), but significantly greater for tumors above 3cm (i.e.,16% (7/44); p<0.005).

## CONCLUSION

With appropriate pretreatment evaluation and PFT criteria, percutaneous lung cryoablation is safe and produces very low local recurrence rates, especially for tumors <3 cm.

## CLINICAL RELEVANCE/APPLICATION

Appropriately delivered thoracic metastasis cryoablation is affected by tumor size yet still produces low recurrence and complication rates.

### SSA24-07 Innovative Technique for CT-Guided Presurgical Lung Nodule Marking: High Efficacy and Safety

Sunday, Dec. 1 11:45AM - 11:55AM Room: S404CD

#### Participants

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**PURPOSE**

To assess outcomes of CT-guided localization for preoperative lung nodule marking prior to video-assisted thoracoscopic surgery and robotic video-assisted thoracoscopic surgery.

**METHOD AND MATERIALS**

25 CT-guided lung nodule localization procedures were performed on 26 nodules in 25 patients prior to surgical resection. The procedures were performed by a fellowship trained radiologist 1 to 2 hours prior to scheduled surgery under local anesthesia. Approximately 4 to 6 ml of methylene blue/collagen solution was injected in a perinodular location under CT-guidance with a 19g trocar needle. Post procedure CT images with increased perinodular consolidation confirmed appropriate marking. Patients were then transferred back to surgery.

**RESULTS**

Accurate perinodular CT- guided needle trocar placement was achieved in all marking procedures. Increased perinodular consolidation was also demonstrated in all patients on the post procedural localized CT scans. One patient with moderate emphysema developed a small to moderate sized pneumothorax and a 8F thoracentesis catheter was placed under CT guidance prior to return to surgery. There was no noted bleeding or hemoptysis in any of the patients. Methylene blue/collagen solution was readily visible by the thoracic surgeon in association with all target nodules. One patient required conversion to open procedure due to advanced disease. Of the 26 identified nodules, pathology specimens confirmed adequacy of nodule resection in all cases.

**CONCLUSION**

Intraoperative identification of pulmonary nodules/ tumors, especially deep nodules and patients undergoing VATS or robotic surgery, may be challenging. Perinodular localization by CT guided methylene blue/ collagen solution injection offers a safe technique with high efficacy.

**CLINICAL RELEVANCE/APPLICATION**

CT-guided methylene blue/ collagen localization allows thoracic surgeons to readily identify nodules/tumors, improve outcomes and decrease morbidity in patients undergoing thoracic surgery.

**SSA24-08 Percutaneous CT-Guided Microwave Ablation of Non-Operable Pulmonary Metastases: Role of Apparent Diffusion Coefficient in Assessment Early Treatment Response**

Sunday, Dec. 1 11:55AM - 12:05PM Room: S404CD

**Participants**

Emad H. Emara, Kafr El-Shikh, Egypt (*Presenter*) Nothing to Disclose  
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**PURPOSE**

To determine retrospectively the early treatment response of MWA in patients with pulmonary metastases using Apparent diffusion coefficient( ADC) value.

**METHOD AND MATERIALS**

51 patients with 76 lung metastatic lesions were included & treated with MWA according to the guidelines. lesions were evaluated by diffusion weighted imaging (DWI) and ADC value before and 24 hours after MWA. DWI was obtained with b-values (50,400, 800:mm2/s) using 1.5& 3 tesla MRI. Postablation follow-up by chest CT and/or MRI with ADC value measurement was done after 24 hours, 3, 6 months, 1 year and every 6 months onwards to determine responsive and local progression cases with residual tumor activity.Immediate postablation changes in ADC values were compared to the net response based on CT and/or MRI follow-up

**RESULTS**

50 lesions(65.8%) showed complete response to treatment and 24 lesions(34.2%)with local progression.We reported statistical significance difference of ADC value measured 24 hours after ablation between the responding( $1.7 \pm 0.2 \times 10^{-3} \text{ mm}^2/\text{s}$ ) and non-responding groups( $1.4 \pm 0.2 \times 10^{-3} \text{ mm}^2/\text{s}$ ) with significant relatively higher values at the former(P0.001); a cut-off ADC value (1.41) has been suggested as reference point to predict the response (66.65% Sensitivity, 84.22%Specificity, 66.72%PPV& 84.21%NPV). No significant difference of ADC value performed before the ablation as a prognostic factor for the response (P0.85 ). No significant difference in post- ablation ADC values of different types of pulmonary metastases (P 0.321)

**CONCLUSION**

ADC value calculated 24 hours post-treatment is a good quantitative measurement that may allow early prediction of the treatment efficacy of MWA of pulmonary metastases before changes in tumor size become detectable on Conventional CT or MRI.

**CLINICAL RELEVANCE/APPLICATION**

ADC can evaluate early MWA efficacy in treatment of pulmonary tumors and Can predict tumor recurrence after treatment.

...can tolerate early, high-dose, in treatment of primary, cancer and can prevent cancer recurrence after treatment.

**SSA24-09 Palliative Role of Non-Selective Intra-Aortic Transarterial Chemoperfusion (TACP) in the Management of Inoperable Cases of Advanced Lung Cancer**

Sunday, Dec. 1 12:05PM - 12:15PM Room: S404CD

**Participants**

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**PURPOSE**

To evaluate the initial tumor response, local control, and survival after the treatment of primary lung malignancies using non-selective intra-aortic transarterial chemoperfusion (TACP) in palliative intent.

**METHOD AND MATERIALS**

Forty-two patients (mean: 63±11 years; 19 females and 23 males) with advanced unresectable lung cancer (stage III=8 & stage IV=34), underwent repetitive TACP, as third- or further-line therapy, between November 2006 and January 2016. The mean number of sessions was 5.3±2.5. The treated pathologies were non-small cell lung cancer (n=29), small cell lung cancer (n=1) and 12 cases of bronchogenic carcinoma with unknown histology. Bilateral lung involvement was present in 61.9% of cases and the median number of lesions was four. Regional delivery was achieved by injecting the chemotherapeutic agents intra-aortic, as a bolus with maximum hand pressure, in close vicinity to the origins of the main tumor-supplying arteries. The treatment regimen included a combination of mitomycin C and Gemcitabine with (n=37) or without cisplatin (n= 3). Two patients received other combinations after their oncologists' recommendations. The treatment was performed in a palliative setting and patients who underwent subsequent ablation were excluded. The response was evaluated according to the revised RECIST criteria and local tumor progression and patient survival were analyzed using the Kaplan-Meier estimator.

**RESULTS**

Partial response (PR) was achieved in 4.8% (n=2), stable disease (SD) in 69% (n=29) and progressive disease (PD) in 26.2% (n=11). The estimated mean survival time (MST), median survival time and mean and median time to progression were 20±5.5, 9.5±0.6, 10.7±1.8 and 6.7±2.2 months, respectively. Technical success was achieved in all patients and no intervention-related complications were recorded.

**CONCLUSION**

Transarterial chemoperfusion is a feasible and well-tolerated treatment in patients with advanced lung cancer who failed prior systemic chemotherapy and have the potential to improve local control and survival, when compared to the published results of other third - and further-line therapies.

**CLINICAL RELEVANCE/APPLICATION**

TACP is a minimally invasive treatment option that can positively affect the local control and survival in patients with advanced lung cancer.

Printed on: 10/29/20



QIE-SUA

## Quality Improvement Reports Sunday Poster Discussions

Sunday, Dec. 1 12:30PM - 1:00PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI102-ED- SUA1 **Our Work is Never Done: Continuous Quality Improvement in the EC**

Station #1

#### Participants

Susanna C. Spence, MD, Houston, TX (*Presenter*) Nothing to Disclose

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### PURPOSE

The pressures on our county EC have not ceased in the last few years, with record setting volumes at our Level III trauma center following closure of two smaller hospitals in our catchment area, with this county EC now the busiest EC in the city. All service lines have been called upon to assist in throughput and flow, with a focus on CT for Radiology, which features prominently as many of our EC patients require imaging. In fact, while imaging utilization across the nation has taken a slight downturn, EC imaging continues to increase. This, and an overall increase in patient visits at our institution, has created continuous pressure on the radiology department to improve turnaround. The measure of EC TAT is set by the voice of the customer, our EC providers. They care little for the tech vs radiologist turnaround time: they place an order, which goes into what they perceive as a 'black box' until some kind of result is returned. Therefore our metric according to the EC: order to 'first actionable' report (whether that be prelim or final).

### METHODS

This poster will describe the methods of several different QI projects undertaken around EC CT turnaround time from 2015 to present. Because we are measured from 'order' to 'first actionable report' we are actively encouraged to undertake projects that improve tech turnaround time and protocolling time in addition to the rendering of the radiology report itself once the exam is completed. Therefore we will describe our analysis of our longest CT exams with the longest TAT (CT A-P with contrast) and our interventions surrounding that (including abandonment of low yield delayed-phase imaging and oral contrast). In addition, this QI report would include description of our workflow changes (shifting of techs from inpt to EC in peak hours, consolidated/streamlined protocolling lists, short 2 hour cross coverage of a second attending during peak hours). The report will also briefly touch on future directions, including clinical decision support to decrease the numbers of changed orders, tech worklist modifications to indication status of pending labs/pregnancy test/IV, and an approved physician order set to bring the orders for labs/pregnancy test to the forefront of the ordering process.

### RESULTS

Despite a continued increase in EC CT exams performed per month (increasing from an average of 1474/month in 2016 to a record setting 2209 last month (Mar 2019) we have not only decreased our prior TATs but we have managed to maintain that improvement despite increases in volume year after year. We have had 24/7 faculty coverage since 2012, so we have neither added overnight faculty coverage nor an extra resident or tech. We did not add a CT scanner or upgrade our current scanner. We did add an additional 2 hour 'swing' shift of a second faculty member during peak evening hours - both to balance neuro coverage and to improve TATs at a time when we were reaching 'critical mass' with a single attending and resident - but the majority of our interventions are workflow related. The attached graph indicates the cumulative impact of our various interventions on our EC CT TATs over this time period.

### CONCLUSION

We look at our volume/TAT data continuously, and watch for volume increases in addition to TAT increases, particularly in the evening hours when the EC is under the heaviest pressure. Queuing theory indicates that wait times will continuously increase as patient volumes exceed throughput capacity in the evening hours. We have done (and continue to do) our level best to keep radiology at the center of throughput facilitation as opposed to being a bottleneck during that time period. This has given us strong bargaining power when we have made requests for IV modifications (due to leaks) or EC assistance with lab and pregnancy test values needed for CT throughput. This collegial atmosphere allows us all to move forward in our common goal.

#### QI100-ED- SUA2 **The Effect of a Radiology Nurse Navigator on Improving the Timeliness of Breast Care by Minimizing the Interval Time between Abnormal Breast Imaging and Image Guided Needle Biopsy**

Station #2

#### Participants

Jae H. Sung, MD, Washington, DC (*Presenter*) Nothing to Disclose  
Judy H. Song, MD, Bethesda, MD (*Abstract Co-Author*) Nothing to Disclose  
Erin P. Crane, MD, Washington, DC (*Abstract Co-Author*) Nothing to Disclose  
Janice Y. Jeon, MD, McLean, VA (*Abstract Co-Author*) Nothing to Disclose  
Xuan-Mai T. Nguyen, MD, Falls Church, VA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Breast Centers incorporate a multidisciplinary team approach to optimize breast care delivery to patients. The National Accreditation Program for Breast Centers (NAPBC), a consortium of professional organizations focused on breast health delivery and improving outcomes, routinely sets out guidelines for accreditation. One of the NAPBC standards regarding diagnosis is 'needle biopsy is the initial diagnostic approach rather than open biopsy...open surgical biopsy as an initial approach should be avoided, as it does not allow for treatment planning and has a high re-excision rate.' (1, Standard 2.9). One of the National Quality Measures for Breast Centers is the Imaging Timeliness of Care, specifically the 'time between diagnostic imaging and Needle Core biopsy'(2). The purpose of this study is to utilize staffing changes to decrease the interval wait time between abnormal breast imaging findings and needle biopsy, or the time to diagnosis, in order to improve care delivery, improve patient satisfaction and improve patient outcomes.

## METHODS

A Nurse Navigator's role is to help patients obtain timely cancer screening, diagnosis and treatment, to optimize patient care and improve patient outcomes.(3,4). A Radiology Nurse Navigator position was created and filled in the summer of 2017, to oversee the breast biopsy program. Her role was envisioned as a facilitator for patients, from their point of entry into the breast care system, when biopsy is recommended, and throughout their course of care to include any advanced imaging, additional biopsies, and initial breast surgery and oncology appointments. Her responsibilities included scheduling biopsies, obtaining referrals, assisting in pre and post biopsy care, and coordinating patient appointments as needed amongst the multidisciplinary breast team.

## RESULTS

IRB approval was obtained for this retrospective chart review. Biopsy cases performed at our academic breast imaging center from January 1-June 30, 2017 and January 1-June 30,2018 (pre and post Nurse Navigator) were reviewed. The following data was obtained: the type of biopsy (US, stereotactic, MRI guided biopsy), interval time between the biopsy recommendation and needle biopsy in working days. Press Ganey scores from the time periods (Jan-June 2017 and Jan-June 2018) for OPT-A 'got tests when wanted' were reviewed. The results were analyzed using a standard T test. In 2017, 326 patients underwent 344 biopsies, 228 US guided biopsies, 80 stereotactic biopsies, 23 Breast MRI guided biopsies and 13 cyst aspirations. The average interval wait time for US biopsies was 12.86 days (1-145), stereotactic biopsies 18 days (2-64), and MRI guided biopsies 20 days ( 6-54). In 2018, 370 patients underwent 405 biopsies, 265 US guided biopsies, 95 stereotactic biopsies, 35 MRI guided biopsies, and 10 cyst aspirations. The average interval wait time for US biopsies was 8.67 days ( 0-63), stereotactic biopsies 10.97 days (1-39), and MRI guided biopsies 18 ( 2-44). The decrease in interval wait times was significant for stereotactic and ultrasound guided biopsies, with a 31% decrease in wait times for stereotactic biopsies ( p= 0.02) and 33% decrease in wait times for ultrasound guided biopsies (p=0.01). Additionally, there was a 10% decrease in interval wait times for MRI guided biopsies. Biopsy volumes increased overall, with the largest relative gains in MRI guided biopsies (152% in 2018 vs. 2017) compared to stereotactic biopsies ( 118%) and ultrasound guided biopsies ( 116%). Press Ganey scores increased from an average of 89.85 (82.9 - 93.3) in Jan. to June 2017 for OPT-A, to 93.9 (89.3-97.6) in Jan. to June 2018.

## CONCLUSION

The Radiology Nurse Navigator improved timeliness of patient care by decreasing wait times for all biopsies by 10-39%, statistically significant for stereotactic and ultrasound guided biopsies, improved patient satisfaction as demonstrated by a rise in Press Ganey scores on average from 89.85 to 93.9, and increased overall biopsy volumes. Future studies evaluating additional timeliness of patient care delivery (from needle biopsy diagnosis to surgery), patient and physician satisfaction, and cost benefit analysis can be performed to justify the implementation of Radiology Nurse Navigators across all breast centers. References: 1.

<https://accreditation.facs.org/accreditationdocuments/NAPBC/Portal%20Resources/2018NAPBCStandardsManual.pdf>

2.<http://www2.nqmbc.org/wp-content/uploads/2014/03/NQMBc-measures.pdf> 3.Academy of Oncology & Patient Navigators.Helpful Definitions.[www.aononline.org/about/helpful-definitions](http://www.aononline.org/about/helpful-definitions) 4.Psooy BJ, Schreuer D, Borgaonkar J, Caines JS. Patient navigation: improving timeliness in the diagnosis of breast abnormalities. *Can Assoc Radiol J.*2004;55:145-150.

## Q1101-ED- SUA3 Procedure for Optimal Implementation of Automatic Tube Potential Selection in Pediatric CT to Reduce Radiation Dose and Improve Workflow

Station #3

### Participants

Jacinta Browne, PhD, Dublin 8, Ireland (*Presenter*) Nothing to Disclose

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## PURPOSE

Automatic tube potential (kV) selection is an important dose optimization technique that has been shown to achieve up to 50% dose reduction in adult body CT. However, clinical implementation of automatic kV selection in pediatric CT is not a trivial task; a quantitative approach is required to determine the optimal settings for different clinical tasks. This optimization often requires manual selection of technique factors by the technologist, which can not only delay workflow, but can also lead to increased radiation dose or poorer image quality if the wrong technique is selected. The aim of this report is to describe the procedure used by our institution to clinically implement an automatic kV selection tool (CAREkV, Siemens) for radiation dose reduction in pediatric abdominopelvic CT. The procedure starts with phantom measurements to determine optimal CAREkV parameters as a function of clinical task and patient size, and is followed by clinical implementation, patient case collection, and objective performance evaluation.

## METHODS

We introduced CAREkV into our pediatric abdominopelvic CT practice in three steps. (1) Phantom measurements were carried out to

determine optimal parameter settings. Six phantoms, representing the sizes of a newborn, 1, 5, 10, 15 year old and young adult, were scanned on a dual-source 128-slice scanner using a routine pediatric abdominopelvic protocol (Flash, Siemens) with CAREkV on and off. The technique chart used for manual technique selection was previously developed as part of a comprehensive clinical study. When CAREkV was on, six of the slider bar settings corresponding to different clinical tasks were evaluated (namely, 2, 3, 5, 6, 8 and 11) for a reference technique of 120 kV and 160 quality reference mAs (QRM). The kVs and corresponding radiation doses (CTDIvol) were recorded for each phantom and each clinical task setting. The optimal CAREkV clinical task setting was chosen by the pediatric radiologists and CT protocol committee based on similarity of the kV settings for different patient sizes and clinical tasks, to the existing technique chart settings. This experimental approach was validated by comparing the kV setting and CTDIvol for different patient sizes and clinical tasks obtained using the manual technique chart with those corresponding to similar phantom sizes and tasks. (2) The optimal CAREkV settings identified in step 1 were programmed into a new pediatric CT protocol, which was used clinically over a 1-month trial. During this evaluation period, various patient data were recorded, including: patient size (as measured by Water-Equivalent-Diameter (WED)), clinical task, the kV and CTDIvol selected by CAREkV and the average subcutaneous fat noise, average liver noise and the aortic iodine CNR as image quality metrics. (3) Following the successful 1-month trial, the new scan protocol was adopted into the clinical practice, and after 3-months of use, the dose performance (in terms of CTDIvol and image quality metrics described above) were compared to that achieved previously in a similar patient cohort using our technique chart.

## RESULTS

Using phantoms, we determined that the kVs selected by CAREkV, for clinical task settings of 2 and 5, were optimum for non-contrast and contrast examinations, respectively (Fig1(a-b)), which was in agreement with our manual technique chart. In the 1 month trial, we found that these settings were appropriate for pediatric abdominopelvic CT, as the kV and CTDIvol values selected by the CAREkV tool were similar to those used by the technique chart and the image quality was similar. The CAREkV tool was then implemented into pediatric abdominopelvic CT and it was found that the CTDIvol before and after the implementation of the CAREkV tool were comparable (Fig 1), with a very slight dose reduction ( $p < 0.05$ ) for all patient sizes apart from  $< 15\text{cm}$ .

## CONCLUSION

CAREkV was clinically adopted into our pediatric abdominopelvic CT practice with use of a 3 step procedure. This ensured that optimal image quality was maintained relative to our kV/mAs technique chart rigorously-developed in a previous clinical study, and that an appropriate radiation dose reduction was incorporated by the CAREkV tool through the careful selection of the clinical task parameter settings. This tool provides the benefits of potentially radiation dose, streamlined workflow and reduction in human-error in the protocol set-up.

### Q1005-EB-SUA Dual-Energy CTA for GI Bleeding: Reducing Patient Radiation Dose and Table Time

Hardcopy Backboard

#### Participants

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## PURPOSE

Gastrointestinal (GI) bleeding is common in the United States, requiring hospitalization in 223 per 100,000 people each year (Laine 2012). In hemodynamically stable patients, our diagnostic workflow in the Emergency Department typically begins with CTA abdomen and pelvis after physical exam. Previously, our CTA protocol for GI bleeding (GIB CTA) included three separate acquisitions performed at single energy: noncontrast, arterial, and delayed venous images. Dual energy CTA (DE CTA) has been increasingly used in this setting to reduce radiation dose and patient table time because of the ability to create virtual noncontrast (VNC) images and forego the true noncontrast (TNC) acquisition. Furthermore, DE CTA provides additional potentially clinically useful reconstructions such as iodine maps and virtual monoenergetic images.

## METHODS

We analyzed the literature to find previously described parameters for performing dual energy CTA for GI bleeding (Wells 2018). The protocols were modified after phantom testing and approved by our departmental medical physicists for clinical use. The new dual energy CTA protocol included only arterial and venous acquisitions with VNC reconstructions. Single energy GIB CTAs from the previous 6 months were analyzed to determine patient table time and effective dose. A total of 67 GIB CTAs spanning from October 2018 through March 2019 were included in this group. Clinical use of the new dual energy GIB CTA protocol began in March 2019. In a similar fashion, patient table time and effective dose were recorded for these studies. As of April 2019, a total of 6 CTAs were included in this group. Patient table time was determined by calculating the time interval from initial scout image to final venous image. Monte-Carlo simulation based software (Radimetrics, Bayer Healthcare) was utilized to calculate effective radiation dose. Statistical analysis was performed using a two sample T-test.

## RESULTS

For scans utilizing single energy GIB CTA with three separate acquisitions, the mean table time was 296 seconds (4 minutes, 56 seconds) and mean effective dose was 39.1 mSv ( $n=67$ ). Upon implementation of the dual energy GIB CTA protocol with two acquisitions, the mean table time decreased to 217 seconds (3 minutes, 37 seconds) and mean effective dose decreased to 30.2 mSv ( $n=6$ ). Statistical analysis with two sample t-Test demonstrated a statistically significant decrease in both effective dose ( $p < .015$ ) and table time ( $p < .033$ ).

## CONCLUSION

Dual energy CT is a novel CT technique with the potential to improve diagnostic capabilities, decrease radiation dose, and enhance patient experience. After implementation of dual energy GIB CTA protocol into the clinical workflow at our institution, we were able to improve the quality of patient care by decreasing both table time and effective radiation dose.

### Q1006-EB-SUA Improving Reporting of High Radiation Dose Events in Fluoroscopy to Meet Joint Commission Requirements

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## PURPOSE

Complex procedures in interventional radiology can result in high radiation doses with the potential of harm to patients. Until recently, detection of high dose events were typically self-reported by the operator or revealed after the exam by patient reported skin injury. As of January 2019, the Joint Commission now mandates documentation of all fluoroscopy dose events, establishment of radiation exposure thresholds, and investigation of excessive dose events. Fortunately, many fluoroscopy exams can now be automatically tracked through dose tracking software. However, some older equipment lacks the capability of automatic reporting, necessitating a robust manual process to capture all dose events. The purpose of this project was to improve detection of fluoroscopy exams with excessive radiation dose by implementing automatic dose tracking and a monthly auditing process.

## METHODS

The baseline process for detecting excessive radiation dose events relied on technologists to fax a form to the Environmental Health and Safety Office when doses exceeded cumulative air kerma (CAK) threshold of 5 Gy or fluoroscopy time greater than 100 minutes. A medical physicist would then calculate the peak skin dose (PSD). If the PSD exceeded 5 Gy, an email would be sent to the operating radiologist or surgeon with guidance on follow-up. To improve detection of high dose events, capable fluoroscopy equipment was configured to automatically send radiation dose structured reports (RDSR) to dose tracking software (Radimetrics™, Bayer Healthcare, LLC). Automatic reporting began in April 2016 and was fully configured by December 2017 for 13 fluoroscopy units used in interventional radiology and operating rooms. Dose threshold alerts were triggered if CAK exceeding 5 Gy for a single exam or 15 Gy cumulative CAK over a 6-month period. Historically, doses above the threshold were not encountered for units outside of interventional radiology although some of these units are still tracked by the software and/or manually audited. Starting in January 2019, manual recording of doses for all fluoroscopy procedures was made mandatory in the radiology information system. To ensure that no high dose events were missed, the manually entered doses were also reviewed monthly starting in January 2019. The new process steps are shown in the process map (Figure 1).

## RESULTS

In 2015 (baseline), 18 high dose events were detected. In 2018, after all capable units were configured to send to the dose tracking software, 24 high dose events were recorded. 21 cases were already detected in 2019 from January to March (see Figure 2). The high number of events in the first quarter of 2019 indicate annual high dose events several fold higher than reported at baseline in 2015. Two of the cases discovered at the monthly audit revealed an error in sending data to the dose tracking software. Several consecutive high dose alerts originated from one fluoroscopy unit, uncovering equipment malfunction after recent service. As a result of this timely discovery, the unit was decommissioned until it could be repaired, thus avoiding further patient overexposure.

## CONCLUSION

Automatic dose tracking of fluoroscopy exams revealed baseline underreporting of excessive dose events using a manual self-reporting process. Automated alerts enabled timely detection of equipment malfunction. A monthly remediation audit process was able to detect dose events that were not captured through the automatically via the dose tracking software. Two additional high dose events were detected through audits of manually recorded doses in the radiology information system. Although automated dose tracking improves event detection, process redundancy is important to ensure all high dose events are captured.

## Q1007-EB- SUA Improving Radioprotection Practices in the Operating Room

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## PURPOSE

Procedures using ionizing radiation are carried out in the operating room (OR) routinely. Except for radiology technologists, the surgical team, which includes anesthesiologists, anesthesiologists, instrument (scrub) nurses and surgeons, might not have an adequate radiation protection education and culture. The objective of this project was to objectively quantify the adherence to radiation protection practices in the operating room and establish guidelines for improvement through an observation checklist audit.

## METHODS

The use of the following radioprotection items was collected through a direct -observation checklist: • Lead aprons • Thyroid shield • Personal dosimeters • Leaded glasses • Leaded curtains on the operating tables • Warning signs at the door of the operating room For each item, its use was characterized as: • Satisfactory (S). • Partial compliant (PC). • Non-compliant (NC).

## RESULTS

In total, direct observation on compliance was obtained from 97 surgical interventions (Table 1) pre and post-improvement plan. After initial observations, a root cause analysis was performed for partial and non-compliant items and a plan for improvement initiatives was developed. The improvement actions identified for implementation included: - Ad hoc radioprotection course for anesthesiologists, scrub nurses and surgeons - Inclusion of a radioprotection checklist during time-out - Increase the number of thyroid shields and leaded glasses - Increased the number of OR tables with removable curtains and schedule surgeries that require higher radiation exposure times in those ORs.

## CONCLUSION

In the operating room, radiology technologists are the most complaint with radioprotection practices. Training ALL surgical staff being exposed to radiation is essential. However, in addition to education, making sufficient gear available and incorporating a radioprotection checklist during time out helps compliance of these important safety measures.

## Q1018-EB- SUA Impact of ABUS Implementation on Workflow in a Small Breast Center

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Participants

Serena Tidwell, MD,MBA, Columbus , GA (*Presenter*) Speaker, General Electric Company; Researcher, General Electric Company

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## PURPOSE

This work focuses on a small breast center opened in 2012. At the time of opening, breast density laws were gaining traction and the center offered hand held screening ultrasound "HHUS" for dense patients. The decision to offer HHUS was based on limited resources for equipment and lack of clarity on optimal technology. HHUS was time consuming and created challenging operational logistics. The center acquired automated breast ultrasound "ABUS" (GE Invenia) in January 2018. The purpose of this quality improvement report is to describe the center's experience with ABUS versus HHUS.

## METHODS

Patients screened using ABUS from February 1 - July 31, 2018 were analyzed for time required in the center (from check-in to check-out) to complete the exam, recall rates to include technical repeats and BIRADS 0 recalls, and pathology in patients who ultimately required biopsy. If the patients had prior HHUS the times for ABUS versus HHUS were analyzed. The center works with all patients to develop a custom screening program, with some patients electing same day MMG + US screening and others electing 6-month interval US. A total of 144 patients underwent ABUS alone during the time period with an additional 124 patients screened with ABUS + MMG. From this total group of 268 patients, 111 patients were identified who had prior HHUS and 82 patients who had prior HHUS + MMG.

## RESULTS

Addition of ABUS improved time required to screen dense patients. The attached charts compare the average times for ABUS vs. HHUS and ABUS + MMG vs. HHUS + MMG. Patients undergoing ABUS + MMG same day experienced a 49% reduction in time requirement. ABUS only patients experienced a 35.9% reduction. This reduction is optimal for patients and the center as it frees up time for the hand-held unit to be used for diagnostic exams. Operationally, the reduction in time yields an additional 5 dense patients daily potentially generating an additional \$300,736 in revenue annually (average Medicare reimbursement \$165.24 per patient). Additional gains in revenue would be recognized given more appointments for diagnostic ultrasound services. Time requirements were analyzed by month of implementation. Time was lowest at months three and four; however, these were also months with high rates of technical repeats. The average BIRADS 0 rate was 34%, with the highest rate of BIRADS 0 during the lowest patient volume month. Technical repeats were also highest in the lowest volume month, with the second highest volume of technical repeats being the months with the lowest time in the center per patient. The data support a learning curve with initial focus on operational efficiency creating lower times per patient in center yielding to awareness of image quality and technical repeats increasing times. The attached charts demonstrate time in the center for ABUS patients and ABUS + MMG for months 1-6. Finally, the results of patients who underwent biopsy based on ABUS findings were reviewed. Eleven patients were identified for whom biopsy was recommended based on findings at time of diagnostic imaging from initial ABUS recall. Of this group, 6/10 (60%) were benign: 1 fibroadenoma, 1 PASH and 4 benign with no further classification. Two of the biopsy patients were positive for CIS - one ALH / LCIS and one DCIS. There were two invasive cancers diagnosed (one infiltrating ductal and one lobular cancer). One patient has not had a biopsy. For the patients who were ultimately BIRADS 4, the positive predictive value of biopsy results was 40%. When this data was analyzed, all available patient follow-up was collected. Two additional cases of LCIS were diagnosed in this group, one at 8 months and one at 11 months. Both cases were women were in the staggered ABUS / MMG group and the biopsies were based off MMG findings at the time of the six-month interval MMG.

## CONCLUSION

The reduction in time to screen ABUS patients has been a positive experience in our center. Patients support the new technology and appreciate the shortened time requirements. Yet, implementation was challenging with high recall rates. We believe our experience will be helpful to others implementing ABUS. Specifically, we would recommend initial same-day reads and continuous monitoring of recall rates until work flow is firmly established. We identified two major improvement actions. First, continuously monitor recalls and when necessary implement same-day reads to identify cause. Second, we identified one interpreting Radiologist to be our ABUS 'champion'. Finally, we plan to analyze overall data for second quarter 2019 to compare to our 2018 implementation experience.

Printed on: 10/29/20



QIE-SUB

## Quality Improvement Reports Sunday Poster Discussions

Sunday, Dec. 1 1:00PM - 1:30PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI104-ED-SUB1 **Centralized Radiology Scheduling: How Improving Its Efficiency Can Improve Patient Access to Imaging and Satisfaction: A Close Examination of Key Process Steps and Process Metrics**

Station #1

#### Participants

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#### PURPOSE

Value based radiology continues to grow with its focus on Quadruple aim: improved patient outcomes, reducing costs, improving the patient experience, and improving the well being and experience of the healthcare provider. Patient access to medical imaging is a critical step towards value based imaging and scheduling is the key intake point that touches our patients early in the Radiology Value Chain. Large radiology practices use centralized scheduling as they benefit from pooling of scheduling resources, common shared knowledge and cost structure. However large centralized scheduling department can be plagued by the problems of decreased efficiency, leakage, reduce access times and radiology order errors. Although scheduling wait times have traditionally been used as the key process metric to measure access to imaging in the care delivery process, it does not capture additional workflow process improvement opportunities that are necessary to drive the overall patient outcome experience. In our experience, an integrated scheduling team with a operational micro team units of Callers, Schedulers and Pre-Auth/Benefits is essential to maximize on efficiency and also patient satisfaction. In this integrated Trio-POD ( Callers, Schedulers Pre Auth) there is significant cross training therefore further maximizing on patient scheduling Turn Around Times. An integrated multifunctional scheduling team also aids in alignment of the process metric toward improved access outcomes.

#### METHODS

We started out by extensively researching and studying the existing work flow and design of the centralized scheduling department. This was followed by a site visit with a team that included multidisciplinary staff (radiologist, IT person, Business support analysts) to gather data on work flow focusing on the bottle necks in the process chain and to assess the resource allocation and productivity of the teams. Data was collected on the call process metrics, access times, scheduling process times and staff productivity and utilization. Additional effort was also made to assess the impact on quality which primarily included measuring the percentage of scheduling errors. After a thorough analysis of a priority risk scoring (heat map) was created to address high impact and easy targets to achieve were charted. Key areas of improvement were identified in the work flow design and the need to integrate scheduler-Caller-Pre Auth teams and ensure visibility of the work across these three domains. Using Six Sigma Lean approach tools, solution pathways with key measuring metrics to assess progress were adapted by an operational excellence team. Key strategic target goals included: A: Redesign the work flow of scheduling & pre Authorization with elimination of waste. B: Create a cross functional units ( A Trio Pod Model) of call handlers, schedulers and Authorization experts. C: Electronic Enhancements to current patient call reminders. D: Visibility and accurate reporting of scheduling access and process metric monthly to operational committee. E: Update all Radiology protocols. F: Increase centralized scheduling staff and measure productivity.

#### RESULTS

Significant improvement in the scheduling process metrics especially the call to wait times decreased from 4min 23 sec to 1 min 55 sec over 5 months (March to July 2018) for the same degree of call volumes/per month. There was also significant decrease in the ACR ( Abandonment call rates) from 19.5% to 11.5% over the same time frame. As part of sustainability of the operational excellence project the current ACR are around 2.5% below industry standards. In terms of the patient Access to imaging schedules the 1st and 3rd available dates for MRI exams also reduced from few week to less than 5 days.

#### CONCLUSION

Centralized scheduling performance efficiency is critical for improved access and patient satisfaction. Although, most practices put more emphasis on operational improvements from time of patients arrival for scan to report delivery bottlenecks in central scheduling can have significant impact on revenues as well. Radiology scheduling for large practices including academic centers have complex work flows secondary to variations in the physician practices, therefore it is important to understand their preferences and need for expedited appointments. We propose for an integrated scheduling model with highly functional units working as TRIO-POD which includes Callers-Schedulers-Authorization experts, an efficient cross functional team to improve throughput and more importantly improved patient experience driven by prompt service and confirmation. Finally we recommend the

departmental operational teams be well informed of the scheduling process metrics looking beyond access times, a window that can shed light on referral leakage.

## **Q1105-ED- SUB2 "United We Stand"; Contrast Reaction Management Training for Outpatient Imaging Centers with Emphasis on Teamwork**

Station #2

### **Participants**

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### **PURPOSE**

Life-threatening reactions to contrast media warrant prompt response by a well-prepared team. Building cohesive teams with an appropriate level of training can be challenging but is especially important at outpatient imaging centers with limited access to hospital services. The aim of this project was to create capable, well-trained teams by restructuring contrast reaction training in a large private practice's outpatient imaging centers. Teams of respondents include radiologists, radiology residents, nurses, radiology technologists, and patient care assistants (PCA). Our training program included over 130 personnel from these diverse roles.

### **METHODS**

The impetus for our project was a potentially life-threatening contrast reaction, leading to a root cause analysis which revealed major deficiencies in our practice's contrast reaction management. Subsequently, two radiologists attended a reaction management training course in 2018, assisting in development of an interdisciplinary three-phase plan to revamp the existing contrast reaction management training: 1. Standardization - ensuring identical emergency contrast reaction boxes at each outpatient center. 2. Education - using multiple modalities, teach staff about reactions and how to manage them. 3. Simulation - participants attend a 2 hour simulation lab workshop, managing contrast reactions in small groups utilizing an interactive robotic patient. To standardize equipment at outpatient imaging centers, two instructors visited each location, assessed the equipment, and interviewed technologists, nurses, and pharmacists about current contrast reaction practices. This information was used to standardize and simplify the emergency contrast reaction boxes (figure 1). Briefing sessions were provided when the boxes were delivered to the outpatient imaging centers. The second phase was comprised of an educational presentation covering contrast agents, contrast reactions, and how to respond to them. This brief was distributed with associated pre/posttests to nurses and physicians online and via a hands-on workshop to technologists and PCAs. After reviewing the presentation, it became apparent that a preparatory step between slides and simulations would be helpful to improve the readiness and confidence of participants and to use the costly simulation lab time most efficiently. Therefore, we created professionally recorded videos of five contrast reaction scenarios and appropriate medication usage. These videos proved to be a vital component of our training program and were available to participants prior to their simulation lab experience. Finally, interactive simulations of six contrast reaction scenarios were scripted: hives, bronchospasm, laryngeal edema, vasovagal, anaphylaxis, and multi-symptom. Employees participated in the simulation lab experience in teams of 4-6, comprised of at least one physician plus technologists, nurses, and PCAs. The standardized emergency reaction box was utilized during simulations. Pre/posttests were provided, as well as a qualitative survey regarding the entire training experience.

### **RESULTS**

Data was collected from multiple choice tests administered before and after each phase and qualitative surveys. Technologists and PCAs were issued different exams from nurses and doctors. Prior to training, average pretest scores were 65% in the MD/Nurse group and 67% in the Tech/PCA group. Statistically significant improvements in pre/posttest scores were made by each group during the first two phases ( $p < 0.05$ ). Posttest scores improved with each phase of training (Table 1). Simulation lab pretest tech/PCA average score was 93% and 90% by the MD/Nurse group. Statistically significant ( $p < 0.05$ ) improvements were made by both groups upon the completion of this training program when initial pretests and final posttests were compared. Lastly, qualitative survey results demonstrated positive feedback with a preference for video and simulation lab training over educational slides and hands-on workshop. Many participants indicated lack of equipment standardization or knowledge of its use as a significant barrier to managing reactions prior to completing training.

### **CONCLUSION**

Participants showed meaningful improvement through each step of this training program. Ultimately, using multiple learning modalities, test scores prior to the simulations were above 90%, improving from an initial average of 65% before any training. It was evident that teams were well-prepared for the simulation labs with strong pretest test scores and, subjectively, their success in treating the simulated contrast reactions. Cost may be a barrier to simulation training, and having well-prepared participants allowed us to use lab time efficiently. The qualitative data collected reinforced the success of this three-part training program for all participants. We plan to utilize surveys in the coming months to measure the current comfort level of teams responding to contrast reactions after this vigorous training.

## **Q1106-ED- SUB3 A Comprehensive Lean Strategy to Improve Patient Access to MRI Examinations in an Integrated Multispecialty Practice**

Station #3

### **Awards**

#### **Quality Improvement Reports Award Identified for RadioGraphics**

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#### **PURPOSE**

MRI is a high cost imaging resource that requires detail-oriented processes to ensure safe, high-quality care. The complexity of managing MRI resources is often a utilization challenge; however, timely access to MRI can be a major satisfier for patients and referring providers. In our integrated multispecialty practice, we noticed an insidious prolongation of our MRI access metrics. To address this issue, we assembled a cross-functional stakeholder team that utilized lean principles to improve MRI access.

#### **METHODS**

This quality improvement project was performed in an integrated healthcare system that serves 650,000 members, interprets 450,000 imaging exams per year, and employs 27 radiologists and 231 technologists and support team members. In June 2018, an interdisciplinary team created a smart goal of decreasing the average days wait by 50% (from 15 to 7.5 days) and creating capacity to meet demand for same day and next day MRI appointments by December 31, 2018. The project team analyzed the process for obtaining and interpreting an MRI. Benchmarking data and best practices were obtained from several peer institutions and from medical literature review. Working groups were assembled to identify and capture opportunities to create standard work, increase practicing to top of scope, remove waste, improve communication, reduce rework, and improve patient experience in every aspect of our MRI processes (Table 1). Working group stakeholders included patients, ordering providers, schedulers, imaging managers, business analysts, MRI technologists, and radiologists. Schedulers identified and removed holds and blocks and converted to an open, patient-centered scheduling template that allowed patients to freely book into appointment time slots. Imaging managers and our business analyst created processes to increase staff situational awareness, including a daily oversight strategy. Managers also performed daily schedule reviews to ensure few gaps and few low utility exams were performed. Radiologists redesigned MRI protocols to either meet or exceed quality and scan time of available external benchmarks. The MRI protocol selection process was codified and transferred to MRI technologists to enable them to practice at top of scope. MRI appointment time slots were decreased from 40/60 mins (noncontrast/contrast) to 30/45 mins. The primary outcome was patient access to MRI was the average days wait (i.e., the number of days from when the patient calls to schedule an MRI examination to the day of the patient's appointment). Secondary outcomes included time to the third available appointment (a lead metric for patient access measured each Tuesday at 4pm), availability of same day and next day appointments, MRI scan time lengths, MRI patient volumes, the number of provider outreaches performed by medical imaging for order changes, the number of technical call-back scans, and overall patient satisfaction. Differences were compared using an unpaired t-test with an alpha level of 0.05.

#### **RESULTS**

Figure 1 demonstrates the lag metric for MRI access, average days wait, decreased from 14.2 days to 5.8 days after intervention (-8.4 days, -59.2%,  $P < 0.0001$ ). The lead metric for patient MRI access, third available appointment, decreased from 18 days on May 1, 2018 to 0 days and was sustained from January through March 2019 (-16 days, -100%). Figure 2 demonstrates that technical callback rate was not changed during the intervention. Figures 3 and 4 demonstrate improvements in patient satisfaction metrics that coincided with this intervention. Pre (4/1/18-6/23/18) to post implementation (1/6/19-3/30/19) metric analysis demonstrated: average scan time decreased from 27.7 to 24.8 (-2.9 mins, -10.5%,  $P < 0.0001$ ), patient exam counts increased from 3,357 to 3,834 (+477 patients, +14.2%,  $P < 0.0001$ ). Total exam volume increased 4.2% in Q1 2019 compared to Q1 2018. 10 to 20 same and next day appointments were routinely available beginning in November 2018.

#### **CONCLUSION**

This project resulted in significant gains in patient access to MRI exams as measured by improvements in lead and lag access metrics as well as increases in the number of same day and next day MRI appointments. Scan times decreased, and patient volume increased after the interventions, confirming gains in operational efficiency at the same time we maintained quality and improved patient satisfaction. Our imaging department now routinely has 10-20 same day and next day MRI appointments, which more effectively matches our supply and demand. Noting that many patients have other commitments and nonurgent exam needs, the average days wait of 5 days reflects a balance of having availability for immediate appointments and openings to meet patient preference. Our findings demonstrate the value of applying lean management principles to enable significant improvements in a complex process such as MRI access.

#### **Q1107-ED-SUB4 Improving Accuracy and Reliability of TIRADS Reporting with Novel Automated Points-Based Template**

Station #4

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#### **PURPOSE**

The American College of Radiology published the thyroid imaging reporting and data system (TIRADS) criteria in May 2017. We questioned the reliability of the radiologist-reported TIRADS score and final management recommendations with free-form style radiologist reporting.

## METHODS

At our institution, a template to directly convert the ultrasound findings into a calculated TIRADS score was built by a Body Imaging faculty member in May 2017, and integrated into our dictation software, to eliminate the biases of free-form reporting. While radiologists using free-form reporting simultaneously calculate the TIRADS score while dictating the ultrasound findings, a points-based template that has entry fields for all the criteria can increase the accuracy and reduce the bias associated with TIRADS assignment. The adoption of this points-based template by the reading radiologists was adopted in a rolling fashion, with a trial period that lasted several months. Inclusion of the TIRADS score within the radiologist report was encouraged, regardless of whether or not the template was used.

## RESULTS

Between 2016 and 2018, nodules on thyroid ultrasound that were recommended for imaging or biopsy were included in our study. For each of the 953 such thyroid nodules, the radiologist-reported ultrasound findings, TIRADS score, and final recommendations were recorded. 721 of the nodules were evaluated after TIRADS criteria adoption at our institution in May 2017, and among these, 534 nodules were evaluated with the use of the points-based standardized template. The remainder were evaluated prior to TIRADS criteria adoption in 2016. For 953 thyroid nodules, we calculated expected TIRADS scores, using ACR criteria and reported ultrasound findings, and then compared these with the observed TIRADS scores in the radiologist report. The expected recommendations for recalculated TIRADS scores were based on the ACR criteria and compared with the observed recommendations in the radiologist report. Chi-squared tests between observed and expected subsets were used to analyze for statistical significance. 473 of 534 nodules assessed with the standardized template had an expected TIRADS score that matched the observed TIRADS score, while only 60 of 187 nodules assessed with free-form reporting after May 2017 had matching scores (89% versus 32%, statistically significant). (Figure 1). 16 of 232 thyroid nodules (7%) evaluated prior to May 2017 adoption of TIRADS criteria had observed recommendations that matched the expected recommendations. This improved to 41% (77 of 187) after adoption of ACR TIRADS criteria in May 2017 among all free-form radiologist reports, which further improved to 56% (297 of 534) with use of our TIRADS standardized template (statistically significant) (Figure 2). 65% of the thyroid nodules studied (121 of 187) should not have been recommended for further management per ACR criteria based on expected TIRAD scores of TR 1, 2, 3 (<1.5 cm), or 4 (<1.0 cm). In comparison, among the 534 nodules reported with our standardized template, only 27% (142 of 534) had these expected TIRADS scores (Figure 3), while 73% had TIRADS scores that require further workup by ACR criteria.

## CONCLUSION

Using a standardized template for thyroid ultrasound reports can improve the accuracy of the TIRADS score, improve the reliability of recommendations for further management communicated to the clinician, and prevent unnecessary workup. Collaboration with the Endocrinology faculty and neuroradiology faculty is underway to implement ACR's R-SCAN tools to further improve interoperability of the thyroid ultrasound dictation among reports that use the new TIRADS template at our institution.

## Q1029-EB- SUB State-Mandated Breast Density Notifications: Can They Be Less 'Dense'?

Hardcopy Backboard

### Participants

Derek Nguyen, MD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Emily Ambinder, MD, MSc, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Mary K. Jones, MA, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Lisa A. Mullen, MD, Cockeysville, MD (*Abstract Co-Author*) Nothing to Disclose  
Susan C. Harvey, MD, Lutherville, MD (*Abstract Co-Author*) Consultant, Hologic, Inc; Consultant, IBM Corporation

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## PURPOSE

For the past decade, increased awareness of the relationship between dense breast tissue and breast cancer risk has led to state legislatures requiring notification statements alerting women that breast tissue density may impact their health. Currently, breast density notifications (BDNs) have become mandatory in 36 states. BDNs are mailed directly to women as a component of their screening mammogram lay letter. Thus, women are expected to comprehend the notification independently, creating a substantial potential for misinterpretation. This has increased the importance of comprehension of written patient communications. Since 2016, the complex language of state-mandated BDNs has been challenged, as it is perceived to be beyond the comprehension of most patients. Yet, no attempts have been made to improve these notifications. Thus, our aim is to assess whether a revised BDN written at an appropriate reading level can improve perceived lifetime breast cancer risk and likelihood of patient-initiated discussion with their providers regarding their breast density compared to the current state-mandated BDN.

## METHODS

The Flesch-Kincaid grade level was utilized to assess the readability of our current state-mandated BDN. A revised notification with similar content formulated at a lower reading grade level was developed. Both notifications were presented to patients for direct comparison, via a paper survey asking questions to evaluate patients' perceived lifetime breast cancer risk and likelihood to discuss breast density with their providers. The survey also recorded age range (e.g., '41-50 years old'), race, highest level of education achieved, and if the patient is a health care provider. The IRB at our institution acknowledged this as a quality improvement project exempt from approval. Surveys were distributed to screening mammography patients at four institutional outpatient imaging centers. Simple randomization was utilized to distribute the surveys in the waiting rooms along with standard intake forms between January 2019 and February 2019. The categorical survey responses were compared between the two surveys using McNemar's test. The Chi-square test was used to evaluate for different distributions of selecting the correct perceived risk and likelihood of initiated discussion for each notification for selected sociodemographic variables. Multivariate analysis was performed for statistically significant variables. For all analyses,  $p < 0.05$  was considered statistically significant.

## RESULTS

The Flesch-Kincaid grade level of the current state-mandated and revised BDN were 12th and 5th grade level, respectively. 500 surveys were analyzed: 283 patients obtained less than a college degree and 217 patients obtained at least a college degree. Survey data demonstrated 56.6% (283/500) of all women perceived dense breast tissue results in a 'high' lifetime risk of developing breast cancer from the current state-mandate BDN compared to only 2.2% (11/500) with the revised BDN ( $p < 0.001$ ). With the current notification, the majority of patients who responded with a perceived 'high' lifetime breast cancer risk achieved less than a college degree (74.9%) [212/283]. Nearly all women were more likely to initiate a discussion with their provider regarding their

breast density after reading the revised BDN (96.0%) [480/500] as opposed to the current BDN (32.8%) [164/500],  $p < 0.001$ . Similar to perceived lifetime breast cancer risk, the majority of patients who were unlikely to discuss breast density with their providers after reading the current BDN achieved less than a college degree (72.0%) [242/336]. On multivariate analysis, education level was a statistically significant sociodemographic factor in selecting the correct perceived breast cancer risk in the current BDN when adjusting for race and being a health care provider (odds ratio 9.02, 95% CI 3.16-25.71). On multivariate analysis, education level was a statistically significant sociodemographic factor for being likely to discuss breast density with her provider with the current BDN when adjusted for age (odds ratio 9.8, 95% CI 3.4-28.0).

## CONCLUSION

Patient directed written materials that exceed the national recommendation of 6th to 8th grade reading level may lead to patient misunderstandings and potentially result in poor compliance. Our study emphasizes the importance of readability and its direct effect on not only improving women's health literacy, but also encouraging women to have an active voice in their own personalized care. Thus, it is imperative to revise any state-mandated breast density notifications written higher than an 8th grade level to decrease the misperceptions related to breast density notifications. This will facilitate better understanding of the notification and improve the quality of individualized breast cancer screening for women with dense breasts.

## Q1019-EB- SUB Using Point-of-Care Patient Photographs with Musculoskeletal Radiography to Identify Errors of Laterality in Emergency Department Imaging

Hardcopy Backboard

### Participants

Shenise N. Gilyard, MD, Decatur, GA (*Presenter*) Nothing to Disclose

Keith D. Herr, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Damian Dyckman, MD, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Matthew E. Zygmunt, MD, Decatur, GA (*Abstract Co-Author*) Nothing to Disclose

Jamlik-Omari Johnson, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Amanda Chahine, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Tarek N. Hanna, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To reduce errors in laterality in musculoskeletal imaging by evaluating the utility of point-of-care extremity patient photographs accompanying musculoskeletal radiography.

## METHODS

352 consecutive musculoskeletal (MSK) radiograph-photograph combinations and corresponding radiography provider orders between October 1, 2018, and January 31, 2019, were retrospectively reviewed. Photographs were obtained simultaneously with the radiographs using the PatCam System (Camerad Technologies, Decatur, GA). In each case, laterality was recorded for all photographs, radiographs (based on lead side markers), and radiography orders. Any laterality discrepancy among these variables was recorded. The side indicated on the provider order was taken as the gold standard.

## RESULTS

347 consecutive MSK radiograph-photograph combinations from 253 unique patients consisted of 129 upper extremity (shoulder, humerus, elbow, forearm, wrist and hand) and 218 lower extremity (hip, femur, knee, tibia/fibula, ankle and foot) radiographs. In total, two discrepancies in laterality were identified, 0.58% of the total sample. The first discrepancy consisted of a left foot radiograph, which was labeled as "R" on the radiograph and left in the order. In this case, the patient photograph confirmed with certainty that the incorrect side marker was placed. The second discrepancy consisted of a hip radiograph, in which one of three total images had discrepant L/R labeling; in this case, the patient was covered with a sheet, and both hips were included in the photograph; however, a monitoring device on the patient's left side in the photograph included on the radiographs was used to determine which film was incorrectly labeled.

## CONCLUSION

In our study, over 1 in 200 patients was identified as having an error in labeling of laterality on radiographs. Patient photographs obtained concurrently with MSK radiographs can provide a valuable quality tool in identifying errors of labeled laterality. Obtaining patient extremity photographs at time of MSK radiography has the potential to reduce right-left errors by introducing additional visual data to confirm laterality.

Printed on: 10/29/20



RC123

## Making Patients and Staff Safer in Interventional Procedures

Sunday, Dec. 1 2:00PM - 3:30PM Room: E353A

**IR** **PH** **SQ**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

William F. Sensakovic, PhD, Scottsdale, AZ (*Coordinator*) Founder, Telerad Physics Teaching, LLC  
Thaddeus A. Wilson, PhD, Madison, WI (*Coordinator*) Nothing to Disclose

### For information about this presentation, contact:

wfsensak@gmail.com

### LEARNING OBJECTIVES

1) Describe cataract and cancer risks associated with typical interventional radiology procedures and workload. 2) Develop and assess institutional policies for implementing radiation dose tracking and auditing in the interventional setting.

### Sub-Events

#### RC123A Patient Doses (in lab) and Patient Dose Management

Participants

Stephen Balter, PhD, New York, NY (*Presenter*) Speakers Bureau, MAVIG, GmbH

### LEARNING OBJECTIVES

1) Understand how in-lab radiation displays and post-procedure radiation use data can be used to optimize patient safety.

### Active Handout: Stephen Balter

[http://abstract.rsna.org/uploads/2019/18001937/Active\\_RC123A.pdf](http://abstract.rsna.org/uploads/2019/18001937/Active_RC123A.pdf)

#### RC123B Staff Protection: Cataract and Potential Cancers

Participants

Madan M. Rehani, PhD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Explain the results from the studies among interventionalists and support staff on eye lens opacities and comprehend the risks. 2) Identify the evidence or lack thereof of cancer risk among interventionalists. 3) Identify the protective measures for staff in interventional suites.

#### RC123C Dose Tracking and Audits: Institution-wide Program

Participants

Pei-Jan P. Lin, PhD, Richmond, VA (*Presenter*) Nothing to Disclose

Shelia Regan, MEd, Richmond, VA (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Learn how the 'event-by-event' RDSR data exported from the patient radiation dose monitoring and tracking (PRDMT) systems may be employed to better estimate the peak skin dose (PSD) from fluoroscopy equipment. 2) The estimated PSD is then classified into three 'alert level' which leads to a better patient care through a follow up process which will be described in detail at the presentation. 3) Identify establishment of a Clinical Radiation Safety Office (CRSO) to handle the technical aspect of PRDMT and administrative processes of 'documentation' and 'patient follow up' is the key to a successful patient care. 4) It is necessary to establish CRSO as an enterprise wide office to govern the entire process and functions provided by the CRSO. It is essential to learn that successful PRDMT requires both the 'organization' must be setup and it must be properly staffed with qualified 'personnel'.

### ABSTRACT

The internal organization structure is described in detail including the 'alert Levels' and what comes next upon receiving the alerts. The Clinical Radiation Safety Office (CRSO) established at VCU Medical Center plays major key rolls in (1) the patient radiation dose monitoring and tracking (PRDMT) and (2) follow up of patients who received 'confirmed' peak skin dose that is required by the Hospital Policy to follow post fluoroscopy examinations as part of VCU's patient care. The key is to establish a Clinical Radiation Safety Office which manage the technical aspect of PRDMT and follow up of patients process. In other words, an institutinal, enterprise wide organization must be created to handle the total patient care for patients who received high dose radiation which could result in deterministic injury.

**Active Handout:Shelia Regan**

[http://abstract.rsna.org/uploads/2019/18001939/Active RC123C.pdf](http://abstract.rsna.org/uploads/2019/18001939/Active_RC123C.pdf)

**Active Handout:Shelia Regan**

[http://abstract.rsna.org/uploads/2019/18001939/Active RC123C.pdf](http://abstract.rsna.org/uploads/2019/18001939/Active_RC123C.pdf)

Printed on: 10/29/20



RC227

## Health Policy and Practice Series: Health Policy & Quality-Buy-in, Metrics, and Motivation

Monday, Dec. 2 8:30AM - 12:00PM Room: S501ABC

HP SQ

AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credit: 0

### Participants

Nadja Kadom, MD, Atlanta, GA (*Moderator*) Nothing to Disclose  
Anil N. Kurup, MD, Rochester, MN (*Moderator*) Research Grant, Galil Medical Ltd; Research Grant, EDDA Technology, Inc; Royalties, Wolters Kluwer nv  
Neville Irani, MD, Kansas City, KS (*Moderator*) Nothing to Disclose  
Shlomit Goldberg-Stein, MD, Bronx, NY (*Moderator*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Negotiate for buy-in (Goldberg-Stein). 2) Identify and mitigate for diagnostic error (Itri). 3) Apply methods for motivating people. 4) Relate knowledge acquired during this session to a real-world example (Duong).

### ABSTRACT

n/a

### Sub-Events

#### RC227-01 How to Get Buy-in

Monday, Dec. 2 8:30AM - 8:50AM Room: S501ABC

### Participants

Shlomit Goldberg-Stein, MD, Bronx, NY (*Presenter*) Nothing to Disclose

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sgoldberg@montefiore.org

### LEARNING OBJECTIVES

1) Classify stakeholders according to their stake (power, agency, constituency) and stance (supporters, undecideds, dissenters). 2) Identify sources of power and motivation used to influence stakeholders. 3) Describe four methods to move an undecided stakeholder from inaction to action.

#### RC227-02 Radiology Patient Outcome Measures: Impact of a Multifaceted Departmental Initiative on Key Quality and Safety Performance Indicators

Monday, Dec. 2 8:50AM - 9:00AM Room: S501ABC

### Participants

Sheila S. Enamandram, BS, MBA, Brookline, MA (*Presenter*) Nothing to Disclose  
Pragya A. Dang, MD, Lexington, MA (*Abstract Co-Author*) Nothing to Disclose  
Wendy Mar, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Cynthia Centerbar, Brookline, MA (*Abstract Co-Author*) Nothing to Disclose  
Giles W. Boland, MD, Wellesley, MA (*Abstract Co-Author*) Nothing to Disclose  
Ramin Khorasani, MD, Roxbury Crossing, MA (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To assess impact of a novel, multifaceted implementation of Radiology Patient Outcome Measures (RPOMs) on radiologist performance for key quality issues of reporting timeliness, safety, and peer-learning.

### METHOD AND MATERIALS

This Institutional Review Board-approved retrospective study was performed at a large academic radiology department in an urban tertiary medical center. RPOMs were implemented 10/1/17-9/30/18 (fiscal year 2018, FY2018) measuring report timeliness, critical results communication, and generation of peer-learning communications between radiologists. Department-wide targets were specified, performance was transparently communicated and updated daily on an institutional intranet dashboard, and accountability was financially incentivized quarterly. Primary outcome was change pre-RPOMs (FY2017, 10/1/2016-9/30/2017) versus post-RPOMs (FY2018) in monthly 90th percentile time from scan completion to final report signature (CtoF). Secondary outcomes were distributions of individual radiologists and subspecialty divisions meeting quarterly targets for critical results communication, finalized signature times, and peer-learning communications. Statistical process control (SPC) analysis was performed to assess for temporal trends.

## RESULTS

1,255,771 reports were generated (613,273 pre-RPOMS) across 13 divisions and 142 radiologists during the study period. Monthly 90th percentile CtoF exhibited an absolute decrease of 4.4 hours (21.1-16.7 hours) and 20.9% relative decrease between 10/2016 and 9/2018. SPC analysis demonstrated significant sustained decreases in 90th percentile CtoF starting 10/2017 ( $p < 0.003$ ). Between 95% (119/125, 7/1/18-9/30/18) and 98.4% (126/128, 10/1/17-12/31/17) of radiologists achieved >90% timely closure of critical alerts; >99% radiologists achieved 80th percentile preliminary to final report signature time <6 hours each quarter; and all divisions exceeded target of >90 (range: 97-472) peer-learning communications each quarter after 1/1/18.

## CONCLUSION

Incentivizing departmental performance via RPOMS implementation increased timeliness of radiology report generation and timely critical alert acknowledgement.

## CLINICAL RELEVANCE/APPLICATION

Implementing imaging-related quality and safety measures via a multifaceted, leadership-driven approach can yield synergistic improvements in key indicators of physician and departmental performance.

### RC227-03 Creating and Psychometrically Validating a Radiology-Specific Patient Satisfaction Survey

Monday, Dec. 2 9:00AM - 9:10AM Room: S501ABC

#### Participants

Valerie Ryan, MA, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Grayson L. Baird, PhD, Providence, RI (*Presenter*) Nothing to Disclose  
Elizabeth H. Dibble, MD, Barrington, RI (*Abstract Co-Author*) Nothing to Disclose  
David W. Swenson, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Terrance T. Healey, MD, North Scituate, RI (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

We created and implemented a survey tailored to evaluate radiology patients' satisfaction with five dimensions of care. This survey is adapted to identify areas of care that could be improved for radiology practices. The present study psychometrically validates this radiology-specific survey.

#### METHOD AND MATERIALS

We developed a survey to measure five dimensions of care: 1.) attributes of making an appointment, 2.) attributes of arriving at the facility, 3.) attributes of registration, 4.) attributes of the radiology procedure, and 5.) attributes of the facility itself. Each dimension included three to five questions. Each question was answered using a Likert-type seven-point response scale ranging from very dissatisfied to very satisfied. We also collected data on type of procedure, facility, if patients met with a radiologist, how patients would rate their overall health, whether or not the survey was too long, and basic demographics. The survey was implemented at 13 radiology offices using Qualtrics Software (Qualtrics, Provo, UT). Preliminary analyses were conducted using survey responses collected from August 2018 through January 2019, N = 6,968. Validation of our five dimensions of care was accomplished using confirmatory factor analysis (CFA). Internal consistency was examined using Cronbach analysis. Patient satisfaction was analyzed using generalized mixed modeling. Analyses were conducted using SAS Software 9.4.

## RESULTS

The total sample was N= 6,968. The five dimensions of care were confirmed using the confirmatory factor analysis achieving the best fit (as well as very good fit) with the 5-factor model, relative to other factor models, (CFI: .95, SRMR 0.0481, GFI .92). Cronbach Coefficient Alpha was .94, indicating very high internal consistency. Item analysis showed that no applicable items were consistently skipped and 85% of participants said the survey was not too long. We also found that patients reported high satisfaction on all dimensions across imaging modalities and practice offices.

## CONCLUSION

The factor analysis and Cronbach analysis provides evidence for this survey having good psychometric properties: construct validity for the 5 dimensions of care and high internal consistency among the items. This survey is intended to be used for and benefit radiology practices.

## CLINICAL RELEVANCE/APPLICATION

Our radiology-tailored survey achieved good psychometric properties and can be used by other radiology practices.

### RC227-04 Learning from Simulation Models to Balance Resource Utilization and Patient Satisfaction in Diagnostic Radiology in a Hospital Setting

Monday, Dec. 2 9:10AM - 9:20AM Room: S501ABC

#### Participants

Lorraine Kelly, ARRT, RT, Burlington, MA (*Presenter*) Nothing to Disclose  
Patricia A. Doyle, MBA, RT, Burlington, MA (*Abstract Co-Author*) Nothing to Disclose  
Usha Nandini Raghavan, Cambridge, MA (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

Under constant pressure to cut costs and improve resource utilization, we wanted to assess the quality of our X-Ray (XR) workflow as it relates to patient satisfaction, particularly patient wait times. Specifically we tried to answer the following questions: a) are the current resources sufficient to handle demand (including walk-ins), b) can reduction of resources be justified without compromising patient satisfaction, and c) assess how "unrestricted-same day add" scheduling affects patient wait times and identify improvement opportunities. Patient demand in diagnostic radiology is variable and appetite for resource scheduling in the

clinic setting is low.

## RESULTS

a) Are existing resources sufficient to manage the current demand? The baseline simulation model was tweaked by adding 1% more volume during the hours of operation. This new simulation model showed an increase in patient wait times compared to the baseline, but the changes were not too drastic. In particular, patients who waited 30 minutes or longer after arrival increased by 3% points. It is safe to conclude that the existing resources and workflow can handle a 1% increase in volume over the next three years. b) Can reduction in resources be justified without compromising patient satisfaction? Keeping all else equal (i.e. patient arrival times and exam durations), the baseline simulation model was tweaked by removing one resource. This new simulation model showed a drastic increase in patient wait times. Overall, patients waiting 30 minutes or longer increased by 21.7% points or 21 more patients per day. c) Assess how unrestricted scheduling affects workflow KPIs and identify improvement opportunities. Data from RIS showed that about 40% of patients are un-scheduled (i.e. walk-ins). The remaining 60% of scheduled arrivals are removed and then added back into the data by evenly distributing them between 8am and 5pm. This was done to mimic a more balanced schedule (as opposed to an unrestricted scheduling in the current practice). The simulation model with this new arrival pattern showed an improvement in patient wait times. In particular, the percentage of patients waiting 30 minutes or longer decreased by 8% points. Further, patients seen within 15 minutes of arrival increased by 15% points.

## CONCLUSION

With the existing resources it will be feasible to maintain the current patient satisfaction KPIs even as the volume grows by 1% over the next three years. On the other hand, any reduction in resources can have a detrimental effect on patient satisfaction. Future opportunities for improvement include review of available scheduling template options in our RIS to provide more "balanced scheduling" and consideration of developing a pilot scheduling process with our high volume ordering departments such as Orthopedic Surgery or Rheumatology to evaluate the impact of resource specific scheduling for their patients. Simulating scenarios have been an effective way of assessing quality of service and improvement opportunities without making any disruptive changes to the existing workflow.

## METHODS

We used simulation based scenario modeling to perform quality assessment of our XR resource. Our department has dedicated resources for ED and general internal medicine, as well as, portable XRs for inpatient services. Aside from these dedicated services, there are six resources (i.e. exam rooms) available for general demand (that includes orthopedics, rheumatology etc.). Our focus for this paper is on these six resources only. Data from the first quarter of 2019 was analyzed for the hours of operation on weekdays between 8am and 5pm. Data points such as exam durations and patient arrivals are obtained from RIS (Radiology Information System powered by EPIC). In this time period a total 6,804 exams were performed (40% of these were walk-ins) with an overall resource utilization of 48%. However, depending on the hour of the day and day of the week; it can rise up to 99%. Patient wait times also follow a similar pattern. That is, overall, only 12% of the patients had to wait 30 minutes or longer after arrival to be seen. However, depending on the hour of the day and day of the week, it can increase to 21%. Simulation of the current workflow was modeled and built using FlexSimHC Software [<https://healthcare.flexsim.com/>]. Patient wait time from this simulation model was in good agreement with the empirical data obtained from RIS. The simulation model accurately captured the percentage of patients waiting 30 minutes or longer (11.72% in empirical compared to 11.12% in simulation).

## RC227-05 Radiologists Commit More Errors in Interpreting After-Hours Abdominal CT Studies during Overnight Shifts as Compared to Similar Length and Frequency Daytime Shifts

Monday, Dec. 2 9:20AM - 9:30AM Room: S501ABC

### Participants

Maitray D. Patel, MD, Paradise Valley, AZ (*Presenter*) Nothing to Disclose

Victor J. Pizzitola, MD, MPH, Scottsdale, AZ (*Abstract Co-Author*) Nothing to Disclose

Anika Patel, Paradise Valley, AZ (*Abstract Co-Author*) Nothing to Disclose

C. Daniel Johnson, MD, Scottsdale, AZ (*Abstract Co-Author*) License agreement, General Electric Company License agreement, E-Z-EM, Inc

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## PURPOSE

To analyze whether there is a difference in the rate of clinically significant interpretation errors for CT examinations of the abdomen and/or pelvis ('abdominal CT studies') initially interpreted by board-eligible on-call radiology fellows based on whether the shift was at night or during the day.

## METHOD AND MATERIALS

Between July 2014 and June 2018, 32 board-eligible radiology fellows training in either Body MR, MSK Imaging, or Breast Imaging independently interpreted 10,090 abdominal CT studies during in-house call shifts. On-call shifts on weekends and holidays were either from 07:00-18:00 ("day") or 18:00-07:00 ("night"). On call shifts on weekdays were from 20:00-07:00 ("night"). All fellows had at least 11 hours off prior to the start of any shift; fellows took no more than 5 consecutive call shifts before having at least 48 hours off. Studies and finalized reports were reviewed within 10 hours of initial dictation by a member of the Abdominal Division faculty, and interpretation discrepancies that affected either acute or follow-up care were documented as "affecting care". The rate of errors affecting care were compared for day and night call shifts.

## RESULTS

During day call shifts, interpretation errors affecting care were identified in 58 of 3126 abdominal CT studies (1.9%). During night call shifts, interpretation errors affecting care were identified in 226 of 6964 abdominal CT studies (3.2%). The difference in the error rate is statistically significant. For 19 fellows, the night error rate was  $\geq 1\%$  higher than the day error rate. For 3 fellows, the night error rate was  $\geq 1\%$  lower than the day error rate. For 10 fellows, the night and day error rates were within 1% of each other.

## CONCLUSION

Collectively, radiology fellows committed clinically important abdominal CT interpretation errors at higher rates during night call

shifts as compared to day call shifts, even when rested. Substantially more fellows made more mistakes at night.

#### CLINICAL RELEVANCE/APPLICATION

Abdominal CT studies interpreted at night by radiologists who routinely work during the day merit more quality assurance scrutiny, even when the radiologists have the usual amount of time away from work prior to the start of their shift. Patients may benefit from subspecialty review of studies initially interpreted at night by rotating radiologists even if those radiologists have completed residency training.

#### RC227-06 Cognitive Load After an 8-Hour Shift in Busy ER Reading Room: How Much Does It Increase After a Shift and Does It Get Worse During the Week?

Monday, Dec. 2 9:30AM - 9:40AM Room: S501ABC

#### Participants

Jason I. Halpern, MD, Providence, RI (*Presenter*) Nothing to Disclose  
Thomas K. Eggin, MD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Shreya Ramayya, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Grayson L. Baird, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Cognitive load has been linked to short-term exhaustion and long-term physician burnout. The purpose of this study is to estimate the degree to which residents' cognitive load increases after an 8-hour shift over the course of a week in a busy, high-volume emergency department reading room. It is hypothesized that cognitive load will increase dramatically after an 8-hour shift compared to before a shift. It is also hypothesized that cognitive load will increase globally as the week continues relative to the beginning of the week. Lastly, it is hypothesized that residents' diagnostic detection performance will diminish after a shift relative to before a shift - due in part to increased cognitive load.

#### METHOD AND MATERIALS

A within-subjects randomized block design was used to examine cognitive load in residents before vs. after a night shift over the course of one week. Data were examined using generalized mixed modeling. Cognitive load was examined using the validated *NASA Task Load Index*, where higher scores indicate higher cognitive load. Diagnostic detection performance was measured before and after a shift using neutral stimuli - *Where's Waldo* scenes, where residents were tasked with finding as many characters possible within 3 minutes.

#### RESULTS

Cognitive load (*NASA Task Load Index*), increased from 25.0 95% CI [20,31] before a shift to 63.3 95% CI[56, 70] after a shift,  $p < 0.01$ ), though this increase was constant over the course of a week (did not increase as the week progressed,  $P = .1500$ ) (Figure 1). We failed to find a decrease in diagnostic detection performance: residents were able to find all *Where's Waldo* characters 63% of the time before a shift and 60% after the shift,  $p = .4986$

#### CONCLUSION

Cognitive load is a well-studied aspect of human performance in many high-demand fields such as air traffic controllers and pilots. However, little research has been done examining cognitive load in radiologists working in high-demand settings. These results indicate that cognitive load increases dramatically after a night-float shift. More research is needed to assess how this increase in cognitive load affects performance and burnout in radiologists, especially in high-volume and high-demand settings.

#### CLINICAL RELEVANCE/APPLICATION

Cognitive load was found to increase dramatically by the end of an 8-hour shift. More research is needed to examine how this increase affects performance and burnout in radiologists.

#### RC227-07 Diagnostic Error

Monday, Dec. 2 9:40AM - 10:00AM Room: S501ABC

#### Participants

Neville Irani, MD, Kansas City, KS (*Presenter*) Nothing to Disclose

#### LEARNING OBJECTIVES

1) Discuss methods to determine diagnostic accuracy. 2) Describe important considerations when implementing metrics related to diagnostic accuracy.

#### RC227-08 Motivating People

Monday, Dec. 2 10:20AM - 10:40AM Room: S501ABC

#### Participants

Michael A. Bruno, MD, Hummelstown, PA (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) Describe the central importance of intrinsic motivation in professional work productivity. 2) Explain the advantages and disadvantages of financial incentive programs with respect to individual motivation. 3) Critique their current practice's approach to financial incentives and other strategies for enhancement of professional motivation, and compare it to the various models presented at the session. 4) Apply their understanding toward the development of new approaches they might recommend to enhance professional engagement in their own practices.

**Active Handout: Michael Andrew Bruno**

[http://abstract.rsna.org/uploads/2019/19000130/Active RC227-08.pdf](http://abstract.rsna.org/uploads/2019/19000130/Active_RC227-08.pdf)

### **RC227-09 Feed Patients without Fluoro: A Teaching Hospital Experience**

Monday, Dec. 2 10:40AM - 10:50AM Room: S501ABC

#### **Participants**

Elizabeth Ryals, MD, Salt Lake City, UT (*Abstract Co-Author*) Nothing to Disclose  
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#### **PURPOSE**

An estimated one-third of patients develop malnutrition during their hospital stay. Malnutrition leads to a higher risk of surgical site infection, decubitus ulcer, and readmission. Thus, feeding critically ill patients in a timely fashion is essential for the safety and quality of patient care. At our institution, fluoroscopic-guided feeding tube placement (FgFTP) is performed by the abdominal radiologists. As the volume and complexity of cross-sectional imaging studies increased over the last several years, the abdominal radiology section struggled to accommodate feeding tube placements in a timely manner. In response to this challenge, our hospital implemented the electromagnetic-guided feeding tube placement (EMgFTP) system (Cortrak; Avanos Medical), which can be performed at the bedside using on-screen visualization of the feeding tube tip, in December 2016. In this Quality Improvement storyboard, we share the process that we took to transition from FgFTP to EMgFTP for inpatients using the Value Summary adapted from the Toyota A3 template.

#### **RESULTS**

The annual number of FgFTP decreased from 182 in 2016 to 129 in 2017, corresponding to a 29% reduction after implementation of the EMgFTP system. The number of EMgFTP steadily increased after its introduction with 115 tubes placed in December 2016, 2,232 during 2017, and 1,284 during the first 6 months of 2018 (see figure 1). Furthermore, the average patient radiation dose decreased with decreasing proportion of the feeding tubes being placed with fluoroscopic guidance. Currently, the Cortrak team consists of 14 nurses available 9a-9p daily for inpatient feeding tube placement. The cost to patients decreased with the introduction of the EMgFTP system. The patient is billed \$275.00 for EMgFTP, while the cost of FgFTP (including the use of the fluoroscopic suite as well as radiological interpretation and supervision) is \$1,185.57.

#### **CONCLUSION**

The transition from FgFTP to EMgFTP has made a dramatic improvement of timely feeding to prevent malnutrition for critically ill inpatients. The risk of fall or line misplacement related to patients' transportation is markedly reduced. Furthermore, there has been a more efficient use of healthcare resources leading to a reduction in the internal cost of feeding tube placement to the health care system and decreased strain on the abdominal radiology section. Finally, the average patient radiation dose has also decreased.

#### **METHODS**

A feeding tube task force was formed comprised by members of the nursing staff and radiology department to address the delay in feeding tube placement for inpatients needing enteric nutrition. Using a fishbone diagram, a root cause analysis was performed. The task force produced a proposal to transition from FgFTP to EMgFTP which was supported by the Chief Value Officer Committee and led by the hospital CMO. Inpatient nurses were recruited and trained on the EMg feeding tube placement system using a simulator. Nine inpatient nurses were trained prior to the transition to EMgFTP. For the first 6 months, a portable abdominal radiograph was obtained after EMgFTP to confirm the position of the feeding tube tip and correlate with the image on the Cortrak monitor. Following nearly perfect correlation of the feeding tube tip position on the Cortrak, screen with the abdominal radiograph, a portable abdominal radiograph was obtained after EMgFTP for only anatomically complex cases. FgFTP was reserved for outpatients and inpatients in whom EMgFTP failed.

### **RC227-10 Improving Abdominal Image Quality at Reduced Radiation Dose with a Model-Based Iterative Reconstruction Algorithm**

Monday, Dec. 2 10:50AM - 11:00AM Room: S501ABC

#### **Participants**

Lanxin Zhang, Xianyang, China (*Presenter*) Nothing to Disclose  
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#### **PURPOSE**

Objective: To study the effect of model-based iterative reconstruction (MBIR) algorithm on improving abdominal CT image quality at a reduced radiation dose.

#### **METHOD AND MATERIALS**

Methods: 30 patients with standard dose in abdominal CT (noise index (NI) = 10HU) were used in this study as a control group

(Group A). Group B (n=30) was acquired under a lower dose at NI = 14HU for the abdominal section and was used for comparison. The adaptive statistical iterative reconstruction (ASIR) was used to reconstruct images in Group A and MBIR was used to reconstruct images in Group B. All images were at 0.625 slice thickness. ROI (area about 25 - 250mm<sup>2</sup>) was put on liver, spleen, subcutaneous fat in the anterior abdominal wall and left erector spinae muscle on the axial image containing the left portal vein to measure their CT value, standard deviation (SD) and contrast-to-noise ratio (CNR). Two radiologists with more than 10 years of experience used a 5-point scoring system to evaluate the subjective image quality including the subjective noise and the display of fine structures.

## RESULTS

Result: There was no different in BMI value between the two groups. Group B reduced the CT dose index (CTDI) by 42% (6.93±3.23mGy vs. 11.88±7.58mGy, p<0.05). There was no difference in CT value for all the organs between the two groups. However, the images noise in the MBIR group (Group B) with the reduced radiation dose was significantly reduced compared with that in the ASIR group (Group A) with the routine liver dose. Group B had lower image noise in liver and spleen (11.66±0.94HU and 11.64±1.26HU vs. 18.80±2.97HU and 18.86±3.62HU) and higher CNR (14.83±3.61 and 14.08±3.59 vs. 12.06±3.19, 11.57±2.93) than Group A (all p<0.001). Images in Group B also had higher subjective image quality scores than in Group A.

## CONCLUSION

Conclusion: MBIR reconstruction algorithm improves image quality at 42% lower radiation dose compared with the state of the art ASIR algorithm at routine radiation dose.

## CLINICAL RELEVANCE/APPLICATION

Clinical Relevance: MBIR algorithm can be used clinically to reduce image noise and improve image quality with much reduced radiation dose.

## RC227-11 Emerging Demand for Guideline-Discordant Lung Cancer Screening: Indications Given by Referring Providers

Monday, Dec. 2 11:00AM - 11:10AM Room: S501ABC

### Participants

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## PURPOSE

Growing public awareness of the benefits of lung cancer screening (LCS) with low-dose chest CT (LDCT) for high-risk smokers may lead patients and providers to knowingly request guideline-discordant LCS outside Centers for Medicare and Medicaid Services (CMS) coverage criteria. Here, we examined whether and why providers within our hospital network intentionally order guideline-discordant LDCTs.

## METHOD AND MATERIALS

This is a HIPAA-compliant, IRB-approved retrospective review of LDCTs ordered within a network of academic and community practices over the initial 5-month period after integration of Best Practices Advisory (BPA) alerts into our LDCT electronic medical record-based order entry system (11/2018-3/2019). Alerts trigger when providers order exams outside institutional LCS guidelines, which mirror CMS criteria (current smoker or quit ≤ 15 years, 30 pack-year history, 55-77 years old). Providers can override alerts, enter reason for LCS, and complete the order. Primary variables of interest are number of LDCTs ordered after overriding alerts and reasons given.

## RESULTS

During the study period, 946 LDCTs were performed. For 35 patients, LDCTs were ordered after overriding a BPA alert. Mean age was 61±10.3 years; 51% (18/35) were female. 37% (13/35) were outside age criteria, 34% (12/35) have never smoked, 31% (11/35) smoked < 30 pack-years, and 29% (10/35) quit > 15 years. Reasons for ordering LDCT were: firefighter (17%, 6/35), carcinogen exposure unrelated to firefighting or smoking (17%, 6/35), family history of lung cancer (11%, 4/35), mediastinal radiation (6%, 2/35), secondhand smoke (3%, 1/35), and epidermal growth factor receptor mutation carrier (3%, 1/35). No reason was provided for 43% (15/35). All LDCTs performed were reported using Lung-RADS.

## CONCLUSION

Patients and providers intentionally request screening LDCTs outside recommended guidelines, including for never smokers. The most common indication was carcinogen exposure unrelated to smoking, such as from firefighting. For these specific patient populations, appropriateness of LCS as well as follow-up imaging, procedures, and costs resulting from management of screen-detected findings with Lung-RADS warrant further study.

## CLINICAL RELEVANCE/APPLICATION

Radiologists should be aware of emerging demand for screening LDCTs for guideline-discordant indications and further evaluate LCS appropriateness and management options for these patients.

## RC227-12 Radiology Assistant for Completion of Recommended Imaging Follow-Ups: Return on Investment

Monday, Dec. 2 11:10AM - 11:20AM Room: S501ABC

### Participants

John Lee, Boston, MA (*Presenter*) Nothing to Disclose  
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**PURPOSE**

To quantify the gain in revenue from additional imaging studies attributable to overdue workup reminder notifications sent by a Radiology Assistant.

**METHOD AND MATERIALS**

The IRB approved this HIPAA-compliant study. Informed consent was waived. A RIS search of imaging reports over 2 months in 2016 at our institution for the words 'recommend' or 'advised' was performed, yielding 4,539 studies. Of these, 1,599 patients were studied. Multiple investigators retrospectively reviewed each report and flagged studies with clinically significant findings and 'firm' recommendations. For patients with overdue follow-ups, a Radiology Assistant notified the provider. Imaging studies performed only after notification were credited to the Radiology Assistant, and annual expected volume was extrapolated. Financial rate of return was based on national average CMS reimbursement rates including professional and technical fees.

**RESULTS**

Of 1,599 patients with 'recommend' or 'advised' in their diagnostic imaging reports, 194 patients had clinically significant findings, 'firm' recommendations for follow-up imaging studies and were overdue for work up. Providers for these patients were subsequently notified by the Radiology Assistant. Of the 194 patients, 86 had follow-up imaging studies performed only after notification, 32 were deemed as medically unnecessary by the provider, and 76 were lost to follow-up. Extrapolation of the 86 patients who received imaging follow-up only after notification yields 1,466 additional studies per year (39.5% CT, 3.5% PET, 19.8% MR, 26.7% US, 9.3% radiographs and 1.2% US guided liver biopsy). Using national average CMS physician fee schedule data (professional and technical fees) yields \$361,378/year in additional revenue from studies performed after reminder notifications.

**CONCLUSION**

A Radiology Assistant to remind providers of overdue follow-up studies yields a significant return on investment from additional imaging studies alone, which easily justifies the Assistant's salary many times over. Improved patient outcomes, revenue from treatment of incidentally detected pathology and mitigation of legal exposure are potential benefits that require further study.

**CLINICAL RELEVANCE/APPLICATION**

A Radiology Assistant for reminding providers of overdue recommended imaging findings has a significant financial rate of return, which easily covers an Assistant's salary.

**RC227-13 A Radiology-Led Rapid Diagnostic Clinic for Primary Care Physicians with a 'Gut-Instinct' About Cancer**

Monday, Dec. 2 11:20AM - 11:30AM Room: S501ABC

**Participants**

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**PURPOSE**

Cancer is a leading cause of death in the UK and when benchmarked to other comparable world healthcare systems, UK countries are reporting poorer outcomes for many major cancers. One potential cause is the lack of timely access to diagnostic tests and lengthy times in clinical pathways. Despite accelerated initiatives such as the 2-week-wait (2-WW) and Urgent Suspected Cancer (USC) pathways, which are based on site-specific red flag symptoms, less than 50% of patients diagnosed with cancer come through such routes. A significant proportion of patients have vague symptoms that do not fit these accelerated pathways and consequently patients experience diagnostic delays. We investigated, based on the Danish model, whether primary care physicians 'gut-instinct' could detect cancer in patients with vague symptoms.

**METHOD AND MATERIALS**

A prospective population-based interventional study was undertaken including patients with vague symptoms of cancer and those who did not qualify for an accelerated red-flag diagnostic pathway, over a one-year period. Primary care physicians referred patients to a rapid diagnostic clinic (RDC). Initial consultation, blood tests and a complete examination was performed then appropriate radiological investigations were requested; the majority of patients had a whole body CT which was 'hot reported' by a consultant radiologist during the clinic.

**RESULTS**

We found that over a one-year period, 9.7% of cancers were diagnosed. The most common malignancy was lung cancer. 76% of patients were diagnosed with stage 4 disease. The most common presenting symptom was weight loss (77%). The majority of patients were seen within 2 weeks of referral and average time taken from referral to start of treatment was 30.7 days.

**CONCLUSION**

The 'gut-instinct' of a primary care physician was superior than our conventional red flag pathways at diagnosing cancer (local

The gut-instinct of a primary care physician was superior than our conventional red-flag pathways at diagnosing cancer (local conversion rate 3-8%). A radiology-led diagnostic clinic investigating patients with vague symptoms has significant benefits for rapid cancer diagnosis though further challenges in health promotion are needed to detect cancer at an earlier stage.

#### **CLINICAL RELEVANCE/APPLICATION**

More than 50% of patients with cancer do not have typical red-flag symptoms but have vague symptoms. A dedicated rapid, radiology-led pathway is useful to help diagnose cancer early and improve access to diagnostic imaging by primary care physicians.

#### **RC227-15 A Practical Example of Buy-in, Metrics, and Motivating**

Monday, Dec. 2 11:40AM - 12:00PM Room: S501ABC

#### **Participants**

Phuong-Anh T. Duong, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

#### **LEARNING OBJECTIVES**

1) Apply methods of obtaining buy-in to a real-world example. 2) Develop a motivating (and achievable) goal. 3) Choose meaningful metrics to drive change.

Printed on: 10/29/20



SSC12

## Physics (CT Radiation Dose)

Monday, Dec. 2 10:30AM - 12:00PM Room: S504AB

**CT** **PH** **SQ**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

**FDA** Discussions may include off-label uses.

### Participants

Kai Yang, PhD, Boston, MA (*Moderator*) Nothing to Disclose  
Sarah E. McKenney, PhD, Stanford, CA (*Moderator*) Nothing to Disclose  
Baojun Li, PhD, Iowa City, IA (*Moderator*) Research Grant, General Electric Company

### Sub-Events

#### SSC12-01 Coronary Calcium Scoring Using Tin Filtration to Dramatically Reduce Radiation Dose

Monday, Dec. 2 10:30AM - 10:40AM Room: S504AB

### Participants

Shengzhen Tao, Rochester, MN (*Presenter*) Nothing to Disclose  
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### PURPOSE

The purpose of this work is to evaluate the ability of tin (Sn) filtration to dramatically reduce radiation dose for CT calcium (Ca) scoring to dose levels comparable to a few chest x-rays.

### METHOD AND MATERIALS

Chest phantoms emulating small/medium/large patients were scanned on a dual-source CT (Definition Force, VB10, Siemens). A piece of pork was placed at the center of the phantoms, which contained three cylindrical hydroxyapatite (HA) inserts (diameter/length = 5 mm, HA concentration = 200/400/800 mg/mL) emulating coronary calcifications. Phantoms were scanned at 100 kV and 600 mAs/rot using a Sn filter to remove low-energy photons that increase patient radiation dose but do not substantially contribute to image quality. The same phantoms were then scanned using a standard Ca scoring protocol at 120 kV, with mAs determined by a clinical technique chart designed for different patient sizes. Images were reconstructed using a specially designed reconstruction kernel (Sa36 kernel), which accounts for the different attenuation of Ca materials due to different x-ray spectra of Sn100 and 120 kV, and generates 120 kV-like images. The CT numbers of pork and a 200 mg/mL HA insert were measured, the Ca scores were calculated using commercial software, and the results compared between 120 kV and Sn100 kV scans.

### RESULTS

Radiation dose was reduced from 2.3/6.8/14.3 at 120kV to 1.5/1.5/1.5 mGy at Sn100 kV for the small/medium/large phantoms, yielding a 34%/78%/90% dose reduction. CT numbers of soft tissue and HA measured from Sn100 kV images were consistent with those of the 120 kV images (max differences < 7/15 HU for tissue/Ca, respectively). Ca scores of HA inserts measured from Sn100 kV images were consistent with those of 120 kV images for the small/medium phantoms (max difference < 16). Larger differences (40-140) were observed for the large phantom.

### CONCLUSION

Ca scoring using a Sn filtered x-ray beam was found to achieve 34-78% dose reduction compared to the standard 120 kV technique while yielding consistent Ca scores for small/medium patients. However, it may not be suitable for large patients due to considerable score elevation.

### CLINICAL RELEVANCE/APPLICATION

The evaluated technique can reduce patient dose from coronary calcium screening to levels comparable to a few chest x-rays.

#### SSC12-02 Impact of Imaging Conditions on Localizer-Based Water Equivalent Diameter Estimation and on Dose Modulation

Monday, Dec. 2 10:40AM - 10:50AM Room: S504AB

## Participants

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Xinming Liu, PhD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

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Matthew R. Palmer, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Water equivalent diameter (WED) is a sound patient-size descriptor, and CTs use localizers to determine WED and to guide dose modulation. Localizer-based WED estimation requires a calibration to relate localizer pixel values to attenuation. We investigated how imaging conditions affect the WED calibration and dose modulation performance.

## METHOD AND MATERIALS

We acquired localizer and axial images of ACR and body CTDI phantoms on 11 CT models from GE, Siemens, Philips, and Canon. We estimated calibration parameters (slope and intercept) by associating axial images with the corresponding localizer lines using custom built software. Experiments were conducted under combinations of kV, mA, orientation, and imaging kernel of localizer radiographs, and axial kV. In separate experiments, the ACR phantom and body CTDI phantom (iso-centered) were imaged together on table top. We repeatedly acquired 120kV-helical scans with dose modulation, after taking localizers at varied kV and mA levels, to examine their impact on dose modulation.

## RESULTS

Calibration slope and intercept depends on localizer kV on all CTs. E.g., on a Canon A-One CT, slope changed from 1.47 to 1.64 for localizers from 80 to 135 kV. Using calibration of 120kV localizers, we simulated errors in WED estimation caused by using unmatched calibrations: WED from 80kV- ~ 135kV-localizers deviated from the truth by 1-5% for the body CTDI phantom and 1-7% for the ACR phantom. Localizer mA and directions have small impacts on calibrations and WED results. Calibration also depends on localizer kernels for Canon CTs. For the A-One, WED calibration slopes under Sharp- and STD-kernels were identical (diff. < 0.01%) but differed from the Soft-kernel slope by 55%. Using the Sharp-kernel calibration, WED from Soft-kernel localizers deviated from the truth by 35% for the CTDI phantom and 42% for the ACR phantom. Localizer kV affected dose modulation performance. On a GE CT750HD, comparing to the CTDI<sub>v</sub> (11.65 mGy) of a baseline condition (120kV-localizer), CTDI<sub>v</sub> from the same helical scans after 80kV-, 100kV-, 140kV-localizers were 12.43 (+7%), 11.98 (+3%), and 11.41 mGy (-2%). Localizer mA did not affect dose modulation.

## CONCLUSION

Localizer kV and image kernels have stronger impacts on WED calibration and dose modulation than other factors.

## CLINICAL RELEVANCE/APPLICATION

Using the same kV and image kernel for localizers may improve consistency of dose modulation and WED estimation.

## SSC12-03 Protocol Optimization of Whole-Body Low-Dose CT in Patients with Multiple Myeloma: How Low is Too Low?

Monday, Dec. 2 10:50AM - 11:00AM Room: S504AB

## Participants

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## PURPOSE

To investigate the minimum radiation dose needed to perform a whole body low dose CT (WBLDCT) with a latest generation CT scanner while maintaining an optimal diagnostic accuracy for bone lesions detection.

## METHOD AND MATERIALS

A preliminary image quality and patient dose assessment was retrospectively performed in 25 patients using a GE Revolution CT scanner, highlighting high subjective ranks and different reader's agreement in osteolytic lesions detection, with a median effective dose of 1.9 mSv. Base on the reference protocol (120 kV, noise index 25, slice thickness 1.25 mm, iterative ASIR-V 50%, collimation 80 mm, average CTDI<sub>vol</sub> of 2.3 mGy), an anthropomorphic whole body phantom (PIXY phantom) was repeatedly scanned varying the acquisition parameters with a relative CTDI<sub>vol</sub> range of 0.3 - 1.5 mGy. For each slice, a noise analysis was performed with means of an automatic segmentation tool and multiple ROI evaluations. Both noise and tube current profiles were compared along z axis in each acquisition. Some phantom details were identified as potential simulation of pathologic bone and assumed as reference for a subjective evaluation by three radiologists (5-point Likert scale). An optimized protocol was defined and employed primarily on 10 patients.

## RESULTS

Individual reader's scores showed stable high values with average of 4.8 up to a CTDI<sub>vol</sub> of 0.9 mGy. For the lower doses

Individual reader's scores showed stable high values with average of 4.8 up to a CTDIvol of 0.9 mSv. For the lower doses, significant lower average scores were observed (4.2 for CTDIvol of 0.5 mGy and 3.2 for CTDIvol of 0.3 mGy,  $p < 0.01$ ). The minimum CTDIvol without loss of diagnostic information was achieved with different combinations of exposure parameters, and among these, a maximum image quality rank was obtained with a scan performed with 140 kV and a percentage of ASIR-V of 80 %. The overall corresponding medians of automatic noise measurements for the phantom were 49 HU (range 22 - 67) with a sharp convolution kernel and 13 HU (range 7 - 21) with a standard kernel. Using the optimized protocol, the median effective dose for ten patients was estimated 0.7 mSv.

## CONCLUSION

Routinary submillisievert WBLDCT can be performed on latest generation CT scanner with a proper balance between tube current modulation parameters and iterative reconstruction strength.

## CLINICAL RELEVANCE/APPLICATION

Assessing the lowest achievable dose for WBLDCT with phantom studies and image quality metrics can be useful to optimize this imaging modality in accordance with the ALARA principle.

## SSC12-06 The Presence of Contrast Agent Increases Absorbed Organ Radiation Dose in Contrast-Enhanced CT

Monday, Dec. 2 11:20AM - 11:30AM Room: S504AB

### Participants

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## PURPOSE

Although intravenous iodinated contrast agents are being used in 50 to 60 % of all computed tomography (CT) scans, their presence is not considered in patient dosimetry calculations. The aim of this study is to investigate the impact of contrast agent on absorbed radiation dose in the venous phase of abdominal CT scans.

## METHOD AND MATERIALS

10 female and 10 male abdominal contrast-enhanced dual energy computed tomography (DECT) scans were retrospectively selected from our patient database. Organ and tissue doses were calculated by an ad-hoc Monte Carlo (MC) simulation model (ImpactMC) that was experimentally validated (accuracy  $< 5.5\%$ ) for the scanner geometry (GE Revolution CT) and acquisition parameters including tube current, tube voltage, beam shape filter, and collimation were modeled. MC simulations were performed in the presence and in the absence of contrast agent using the contrast-enhanced and virtual-unenhanced dataset of DECT as patient models. The simulated dose volumes were segmented (3D slicer) to obtain the dose in the liver, liver parenchyma, left kidney, right kidney, aorta, and spleen. We calculated the relative dose increase due to contrast as  $(DI - D0)/D0$  where DI is the dose in the presence of contrast agent and D0 is the dose in the absence of contrast agent. The iodine concentrations in the simulations were estimated using iodine content calculated by DECT.

## RESULTS

The average iodine concentrations among 20 patients are  $7.16 \pm 1.51$  mg I/ml for left kidney,  $6.98 \pm 1.58$  mg I/ml for right kidney,  $5.62 \pm 1.04$  mg I/ml for aorta,  $3.76 \pm 1.03$  mg I/ml for spleen,  $3.22 \pm 0.97$  mg I/ml for liver, and  $2.95 \pm 0.87$  mg I/ml for liver parenchyma. Compared to a non-contrast scan, the relative doses increase in the liver ( $21 \pm 5\%$ ), liver parenchyma ( $20 \pm 5\%$ ), aorta ( $34 \pm 6\%$ ), right kidney ( $37 \pm 7\%$ ), left kidney ( $39 \pm 7\%$ ) and spleen ( $26 \pm 3\%$ ).

## CONCLUSION

In abdominal CT, organ radiation doses increase due to the presence of contrast agents. On average, doses increase by 29 %. The highest increase is observed in kidneys, then in aorta, spleen, liver, and lowest in liver parenchyma.

## CLINICAL RELEVANCE/APPLICATION

The presence of contrast agents should be considered in patient dosimetry calculations.

## SSC12-07 Paradoxical Increase in Eye Lens Dose When Using Automatic Exposure Control During Non-Contrast Head CT and Mitigation by Organ-Based Tube-Current Modulation

Monday, Dec. 2 11:30AM - 11:40AM Room: S504AB

### Participants

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## PURPOSE

In CT scanning, tube current modulation techniques aim to maintain image quality over a variable anatomy. We examined eye lens

dose and image noise when activating a combination of automatic exposure control (AEC, current modulated based on anatomic attenuation measured on localizer) and organ-based tube-current modulation (OBTCM, current decreased over anterior portion of tube arc).

## METHOD AND MATERIALS

We performed CT scans of an adult anthropomorphic head phantom on 2 scanners (SOMATOM Force and SOMATOM Definition AS+, Siemens Healthcare) using 4 acquisition modes: 1) fixed mAs; 2) AEC (CARE Dose 4D) only; 3) OBTCM (X-CARE) only; 4) and both AEC and OBTCM active. For both scanners, we used 2 protocols: 'trauma' with 310 and 'follow-up' with 250 effective mAs or quality reference mAs, as applicable. We maintained a constant kV of 120. For each of 6 replicates at each acquisition mode, we placed an optically stimulated luminescence (OSL) dosimeter in each orbit to measure absorbed dose. We averaged OSL doses at each mode to obtain generalized lens dose and characterized image noise ( $\sigma$ ) from 4 ROIs placed at the level of the sella on subtraction images derived from consecutive scans with the least interscan motion. We used Student's t-test and distribution to test for significance and to calculate confidence intervals.

## RESULTS

For the Force trauma, Force follow-up, AS+ trauma, and AS+ follow-up protocols, respectively, fixed current technique produced average lens doses of 35.8, 28.0, 32.1 and 25.5 mGy. As compared to the benchmark fixed technique, AEC alone paradoxically increased eye lens dose (+11%, +21%, +22%, +21%), while OBTCM decreased lens dose (-33%, -33%, -29%, -35%), and combining both techniques decreased lens dose (-21%, -21%, -21%, -20%). Every acquisition mode produced a significant change from the benchmark ( $p < 0.05$ ). Noise measurements revealed a roughly inverse linear relationship between  $\sigma$  and vdose ( $R^2 = 0.88$  and 0.72 for Force and AS+, respectively).

## CONCLUSION

Compared to the standard fixed technique, activating AEC on non-contrast head CT paradoxically causes a significant increase in eye lens dose. Conversely, OBTCM with or without AEC significantly decreases lens dose.

## CLINICAL RELEVANCE/APPLICATION

In designing non-contrast CT head protocols, use of AEC requires careful consideration because it may increase eye lens dose despite reducing overall dose. Adding OBTCM to AEC can mitigate this effect.

## SSC12-08 kV Independent Coronary Calcium Scoring: A Phantom Evaluation of Score Accuracy and Potential Radiation Dose Reductions

Monday, Dec. 2 11:40AM - 11:50AM Room: S504AB

### Participants

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## PURPOSE

Because of the use of a fixed CT number threshold in the Agatston calcium (Ca) scoring method, and the dependence of CT numbers on photon energy, coronary Ca CT exams are required to be performed at a fixed tube potential (120kV). Here, we determine the accuracy of a kV-independent Ca scoring technique and its potential to reduce radiation dose by using tube potentials below 120kV.

## METHOD AND MATERIALS

Three hydroxyapatite (HA) cylinders (5 mm diameter and length; 200, 400, 800 mg HA/mL) were inserted into a piece of pork and placed within anthropomorphic chest phantoms representing small, medium, and large adults. Phantoms were first scanned at 8 tube potentials (70-140kV) to compare CT numbers and Ca scores. Next, phantom scans were performed with automatic exposure control (AEC) and automatic kV selection (CareDose4D QRM=180/150/120/90mAs, CarekV setting = 4) to evaluate potential dose reduction. A dedicated reconstruction kernel (Sa36) was used to create 3-mm-thick 120kV-like images every 1.5 mm, from data acquired at other kVs, by appropriately scaling CT numbers above a soft tissue threshold. Phantoms were also scanned at 120kV using our clinical size-dependent mA chart. CT numbers were measured from images at different kVs, and Agatston scores calculated using commercial software.

## RESULTS

Absolute CT number differences at different kVs (relative to 120kV) were small (tissue  $< 4$  HU; HA/Ca  $< 5$  HU for kV  $> 80$  and  $< 18$  HU for kV  $\leq 80$ ). The differences in Ca scores for kV  $\geq 90$  (relative to 120kV) were  $< 13.8$  (8%) for 200/400 mg HA/mL, and  $< 22$  (7%) for 800 mg HA/mL cylinders. The use of AEC and lower tube potentials reduced CT DIvol from 4.1/10.0/20.8 mGy (120kV, small/medium/large phantoms) to 2.1/4.4/5.6 mGy (for QRM=90mAs), yielding 48/56/73% reduction in CT DIvol and Ca score difference (for 400 mg HA/mL insert)  $< 13$  (8%) in relative to 120 kV.

## CONCLUSION

kV independent Ca scoring methods, coupled with AEC and lower tube potentials, provide a 48-73% reduction in CT DIvol and Ca scores that are consistent with those at 120 kV.

## CLINICAL RELEVANCE/APPLICATION

The reported technique benefits patients undergoing coronary Ca scoring CT by considerably reducing radiation dose while maintaining accurate Ca scores.

## **SSC12-09 Exploring the Limits of Size-Specific Dose Estimates (SSDE) as an Estimate of Organ Dose from Routine Chest and Abdomen/Pelvis CT Examinations**

Monday, Dec. 2 11:50AM - 12:00PM Room: S504AB

### **Participants**

Anthony Hardy, MS, Los Angeles, CA (*Presenter*) Nothing to Disclose

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Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Abstract Co-Author*) Institutional research agreement, Siemens AG

### **PURPOSE**

Size-Specific Dose Estimate (SSDE) adjusts scanner-reported CTDI<sub>vol</sub> to account for patient size and should be widely available on future scanners. While not intended to represent organ doses, the purpose of this work was to explore the ability of SSDE to provide a reasonable estimate of organ doses in routine chest and abdomen/pelvis exams across a wide range of patient sizes.

### **METHOD AND MATERIALS**

Raw projection data and patient protocol pages for 133 routine chest (71 women, 62 men) and 82 routine abdomen/pelvis (40 women, 42 men) CT exams performed with tube current modulation (TCM) were gathered from two Siemens MDCT scanners (Sensation 64 and Definition AS64, Siemens Healthineers, Forchheim, Germany). Image data were reconstructed and were semi-automatically segmented to identify lung and glandular breast tissues in chest exams and liver, spleen, and kidneys in abdomen/pelvis exams. Segmented image data were used to create voxelized models of chest and abdomen/pelvis anatomy. TCM data was extracted from the raw projection data to describe the tube current values as a function of gantry angle and table location. Voxelized patient models and TCM data were incorporated into a validated Monte Carlo (MC) simulation engine to estimate absolute lung, breast, liver, spleen, and kidney dose using MDCT source models. Normalized lung (nD<sub>lung</sub>), breast (nD<sub>breast</sub>), liver (nD<sub>liver</sub>), spleen (nD<sub>spleen</sub>), and kidney (nD<sub>kidney</sub>) doses were obtained by dividing respective absolute doses by the CTDI<sub>vol</sub> values from the patient protocol pages. SSDE values were acquired using AAPM Report 204 and the water equivalent diameter (D<sub>w</sub>) from the image data. Normalized doses were then compared to SSDE f-factors.

### **RESULTS**

The relative bias of nD<sub>lung</sub>, nD<sub>breast</sub>, nD<sub>liver</sub>, nD<sub>spleen</sub>, and nD<sub>kidney</sub> to the SSDE f-factors was observed to be 17.4%, 35.4%, 16.2%, 17.9%, and 17.1%, respectively. SSDE overestimates organ dose in small and large patients.

### **CONCLUSION**

SSDE may serve as a reasonable estimate lung, liver, spleen, and kidney dose across patient size within 20%, but may overestimate dose in small and large patients. For breast, SSDE may serve as a reasonable estimate within 36%.

### **CLINICAL RELEVANCE/APPLICATION**

SSDE may provide reasonable estimates of organ dose for routine chest and abdomen/pelvis CT exams for most organs; however, estimates of breast dose may require wider tolerances.

Printed on: 10/29/20



QIE-MOA

## Quality Improvement Reports Monday Poster Discussions

Monday, Dec. 2 12:15PM - 12:45PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI108-ED- MOA1 Use of a Novel Web-based Tool to Improve Communication Between the Emergency Department and Radiology

Station #1

#### Participants

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#### PURPOSE

Streamlining communication between radiology and other departments is critical for ensuring timely and appropriate care. With increasing radiologic subspecialization, radiology physicians may work in geographically disparate parts of the department. At our hospital, we anecdotally observed that a significant portion of incoming phone calls were misdirected to incorrect destinations. This resulted in wasted time, increased interruptions, and delays in care because the referring clinicians could not efficiently navigate the radiology department staffing structure. Our quality improvement project involved the development of a web-based tool that would allow the emergency department (ED) to more efficiently contact the appropriate radiology station in a timely manner and reduce misdirected phone calls.

#### METHODS

Surveys were sent to both the radiology residents and ED clinicians (attending, residents, physician assistants) to assess how frequently phone calls were misdirected. Radiology residents were asked which stations received the most misdirected phone calls, and in those circumstances, which desk the caller requested. ED clinicians were asked which stations they were looking for when they were told they called the wrong station, and were also given a series of questions to assess their knowledge of commonly called radiology stations (Plain Film, CT Body, Ultrasound, Neuroradiology, Pediatrics, and Overnight). ED and radiology physicians worked together to design an easy-to-use, intranet-based tool informing ED clinicians about the appropriate destination by subspecialty and hour of the day. After the tool was implemented for six months, surveys were again sent to radiology residents and ED clinicians asking the same questions as before in order to assess for any significant change in response. Additional questions were added to the ED survey to assess awareness of the new tool.

#### RESULTS

An interactive, editable schedule with numbers was made available through the ED intranet, allowing for flexibility with changes in reading room numbers and/or new staffing parameters (Figure 1). Previously, there was a static image of radiology numbers in this space, which was unable to be changed and included multiple incorrect and defunct numbers. Additionally, the list defaulted to a 'radiology pager,' which is ordinarily carried by a resident responsible for plain films. Numbers included in the new intranet tool were all pertinent reading room stations, all scheduling desks, and all technologist workspaces. Different schedules were provided for weekdays and weekends. Initial survey results showed that prior to the intervention, 74% of radiology residents said they received misdirected phone calls at least twice a day, compared to 57.9% of ED respondents who experienced this problem at least once a day (Tables 1 and 2). This number dropped to 58.4% of radiology residents ( $p=0.37$ ) and 17.9% of ED respondents ( $p<0.01$ ) on follow-up surveys 8 months after the tool was established. After the establishing the new tool, 82.1% of ED respondents were aware of the new intranet contact tool and used it to contact Radiology (Figure 2). On the series of questions that assessed the ED respondents' knowledge of radiology numbers, after the intervention, over 50% of respondents knew the correct answer or answered correctly using the call sheet; this resulted in statistically significant increases in accuracy for Body, Neuroradiology, and Pediatric radiology stations (Table 3). 50% of radiology residents believed there was a reduction in the number of misdirected phone calls from the ED.

#### CONCLUSION

Our tool was successful in accomplishing multiple goals. Firstly, we were able to gain acceptance of the new tool by over 80% of ED respondents. Secondly, we were able to reduce the number of misdirected phone calls based on the subjective perception of ED respondents and radiology residents. Thirdly, we objectively improved the ED respondents' behavior pattern in contacting the radiology department by either calling the correct number or using the call tool. However, a few limitations were recognized. The number of respondents differed before and after intervention, limiting statistical analysis. The tool itself is limited as certain subgroups were not included; for example, the ENT reading room was not given as there was a concern it would be difficult for the clinician to determine the distinction of ENT cases from Neuroradiology cases. Each of the surveys had an open-ended box to give

comments concerning radiology and ED communication, which raised additional concerns that can be addressed in the future. Going forward, we hope to be able to expand use of this tool throughout the hospital in order to provide more timely and efficient care by reducing wasted time on the phone.

## **Q1109-ED- MOA2 Offering Diagnostic Imaging Services in Public Hospitals: A Successful Public-Private Partnership Model**

Station #2

### **Participants**

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### **PURPOSE**

The state government implementing the presented diagnostic imaging project faced numerous challenges in delivering public health services, including low availability of imaging technology, a rapidly growing demand for imaging tests, low bed turnover and hospital overcrowding. In addition, the state did not have the financial, logistical, and agile resources to handle new investments in imaging equipment and their maintenance, or the required human resources such as an adequate number of radiologist specialists to deliver test imaging results timely and efficiently. The purpose of the diagnostic imaging project was to improve the availability, operations and maintenance of diagnostic imaging services in publicly administered hospitals, thus increasing bed turnover rate and reducing the long waiting times for patients.

### **METHODS**

To address the aforementioned health service challenges, the state government engaged with the private sector in a public-private partnership (PPP) to provide citizens access to imaging and telemedicine services, including Magnetic Resonance Imaging (MRI) and Computed Tomography (CT), X-ray and Mammography through the public healthcare system. While the PPP model has been propagated as one of the most effective approaches for establishing diagnostic services in some countries (Brazil, India, Moldova), data on PPP success has been limited. In this imaging PPP, a guaranteed global payment was legally institutionalized as a mechanism to attract private actors to participate in the project and to avoid state government delays or defaults in payments. The presented PPP agreement defines 10 quality and 7 availability indicators to be met by the private partner and to guarantee higher efficiency, measured through the number of exams delivered, number of exams that required the patient to come back, number of cancelled appointments as well as waiting times. If the aforementioned 17 key performance indicators pre-defined in the PPP contract are not met, the government can enforce penalties in the form of payment deductions. All employees, including receptionists, technicians, nurses as well as remote radiologists are hired and managed by the private partner.

### **RESULTS**

In our PPP case, the radiology sectors of 11 public hospitals were remodeled and received new equipment, with a total private investment in infrastructure and operating equipment of over US\$30 million. Whereas there were previously only 2 available MRI scanners in public hospital in the state, the PPP installed 6 new MRI scanners. As such, the diagnostic imaging PPP increased the availability of MRI and achieved an enormous improvement in access to diagnostic exams for both inpatients and outpatients who depend on the public health care system. The average number of MRI scans performed in the state in 2018 was almost 8-fold compared to the reported numbers of MRI scans before the PPP implementation in 2011 while the average number of CT scans performed in 2018 was more than 2-fold compared to the reported CT scans performed in 2011. The PPP accomplished availability of diagnostic exams not only through the investment in new equipment but also through preventive equipment maintenance and repairs which are not timely dealt with in the bureaucracy of publicly administered hospitals, thus contributing to the inefficient use of even the minimal resources that might be available. Immediately before the project started, the state of the radiology sectors in the implementing hospitals was precarious with respect to outdated x-ray and CT equipment as well as experienced less than optimal equipment maintenance. CT scanners in different cities were reported to be out of service anywhere from 2-6 months either due to the need of an x-ray tube, software configuration or a fuse replacement. These CT scanners were the only ones available in their respective cities, highlighting the impact of lack of health care services on the local population. While it is hard to document the direct impact of the PPP on average length of stay, bed turnover and therefore hospital cost, it has been reported that prior to this project, hospitalized patients took up to 20-30 days to perform CT or MRI exams and the reports took 7-10 days to be released. Some hospitals only had reports for 10-20% of the diagnostic exams performed. Currently, most patients admitted to PPP hospitals perform their exams on the day they are prescribed. All exams have their reports released within 2 hours (urgent care), 12 hours (regular inpatient) or 2 days (outpatient).

### **CONCLUSION**

Our case provides evidence that the diagnostic imaging PPP is an innovative model of health care delivery which has been able to increase the availability of diagnostic radiology services in the state and achieve an enormous improvement in access to imaging diagnostic exams for patients who depend on the public sector for health services, performing more than 1 million diagnostic exams in less than 4 years, free of charge to patients.

## **Q1110-ED- MOA3 Emergency Radiology Workflow During a Simulated Mass Casualty Incident (MCI) in a Level 1 Trauma Centre: Importance and Learning Points**

Station #3

### **Participants**

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## PURPOSE

To simulate an MCI scenario and examine the Emergency Radiology workflow. An MCI is a scenario where there is a large number of casualties in a short period of time. The role of radiology is to image patients in a rapid efficient manner and to communicate relevant findings quickly and accurately. The purpose of planning for MCIs is to anticipate these scenarios and optimise preparedness. A simulated MCI can act as a road test for the Emergency radiology team, the workflow, the CT protocol and the network. It can help estimate maximum capacity as well as establish where delays happen.

## METHODS

trauma CT scans in rapid succession in Level 1 trauma centre with Emergency Radiology. A single CT scanner adjacent to the trauma bay was used to acquire all scans. Standard Rapid Imaging in Trauma Protocol (RIPIT) used in all cases comprising non contrast CT head, CT angiogram arch to vertex with cervical spine reformats, CT angiogram of chest, abdomen and pelvis with thoracic and lumbar spine reformats and portal venous CT of abdomen and pelvis. Radiology service provision and CT workflow simulated to as close as realistic as possible. A volunteer was used in place of a patient for transfer from trauma bay to CT, spinal lift onto CT table, scan positioning and set-up. An anthropomorphic phantom was substituted in place of the volunteer for scan acquisition. Following acquisition the volunteer was then repositioned on the table and transfer from the scan table to trolley and back to trauma bay performed. Actual CT data from the acquisition including multi-planar reformats were sent to PACS. The time taken for each step in the process was documented for each 'patient'. All Emergency Radiology participants took part in a post-exercise debrief. Data were analysed using GraphPad Prism 8.

## RESULTS

The mean time in CT scan room was 8.45 min (range 7.72-9.75 min), with a derived maximum capacity of 6 patients per hour. Transfer times to and from the CT table were quick, less than 1 minute in all cases. The mean time spent on CT table was 7.65 min (range 7.13-8.62 min) and the mean actual scan time was 5.92 min (range 5.27-6.48min). The first CT images were available on PACS within an average of 12.83 min (range 3.37-18.6 min, median 16.18 min) but on the dedicated CT workstation within 3.78 min (range 3.17-4.57 min). Time to the complete set of images to PACS was extremely variable, ranging from within 43 min to 205 min (median 163.5 min). This wide range was partially due to the sequence of sending from the scanner to PACS and partially due to progressive network delays with increases in queued data.

## CONCLUSION

In an MCI scenario, up to 6 patients can be scanned within an hour using the standard trauma protocol. Overall, times for patient transfer, scan acquisition and initial image transfer were quick however images transfer to PACS was prohibitively long. This is something we had suspected but had not previously quantified in our institution. This has dataset become the driving force behind network upgrades in our institution. To date, a new dedicated server for the emergency CT scanner has been installed and network hardware installation in progress. Front and back-end software improvements are also being made. We have a repeat simulated MCI exercise planned for May 4th to test improvements to date using identical methodology with a subsequent exercise in late summer 2019 once all improvements are in place. We have also critically reviewed the protocol we use in MCI events in terms of the necessary components of the protocol and the multiplanar reformats that are required for, at least, the initial read. We have developed a 'disaster protocol' which is a streamlined version of a RIPIT and hope to test this also at the next MCI simulation. This simulated MCI scenario demonstrated that, even in Level 1 trauma sites with an established Emergency Radiology division and proven algorithms for polytrauma imaging, there is potential for optimisation of workflows. Simulations allow for team familiarity with the MCI algorithm, streamlining of processes and workflows, and, in this case, demonstration of previously unrecognised stumbling blocks to efficiency that may have remained occult without this real-time practice.

## Q1009-EB- MOA High-Fidelity Simulation Training for Radiological Emergencies: A Multidisciplinary Approach

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Participants

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Eleanor Powell, MBBS, Cardiff, United Kingdom (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Our purpose was to develop and introduce a focussed and multidisciplinary simulation course to train radiology healthcare professionals to manage common medical emergencies that may be encountered in their everyday practice. Recently, the Royal College of Radiology have stated the importance of incorporating simulation in radiology training and the GMC-approved RCR curriculum. They have suggested identifying areas where simulation may be beneficial, especially in a multi-disciplinary setting, and incorporating this into their training as part of their professional development. Life-threatening medical emergencies are uncommon in the radiology department, but when encountered, pose a significant challenge to radiology healthcare professionals. We developed a high-fidelity simulation course for radiology staff focusing on early recognition and intervention for three medical emergencies which may be encountered. To select the most relevant clinical scenarios to include, we reviewed the critical incident log for the radiology department at University Hospital of Wales, Cardiff. There had been 18 medical emergency incidents over the preceding year - the most common being loss of consciousness/airway and anaphylaxis.

## METHODS

A mixed group of radiology healthcare professionals, including consultants, registrars, nurses and radiographers attended a three-hour simulation course consisting of a mix of lectures, skill stations and simulation scenarios. The participants were divided into four

equal groups and invited to attend the course, which was provided free of charge. The simulation faculty comprised two anaesthetists, one radiologist and a simulation laboratory facilitator. Training included basic management of cardiac arrest, anaphylaxis and contrast agent reactions and airway obstruction. The programme was specifically designed for radiology healthcare professionals by a dedicated team of anaesthetists, radiologists and simulation technicians. Before attending the course, the participants completed a short battery of questions which assessed their existing knowledge and perceived confidence with dealing with these clinical scenarios. These questions were asked again immediately after completing the course and then again six months later to assess the retention of the new skills and knowledge gained. The pre- and post-test results were analysed by combining all test results and the McNemar test was used to compare correct responses.

## RESULTS

Thirty-two radiology healthcare professionals attended the course over four different sessions. The groups consisted of 4 radiology consultants, 8 radiology registrars, 6 nurses, 8 radiographers and 6 healthcare assistants. The average pre- and post-course knowledge scores were 17/36 and 29/36 respectively, with an average difference between scores of 10 ( $p < 0.0001$ ). The average pre- and post-course scores for perceived confidence of managing the clinical scenarios were 4 and 7 out of a possible 10, respectively. Areas of knowledge that showed particularly marked improvement were of the airway equipment available and possible airway manoeuvres. After the results were collected and analysed for the first two sessions, we then introduced an airway skills breakout workshop to focus particularly on this area which delegates were initially struggling with. After the introduction of the airway workshop, there was an improvement in perceived confidence with managing an obstructed airway. The questionnaires collected six months later were completed by 23 of the delegates. These showed an average knowledge score of 24 which showed a decrease of 5 from the scores taken initially after the course was completed. The average perceived confidence score was 7 which remained the same.

## CONCLUSION

Simulation training is a well-validated teaching methodology for rehearsing low frequency, high acuity events in a supportive and safe environment. Our results show a statistically significant improvement in knowledge scores and perceived confidence across the multi-disciplinary team to manage common medical emergencies. This study demonstrates that embedding high fidelity simulation training into the radiology curriculum enables healthcare professionals to build confidence, improve knowledge, as well as enhancing teamwork skills, communication and prioritisation. The follow up results show that the improvements in clinical knowledge and skills were partially retained over a six-month period, however there was some decrease in knowledge scores. This suggests that regular update training sessions would be of benefit to maintain these skills and we will aim for this to be integrated into practice as part of the continued professional development.

## Q1028-EB- MOA RESPECT - Radiology Employees Striving for Productive and Effective Communication

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### Awards

Quality Improvement Reports Award  
Identified for RadioGraphics

### Participants

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## PURPOSE

Effective teamwork is predicated on good communication between team members. Recently, the technologists in our department reported an increasing number of negative interactions between radiologists and frontline staff which include imaging technologists, child life specialists, and reading room assistants. A baseline survey identified that only 45% of technologists would describe their interactions with radiologists as very good or excellent. The purpose of this improvement work was to change the culture in our department, with the specific goal of increasing the percentage of technologists who describe their interactions with radiologists as very good or excellent from 45% to 90% by the end of June 2019.

## METHODS

A multi-disciplinary improvement team was created. The team included radiologists and technologists from all divisions in the department as well as child life specialists and reading room assistants. Based on the comments obtained from the initial and subsequent surveys, the team identified three main areas of focus: in-person interactions, telephone interactions, and trainee interactions. Three subgroups were then formed. Each sub-group worked to identify some of the root causes for negative interactions, and then initiated a series of interventions to attempt to reduce the frequency of negative interactions and increase the frequency of positive interactions. The subgroup focusing on in-person interactions worked to clarify the roles of radiologists during conference hours and shift changes, and created a mechanism for technologists to provide radiologists feedback on behaviors that lead to negative interactions. The telephone interaction subgroup worked to reduce the overall number of telephone calls in the reading room, created a script for technologists and radiologists when making phone calls and answering phone calls respectively, and created shadowing opportunities for technologists to better understand the radiologists' workflow and how multiple phone calls can affect that workflow. Finally, the trainee interactions subgroup worked to create opportunities for the trainees to shadow technologists to better understand the technologist's work and to make a personal connection with the technologist. In addition, this group is working to redesign a component of the departmental orientation for departmental trainees. Improvement was assessed through a departmental survey sent to technologists every three weeks, on average.

## RESULTS

Over the course of this improvement project, multiple surveys were sent to the 180 departmental staff. On average, there were 50 respondents per survey for a mean response rate of 28%. The percentage of technologists who describe their interactions with radiologists as very good or excellent increased from 45% to 76%. Through this improvement work, we identified two root cause problems. First, a power-gradient exists between radiologists and front-line staff. Second, as workloads have increased, and the department has become distributed over multiple physical locations, there are fewer informal interactions between radiologists and technologists. The combination of factors has prevented radiologists and front-line staff from knowing each other on a personal

level. Because of this, small interpersonal shortcomings, such as tone of voice, lack of eye-contact, or failure to identify oneself (including last name and role) when answering the phone have greater importance and are more likely to cause a negative interaction.

## CONCLUSION

Quality improvement methodology can be used to improve culture. Through a series of interventions, we have been able to improve the percentage of technologists who describe their interactions with radiologists as very good or excellent.

### Q1010-EB- MOA **QI: Pediatric Appendicitis Ultrasound Across A Quaternary Health System**

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#### Participants

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## PURPOSE

Pediatric patients with right lower quadrant pain routinely are evaluated by CT across our quaternary Health System as our current ultrasound (US) was believed to be ineffective as a screening tool. Concern over increased radiation dose led to an initiative to improve right lower quadrant (RLQ) US. Our goals were to improve technical skill of the sonographers and to increase confidence in the reporting of pediatric ultrasound by the clinicians.

## METHODS

In an effort to improve the diagnostic accuracy of pediatric right lower quadrant ultrasound across the health system for the diagnosis of appendicitis, we first provided didactic and technical education to the ultrasound technologists. A pediatric radiologist and lead ultrasound technologist, from another Children's hospital with a successful appendicitis ultrasound program, were invited to provide hands on instruction. A didactic lecture and live demonstration of ultrasound methods was provided to all ultrasound technologists across the enterprise. Attendance was mandatory. Pediatric surgeons and pediatric Emergency Department (ED) staff were encouraged to attend. Further education was provided to pediatric radiology and ED staff including our goals of decreased CT use and how to read/interpret the new structured reporting. An updated technique was sent to sonographers requiring at least 20 minutes of scan time. A new structured report was created using the Nationwide Children's Hospital scale. All radiologists were advised to use the new macro which automatically populated at the start of dictation. Ultrasound cases were reviewed at the end of the month and discrepancies between CT and/or surgical outcome with ultrasound report were sent to the lead sonographers for review. Additionally, discrepancies were reviewed with the interpreting radiologist.

## RESULTS

Methods for clustered proportions were used to compare the new structured report to the old template with respect to the proportion of cases requiring a follow up CT. The sensitivity and specificity of the structured report versus old template were estimated after correcting for verification bias. Pathology results were used as the reference standard when possible; CT results were used otherwise. This sample consisted of 804 ultrasounds (from 793 patients) performed between October 2017 and December 2018. The patient's mean age at the time of US was 10.6 years (standard deviation: 4.3 years, range: 0 - 18 years). The proportion of ultrasounds being read with the new structured report steadily increased over time (Figure 1). The proportion of ultrasounds requiring a follow up CT was significantly lower when the new structured report was used (141/656 = 21%) compared to when the old template was used (46/148 = 31%) ( $p=0.021$ ). Of the 804 ultrasounds, 247 had a reference standard result (100 surgery, 147 CT). Patients who were positive on US were much more likely to have a reference standard result (98/103=95%) compared to patients who were negative or indeterminate on US (149/701=21%). After making a statistical correction for this verification bias, sensitivity and specificity were 21% and 99% with the old template (diagnostic odds ratio: 23.2) and 42% and 96% with the new template (diagnostic odds ratio: 17.4). (Table 1)

## CONCLUSION

As a quaternary health system with multiple hospitals and sonographers, we faced the challenge of uniform improvement across the enterprise. How do we train general sonographers, particularly if their pediatric population is limited? An additional challenge was in the reporting of the ultrasound. We needed all radiologists reading the ultrasounds, pediatric and general, overnight and daytime, to be comfortable with the sonographers and to provide definitive reports. All radiologists needed to commit to the new structured report to gain the confidence of our clinicians. The use of structured reporting improved and the use of CT following RLQ US decreased. A limitation of this study includes a selection bias because only cases with higher clinical concern or US features concerning for appendicitis went on to CT or surgery. Additionally there is a paucity of surgical/pathologic correlation and limited number of CT's. The assessment of the accuracy of US results is subject to imperfect gold standard bias (CT is an imperfect reference standard).

### Q1004-EB- MOA **Integration of Referring Physician Survey into the Electronic Medical Record (EMR): 2 Year Experience, Challenge and Improvement of Imaging Report Opportunities**

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## **PURPOSE**

Our Institution is a non-profit academic healthcare center founded in 1853. It has a network of two hospitals with 785 total beds (200 for intensive care), 41 operating rooms, 800 home care beds, 25 outpatient clinics and 150 associated private practices. Its work team is made up of 9237 people: 3400 medical doctors, 3337 members of the health staff and 2,500 people from the administrative sectors. Since 1998, the Institution has run an in-house-developed health information system (HIS), which includes clinical and administrative data. It has been certified by both The Joint Commission International and the HIMSS as level 7 in the Electronic Medical Record Adoption Model. Although verbal feedback sometimes exists, we lacked an objective record of the satisfaction of the referring physicians with respect to the imaging reports of the studies carried out. With the intention to provide feedback to our radiologists so they could improve their reports to be more useful to the referring physician we create a standard survey of the key clinical providers of the radiology department to understand their perceptions, their needs, and suggestions for improvement of the radiology reports. This projects reports the process and results of the referring physician satisfaction survey 2 years after implementation.

## **METHODS**

In this high-productivity context we developed with the IT department a volunteer quality satisfaction referring physician survey that could be completed directly from the EMR to capture improvement opportunities and achieve initial 'customer' feedback. The survey was therefore short. It is a survey form filled in by the referring physician who requests the imaging test. This survey is located next to the received imaging report. It consists of the following seven questions with 5 scale-Likert-like choices (1: not at all, 3 neutral, 5: excellent) and a last suggestion box to be completed with free text. 1-Was the imaging report clearly structured and organized? 2-Was the report brief and concise? 3- Were the most significant clinical/surgical findings completely described? 4- Did the report provide the information that was requested? 5- Did it contain the images and reconstructions that you needed in the report? 6- Was the report timely? 7- Was the imaging study of the quality you expected? 8- A suggestion box to complete with free text Once the surveys are completed, the quality improvement officer consults the management board to verify if surveys were loaded and classifies them and send them to the head of subspecialty. When at least one question is rated 1, 2 or 3 the survey is classified within that parameter. The head of subspecialty reviews the surveys together with the signing radiologist and the rest of the subspecialty team under the concept of peer learning. The feedback loop closes internally by archiving the survey. Externally a kind and constructive feedback email is send to the referring physician.

## **RESULTS**

A total of 673 were completed (264 in 2017 and 409 in 2018, 13% increase from one year to the next). 18.5% of responses were labeled score 4 and 5 (mean; 30, median: 22 and range: 59) while the majority (57.5%) was rated score 1, 2 or 3 (mean:64.5, median: 36.5 and range: 169). When the answers to the questions are rated score 4 and 5 we send a congratulation to the signing radiologist with a motivating purpose to his/her daily work. When the answers are from score 1 to 3, the case is analyzed under the concept of peer learning. The distribution of qualifications may be seen in figure 1. Cases scored 1 to 3 were taken as opportunities for improvement for the entire team involved. We classify as "Doesn't apply" those cases in which referring physicians click by mistake the survey without wishing to complete it. When making the contact with them they explain that they completed anything to exit the survey. Unqualified responses correspond to those cases in which the referring physician only write comments in free text without answering the questions.

## **CONCLUSION**

The work of the radiologist often lacks objective feedback from the referring physician. So far this QI project stimulated dialogue with referring physicians and meaningful radiology peer learning. It allowed us to improve processes, study protocols, lack of individual attention and attemption to standardize/structured the reports into templates. However, the feedback survey continues to be used most commonly as a "complaint line". We are working to achieve greater adherence of the referring physicians to complete the survey.



QIE-MOB

## Quality Improvement Reports Monday Poster Discussions

Monday, Dec. 2 12:45PM - 1:15PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI111-ED-MOB1 **Enhancing Undergraduate Clinical Radiology Education in A University Teaching Hospital- A Two-year Mixed Methods Evaluation of Learner Feedback to Improve Practice**

Station #1

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#### PURPOSE

Integration of clinical radiology is a key component within the UK undergraduate curriculum with outcomes and capabilities aligned the UK Regulator's (General Medical Council) outcomes framework. Medical students are introduced to imaging across the medical curriculum with a requirement that newly qualified medical practitioners have the necessary knowledge and skills to arrange and correctly interpret basic radiological investigations. However, delivering a learner-centred undergraduate programme in a busy radiology department is challenging with competing service and research demands. Our institution is aligned to a major UK medical school with >500 undergraduate students in each year group. All are required to undertake a placement in clinical radiology with Radiologist-led clinical teaching and exposure to all general imaging modalities. The core curriculum is composed of four components: 1) Fundamental principles 2) Common emergency conditions 3) Imaging in other common presentations 4) The role of the radiologist as part of the multidisciplinary team. Clinical teaching is grounded in Adult Learning theory; we deliver teaching and learning using a constructivist approach using role-modelling and work-based learning techniques. This enables medical students to experience interpreting a spectrum of clinical cases in a safe environment with targeted feedback and practical skills acquisition. We obtained prospective feedback from learners to guide quality improvement and alignment to their learning outcomes. Our standard is to achieve 100% of feedback responses to be satisfactory or above. We present quantitative and qualitative data over two years from direct anonymised feedback from medical students.

#### METHODS

A mixed methods approach of evaluation of teaching and learning was undertaken. The radiology registrars (residents) lead this programme, supervised by a Radiology Consultant. Quantitative data was collected using Likert scales (visual analogue) over a linear time period. Qualitative data was collected using open questions and thematic analysis. Feedback was then used at each time point over the two year period to enact changes in our departmental curriculum and teaching programme. This was then subject to ongoing learner feedback, as described above.

#### RESULTS

Feedback is given by each medical student for each session, using a Likert scale; 'Very Unsatisfactory', 'Unsatisfactory', 'Satisfactory', 'Good' or 'Excellent'. In 2015-16 academic year, 93.1% of learners rated teaching as Satisfactory or above (standard: 100%). A detailed breakdown is outlined. Thematic analysis of qualitative data included a need for; 1). Improved structure 2.). Clearer objectives sessions 3). Clarity of the learners' role in clinicoradiological meetings. In 2016-17 98.3% of learners rated teaching as Satisfactory or above (standard: 100%). A detailed breakdown is outlined. Thematic analysis of qualitative data included demonstrated increased satisfaction in but one of the previous themes with 'clarity of the learners' role in clinicoradiological meetings remaining an area where learners feel they need more guidance. Specific responses to improved teaching delivery included 'Emphasis on structured teaching was excellent...' and 'practical ultrasound very useful'.

#### CONCLUSION

The role of the radiologist in contemporary clinical practice and medical education is multi-faceted: However, medical students traditionally have limited exposure to Consultant-delivered teaching and departmental experience. Using established educational theories of role-modelling and work-based learning we have developed a practical and feasible curriculum blueprint for learner-centred teaching in a busy, service-led departmental setting. Using mixed methods evaluation techniques we have gathered quantitative and qualitative feedback to demonstrably improve the medical student experience. We believe that this is a feasible and effective template for other Radiology departments to set learning objectives to achieve the best outcomes for undergraduate radiology education.

#### QI112-ED-MOB2 **Modified Imaging Algorithm for Patients Presenting with Suspected Acute Cord Compression (ACC) in the Emergency Room**

Station #2

#### Awards

Quality Improvement Reports Award

## Participants

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## PURPOSE

To improve the speed (order to scan start) in which patients with suspected acute cord compression receive diagnostic MRI imaging by 20%. To reduce the 'table' time to complete the total spine MRI performed for acute cord compression by 20% by creating a targeted MRI protocol specifically for ruling in or ruling out ACC.

## METHODS

Baseline data was obtained from 10/1/17 - 3/31/18 for all patients presenting to one of our health network facility locations who obtained a total spine MRI for suspected acute cord compression (n=55). Metrics assessed included MRI order to start time, total MRI imaging time, and total time from order entry to MRI completion. After initiating the ACC redesign, the same data was re-assessed from 7/1/18 - 2/28/19, assessing the impact of new protocol (n=28). Lean QI techniques were utilized including A3 form completion and process mapping. A new electronic medical record order was created for the protocol.

## RESULTS

The ACC protocol exceeded our goal reductions in scan start time and total scan 'table' time. Median total MRI scan 'table' time was reduced by 44% (from 48 to 27 minutes) post intervention. Median time from order placement to exam begin was reduced by 50% (from 248 minutes to 124 minutes) post intervention. The rate of positive exams pre and post intervention was 35% and 32%, respectively.

## CONCLUSION

Acute spinal cord compression (ACC) is a neurosurgical emergency where rapid radiological diagnosis via MRI has the potential to greatly impact clinical care and patient outcomes. Our QI project aimed at re-structuring the diagnostic work-up for patients presenting to the emergency room with symptoms of acute cord compression to allow for more streamlined diagnoses and decreased delays for these cases that often reflect a surgical emergency. Through creation of a new multi-specialty designed/approved EMR order set in conjunction with a new MRI ACC protocol, we were able to surpass our goal metrics with reductions in MRI scan 'table' time by 44% and decrease delay from MRI order to MRI begin by 50%. Creation of a new diagnosis specific protocol required detailed data analysis before and after intervention and close collaboration between multiple specialties involved in the management of these patients. The rate of positive exams pre and post intervention was 35% and 32%, respectively. Through this collaboration we were able to reach agreement on which patients this expedited algorithm should be employed, with sustainment of appropriate order set utilization and maintenance of goal metrics.

## QI113-ED- MOB3 Determining Radiologists' Preferences for Quality Reporting in Peer-learning and Score-based Peer-review Systems

Station #3

## Participants

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## PURPOSE

To determine radiologists' use of and preferences for a peer-learning (PL) case submission module incorporated into the score-based (SB) randomly assigned peer-review system in efforts to improve patient care in radiology.

## METHODS

A voluntary peer-learning (PL) case submission module was added to the internally developed score-based (SB) traditional peer-review system for cases encountered during clinical workflow. Submitted cases represented opportunities for improvement in interpretation and reporting, patient care, or results communication or were 'great calls.' Cases were categorized by modality, subspecialty, anatomy, and type of pathology. PL conferences were organized by the section chiefs. The quality reviewed PL cases for inclusion into the teaching archive. An anonymous 22 question survey was constructed and distributed using SurveyMonkey following literature review and approved by the quality committee to identify radiologists preferences and opinions regarding traditional SB peer review and the new PL system. An email was sent with a link to the survey to all 137 radiologists at our institution. A reminder was sent at 1 week and the survey was closed after 2 weeks.

## RESULTS

A total of 583 of cases were identified during the first 30 months of PL from January 2016 to June 2018, with 519 (89%) of cases considered peer learning opportunities and 64 (11%) considered "great calls." Average case submission volume varied by month with a progressive increase over time. A total of 123 radiologists received PL, ranging from 1 to 30 per individual radiologist, and a total of 63 radiologists submitted PL, ranging from 1 to 70 cases per radiologist. Sixty-six responses were obtained for a 48% response rate representing individuals from all subspecialty sections. The average years in practice was  $16.5 \pm 9.8$  years. PL cases were identified most often during routine clinical work including comparison studies (67%). The preferred methods of communication to

others were the PL website (30%), phone call (21%), direct email (18%) or in-person conversation (18%). Most (63.5%) respondents believe the addition of peer learning to the traditional score-based peer review system has been an improvement, 29% were unsure and 7.5% responded no. Most (56%) respondents agreed the additional time needed to send peer learning is worthwhile; 36% were unsure and 8% responded no. PL increased the number of reported cases for 32% of respondents and was the same for 27%. Most (67%) respondents indicated peer learning cases contribute more important learning material than the random auditing of cases, 25.5% were unsure and 7.5% responded no. A minority (29%) of radiologists reported being more comfortable pointing out errors with the peer learning method of reporting rather than with the traditional scoring system; 15% responded no more comfortable and 56% responded the same comfort level. Approximately half of radiologists (48%) indicated they prefer that peer learning cases be anonymized, 26% were unsure and 26% responded no.

## CONCLUSION

A majority 74% of radiologists using both PL and SB peer review believe the best method to provide peer feedback and improve care is through the combination of traditional peer review and peer learning. None reported that only traditional peer review is the best method and a minority (10%) believed that using only PL is the best method to provide feedback and improve care. Radiologists indicate that the time commitment for PL is considered much less based on cases encountered in daily clinical workflow, which according to our survey is how radiologists learn most about errors, rather than a truly random SB review based on assignment of randomized cases. PL conferences which focus on those areas of greatest educational need were mostly well received although radiologists noted preferences for direct communication face-to-face, via an IM link to the case and commentary, for reporting.

## Q1015-EB- MOB A New Strategy Preventing Medical Errors Caused by Unread Imaging Interpretation Reports: Star Search Project

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## PURPOSE

The role of the radiologist in patient care does not end with appropriate reporting of imaging studies. Timely, effective communication of reports to health care providers (i.e. referring physicians) is also important. Failure to communicate findings in a timely, appropriate manner is a potential cause of malpractice action against not only radiologists, but also referring physicians. The purpose of our study was to propose a new strategy preventing medical errors caused by unread imaging interpretation reports.

## METHODS

In April 2018, our radiology department began a trial measure in which radiologists did the following to confirm that interpretation reports were appropriately utilized by referral physicians. 1) Medical emergencies were prefixed with three stars (\*\*\*) in the diagnostic impression sections of the imaging interpretation reports, and the referring physician was contacted by telephone as soon as possible (this action had been performed on a regular basis long before this trial began). 2) Semi-emergencies (medical issues needing addressing within two weeks) were prefixed with two stars (\*\*). After two weeks, the duty radiologist reviewed starred reports and patient charts to confirm that the information had been correctly conveyed. This trial included the reports of CT, MRI, NM and ultrasonography examinations. The results of this system being implemented for eleven months (Apr. 2018 - Feb. 2019) were retrospectively evaluated. The ethical committee of our institution approved this study, and the committee waived informed consent from patients, radiologists and referring physicians.

## RESULTS

The total number of reports during the period was 56,978 (5,180 per month). Two hundred ninety-two reports contained \*\* (0.51%, 1.31 reports/day). The medical issues addressed as semi-emergencies are summarized in Table 1. The most frequent issue was new, unexpected malignant tumors (or findings suggestive of them) (56.8%; 166/292), followed by unexpected spread of known malignant tumor. There was incomplete transmission of relevant information in 20 cases (6.85% of all two-starred reports; CT, n=14; MRI, n=6). Causes of incomplete transmission were 1) reports not being opened (n=14), 2) relevant information on reports being overlooked (n=5), and 3) the wrong report being opened (n=1; the referring physician incorrectly opened and read the report of the patient's annual CT examination performed the previous year). In these 20 cases, although the primary purposes of the CT examinations varied, the most frequent medical issue addressed as semi-emergency was new, unexpected (suspected) malignant tumors (n=12) (Table 2). Sixty-one reports contained \*\*\* (0.11%, 0.27 reports/day; In many cases with emergency findings, if radiologists thought that their communication was sufficient [e.g. they were able to speak directly to the referring physician by telephone to convey relevant findings and implications], they did not prefix with three stars. Thus, the incidence of emergency findings is greatly underestimated in this study). The two medical issues most frequently addressed as emergencies were acute abdominal diseases, such as intestinal perforation and ileus, and pulmonary artery thromboembolism/ deep vein thrombosis. Forty (65.6%) were starred for diagnoses unrelated to the initial target organs of the CT examinations.

## CONCLUSION

Our new "risk-based approach" allows prioritization of intervention based on severity of risk (appropriate measures are taken focusing on high-risk cases). This is more efficient and more economical compared to the conventional approach of reviewing all radiology reports to confirm their having been read by referring physicians. In this strategy, we ensured only the correct transmission of important information. This did not require a medical informatics system upgrade, and the additional effort required by radiologists was reasonable. We found this strategy to be effective, since important information was not appropriately transmitted to the referring physicians (without intervention) in 6.85% and intervention allowed us to avoid communication errors

that could lead to medical incidents at least in 20 semi-emergency cases during 11 months. In emergency cases, communication by telephone or in person is usually performed, so we suspect that communication errors are less likely. A possible drawback of this strategy is that referring physicians may come to depend on this system and not read reports not marked with stars as carefully. We must reemphasize that it is the basic responsibility of the referring physicians to read reports in a careful and timely manner. The professional approach to quality practice in radiology requires radiologists to take responsibility beyond writing reports in order to influence patients' care. This measure can be implemented immediately regardless of the size of the facility.

#### **Q1016-EB- MOB Semi-Structured Clinical Event Documentation of Acute Adverse Reactions to Contrast**

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##### **PURPOSE**

Allergic-like and physiologic reactions can occur acutely following contrast media administration. An on-site radiologist, often a radiology trainee, is typically the first physician responder to such events. Key assessments of the event inform immediate as well as future management, including identifying the culprit contrast class and specific agent, the type of reaction mechanism, and the severity of the reaction. The responding radiologist should record these assessments explicitly and communicate a plan for contrast administration to those who may order or protocol radiologic exams for this patient in the future, rather than delegate these details for non-expert providers to record, for the patient to relay, or for future clinicians to infer. However, documentation of clinical events in the electronic medical record (EMR) is a skill that radiologists infrequently practice, so important elements may be forgotten at the point of care. Further, as the responding radiologist may not be the one who interprets the corresponding study, the documentation in the event note and radiology report can be disjointed. We propose that providing a semi-structured clinical documentation support tool can improve the completeness of radiologists' notes on acute contrast reactions.

##### **METHODS**

Contrast Incident Support and Reporting (CISaR) is a web-based application for acute contrast event documentation. Users select options specifying the following elements: the type of event (extravasation or reaction), the contrast agent class (iodinated or gadolinium), the reaction mechanism and severity based on specific signs/symptoms (as defined in the American College of Radiology Manual on Contrast Media), and the treatments provided. Based on those assessments, CISaR generates a recommendation for future contrast-enhanced studies. The user can edit or append free-text details and recommendations, and then CISaR creates an event report under an imaging accession (in Epic) and appends a brief statement in the associated radiology report (in PowerScribe). We collected baseline data for three months and, after introducing the tool to trainees with a three-week wash-in period, post-intervention data for four months. Events included were acute contrast reactions identified by safety reports (submitted by radiology technologists or nurses) or CISaR reports. Extravasation events, delayed reactions, and acute drug reactions other than to contrast were excluded. Charts were reviewed, excluding the allergy history module, for completeness of event documentation by radiologists. Comparisons of baseline and post-intervention data on documentation elements were made using Fisher's exact test.

##### **RESULTS**

Fifty acute contrast reactions were identified in the baseline period and 82 in the post-intervention period. In the baseline and post-intervention periods, 32 (64%) and 62 (76%) events had radiologist documentation, respectively. When available in the post-intervention period, CISaR was the preferred but not only method of radiologist event documentation, used in 50 events (61% of total). When considering all radiologist documentation, CISaR availability was associated with a significantly higher proportion that specified the culprit contrast agent or class (78% vs. 95%,  $p=0.03$ ) and rated the reaction severity (78% vs. 94%,  $p=0.04$ ). Non-significant positive differences were seen in the proportion that classified the reaction mechanism type (81% vs. 92%,  $p=0.18$ ) and provided a recommendation on future contrast administration (75% vs. 86%,  $p=0.26$ ).

##### **CONCLUSION**

High quality clinical documentation of acute contrast events by radiologists was observed following implementation of a semi-structured documentation tool that integrates with both the EMR and radiology reporting software. Greater than 90% of reports included the key assessments of the culprit contrast agent or class, reaction severity, and reaction mechanism type. Documentation quality, including rates of making recommendations for future management, remains limited by lapses in using the documentation tool or in documenting the events at all. Further work is planned to improve the usability and acceptability of the CISaR interface and output.

#### **Q1017-EB- MOB Evaluation and Reduction of Acoustic Noise in PET/MR**

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##### Participants

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##### **PURPOSE**

Excessive acoustic noise during MR scanning poses a risk of injury to patients if steps are not taken to reduce sound levels at the patients' ears. Typical measures used to reduce acoustic noise for the patient include utilizing foam ear plugs and / or acoustic noise attenuating earphones, as well as modifications to pulse sequences, e.g. to limit gradient amplitude. Our institution recently installed a PET/MR scanner (SIGNA PET/MR, GE Healthcare), and it was initially subjectively observed that the PET/MR scanner was louder than other MR-only scanners at our institution. It has been suggested that scanner design modifications to allow insertion of the PET detector ring may contribute to increased acoustic noise in the bore of the scanner. In the course of clinical scanning, 3 patients expressed complaints of excessive acoustic noise with documented transient hearing loss in one patient. Since acoustic noise attenuating earphones do not fit in the head coils, patients with head scans must use foam ear plugs only. The ear plugs must be inserted properly and must not shift out of position during scanning. The purposes of this project were to evaluate acoustic noise levels for all clinical sequences used for head and neck imaging, to reduce sequence noise levels when possible while maintaining adequate image quality, and to educate staff regarding noise levels and methods used to reduce risk to patients.

## **METHODS**

A sound level meter with MR Safe microphone and cable (Bruel & Kjaer model 2250L) was used to measure A-weighted sound levels (dBA) for each clinically approved sequence used with the head coils. The microphone was positioned in the head coil adjacent to a spherical phantom in a location approximating ear level, and then positioned at isocenter. Sequences with measured sound levels above a conservative 105 dBA were identified to be modified to reduce sound levels. Acoustic noise for these sequences was re-measured to determine modified sound level. The modified sequences were then scanned on a volunteer with images reviewed by Radiologists to identify any image quality issues that may need to be addressed. In conjunction with the acoustic noise measurements, other aspects of our safety program related to hearing protection were reviewed.

## **RESULTS**

Acoustic noise measurements conducted on imaging pulse sequences resulted in a range of sound levels from 104.9 to 122.6 dBA. Modifications were made to 42 sequences in an attempt to reduce sound levels. Initial adjustment was made simply by turning ON the vendor supplied 'quiet' option for the pulse sequence; manual modifications were made to several sequences. The average sound level for un-modified sequences was 112.4 dBA. After modifications the average sound level of these sequences was 101 dBA, resulting in an overall average decrease of 11 dBA. The reduction in sound level resulted in decreased resolution or increased scan time for many sequences, thus these aspects were carefully considered in the decision to keep the new sequence or revert to the louder sequence. It should be noted that measurements by manufacturer service indicated that acoustic noise levels of our PET/MR scanner were within FDA and manufacturer specifications. During review of our hearing protection safety program, we discovered or were reminded of several important factors: 1. Proper technique must be used when inserting ear plugs. 2. Ear plugs are not 'one-size-fits-all.' Patients with small ear canals should be given appropriately sized ear plugs. 3. Improperly inserted or incorrect size ear plugs may shift in position during scanning, reducing effectiveness. 4. Technologists should communicate with patients about acoustic noise, just as they communicate with patients about other risks such as RF warming. 5. Hearing protection combination of ear plugs plus ear phones may be used for non-head coil scans. Ear phones may not fit in head coils, thus ear plugs alone must be used possibly exposing patient to increased risk if ear plugs do not fit well or are not inserted properly. 6. Some patients (e.g. those with pre-existing conditions, and those undergoing certain types of chemotherapy) may be more sensitive to acoustic noise issues.

## **CONCLUSION**

Patients may be subject to increased risk of damage to hearing when a combination of conditions exists including: scans in which ear plugs only are used, improperly inserted or incorrect size ear plugs are used, and use of particularly loud pulse sequences. Ear plugs plus ear phones should be used when possible. Technologists should be well educated regarding the use of hearing protection and should instruct patients to notify them if they experience excessive acoustic noise levels.

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SPPH21

### Basic Physics Lecture for the RT: Radiation Safety Refresher Course

Monday, Dec. 2 1:30PM - 2:45PM Room: S402AB

**CT** **PH** **RO** **SQ**

AMA PRA Category 1 Credits™: 1.25  
ARRT Category A+ Credits: 1.50

#### Participants

Scott J. Emerson, MS, Royal Oak, MI (*Moderator*) Nothing to Disclose  
Rebecca M. Marsh, PHD, Aurora, CO (*Presenter*) Nothing to Disclose

#### For information about this presentation, contact:

Rebecca.Marsh@ucdenver.edu

#### LEARNING OBJECTIVES

1) Understand and describe the risks and benefits associated with patient shielding. 2) Critically evaluate common radiation safety practices. 3) Apply current data about radiation risk from diagnostic imaging exams to clinical practice.

Printed on: 10/29/20



SPSP21

**Contrastes y Trazadores: Estado del Art-Sesion del Colegio Interamericano de Radiologia (CIR) en Espanol/Contrast Agents and Radiopharmaceuticals: State of the Art-Session of Interamerican College of Radiology (CIR) in Spanish**

Monday, Dec. 2 1:30PM - 3:30PM Room: E353C

**CT** **GI** **MR** **NM** **SQ** **US**

AMA PRA Category 1 Credits™: 2.00  
ARRT Category A+ Credits: 2.25

**FDA** Discussions may include off-label uses.

**Participants**

Jose L. Criales, MD, Huixquilucan, Mexico (*Moderator*) Nothing to Disclose  
Jorge A. Soto, MD, Boston, MA (*Moderator*) Royalties, Reed Elsevier

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**LEARNING OBJECTIVES**

1) Conocer el uso actual, ventajas y desventajas de los medios de contraste en diferentes modalidades y en diversas situaciones clinicas. 2) Conocer los diversos trazadores, ademas de FDG, analizando su metabolismo normal y las indicaciones mas frecuentes. 1) Understand the current indications, benefits and limitations of the use of contrast agents for various imaging modalities. 2) Review the various types of radiotracers available today for PET Imaging, along with their normal metabolism and common indications for their use.

**Sub-Events**

**SPSP21A Bienvenida/Welcome**

**Participants**

Jose L. Criales, MD, Huixquilucan, Mexico (*Presenter*) Nothing to Disclose  
Jorge A. Soto, MD, Boston, MA (*Presenter*) Royalties, Reed Elsevier

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**SPSP21B Aplicaciones de Contraste en Ultrasonido/Use of Contrast Agents in Ultrasonography**

**Participants**

Alison C. Harris, MBChB, Vancouver, BC (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Review the general principles and technique of using CEUS in the abdomen. 2) Discuss the role of CEUS in the diagnosis and characterization of masses in the liver and kidney. 3) Briefly discuss other applications of CEUS including guiding interventional procedures and monitoring of therapy.

**ABSTRACT**

Contrast-enhanced ultrasound (CEUS) continues to gain traction as a technique that complements traditional B-mode and Doppler ultrasound in the evaluation of the liver and other organs. Because the micro-vasculature can be visualized with CEUS and real-time imaging of tissue perfusion can be performed, imaging with this technique yields supplementary information, including flow and perfusion kinetics. The contrast agent used in CEUS is comprised of microbubbles, which are injected into a peripheral vein. The microbubble composition varies depending on the agent used, but the agent typically consists of an inert gas encased by a stabilizing shell composed of phospholipid, galactose, or albumin. The microbubbles circulate in the bloodstream and oscillate irregularly at low mechanical index settings within the acoustic field, creating nonlinear reflections that resonate at diagnostic ultrasound frequencies (3-5 MHz) and increase the signal produced. Proper technique and optimization of contrast-enhanced ultrasound require a balance between maintaining the integrity of the microbubble contrast agent and preserving the ultrasound signal. Established and emerging applications in the liver include diagnosis and characterization of focal lesions, aiding ultrasound-guided intervention, monitoring of therapy, and aiding surgical management. Read More:

<https://www.ajronline.org/doi/10.2214/AJR.17.17843> Read More: <https://www.ajronline.org/doi/10.2214/AJR.17.17843> Read More: <https://www.ajronline.org/doi/10.2214/AJR.17.17843>

**SPSP21C Uso de Agentes Organoespecificos en RM de Hgado/Use of Organ-specific Agents in MR of the Liver**

**Participants**

Claudio Bonini, MD, Rosario, Argentina (*Presenter*) Speaker, Bayer AG

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### LEARNING OBJECTIVES

1) Medios de contraste hepatoespecíficos por MR. 2) Estructura molecular y su interacción a nivel celular. 3) Indicaciones actuales. 4) Ventajas y desventajas en comparación con los contrastes convencionales. 5) Contraindicaciones / 1) Hepatospecific contrast by MR. 2) Molecular structure and interaction at the cellular level. 3) Current indications. 4) Advantages and disadvantages compared to conventional contrasts. 5) Contraindications.

### SPSP21D PET-CT: Radiotrazadores Mas Alla de FDG/PET-CT: Beyond FDG

Participants

Belen Rivera Bravo, MD, Mexico City, Mexico (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Identify PET/CT radiopharmaceuticals other than FDG, used in clinical practice. 2) Describe the uptake mechanism of each radiopharmaceutical. 3) Differentiate the normal biodistribution of each radiopharmaceutical by reading the images of the study. 4) Recognize the clinical indication of each radiopharmaceutical based in the uptake mechanism. / 1) Al final de esta actividad, los participantes deberán ser capaces de. 2) Identificar radiofármacos de PET/CT diferentes al FDG utilizados en la práctica clínica. 3) Describir el mecanismo de concentración de cada radiofármaco. 4) Diferenciar la biodistribución habitual de cada radiofármaco al observar las imágenes del estudio. 5) Reconocer la indicación clínica de cada radiofármaco basado en su mecanismo concentración.

### SPSP21E Preguntas/Q&A

### SPSP21F Presentacion del CIR/CIR Update

Participants

Henrique Carrete Jr, MD, Sao Paulo, Brazil (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Present the Inter-American College of Radiology and its main educational activities. 2) Address the activities of the CIR throughout the year 2019. 3) Outline future directions of CIR.

### SPSP21G Contraste Oral en TC: Nunca, Siempre O Algunas Veces? / Oral Contrast for Abdominal CT: Never, Always or Sometimes?

Participants

Antonio Jose B. Madureira, MD, Porto, Portugal (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand the rationale for the use of oral contrast agents in CT examinations. 2) To become familiar with the major indications of oral contrast use. 3) To discuss the benefits and drawbacks of their use.

### ABSTRACT

There has been a gradual decline in the last years in the use of oral contrast agents in CT examinations. In spite of these there are some clinical scenarios in which their use is of great benefit as it can clearly establish a diagnosis. In the emergency setting and in patients suspected of high-grade bowel obstruction their use is not warranted and may even be contraindicated. Oral contrast agents administration still has a role in CT imaging and every radiologist should be familiar with their indications and benefits in specific clinical situations.

### SPSP21H Daño Renal Agudo por Contraste Iodado: Conceptos Actuales/ Iodine Contrast Induced Acute Kidney Injury: Current Concepts

Participants

Cristian Varela, MD, Santiago, Chile (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Revisar la definición actual de daño renal agudo inducido por medio de contraste iodado/ Review the current definition of contrast induced acute renal injury. 2) Conocer las características de los pacientes en riesgo/ To know the characteristics of the high risk patients. 3) Definir las medidas de prevención basadas en la evidencia que el radiólogo debe conocer y practicar/ Define the evidence based prevention that the radiology need to know and apply.

### SPSP21I Retencion de Gadolinio/ Gadolinium Retention

Participants

Juan E. Gutierrez, MD, Medellin, Colombia (*Presenter*) Speakers Bureau, Bayer AG

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### LEARNING OBJECTIVES

1) Define the classification of GBCAs based on molecular structure and other physicochemical properties. 2) Discuss current

literature regarding deposition of gadolinium in the brain (Clinical - Pre Clinical). 3) Describe the relationship between the type of contrast agents and gadolinium deposition in brain Describe FDA, ACR, and European Medicines Agency (EMA) guidelines for GBCA usage.

#### **ABSTRACT**

Gadolinium Based Contrast Agents (GCBA) had been part of MRI environment for three decades with great benefits on the development of imaging as well as helping radiologists to achieve a better knowledge of the human body and its diseases. So far more than 500 million injections of GCBA's have been applied Worldwide, initially and for many years GBBA's were believed to be a harmless solution, to the point of being used as contrast for DSA and also in double or triple dose for MRI, however, in 2006 evidence of Gadolinium retention in tissues was published proving its link with Nefrogenic Systemic Fibrosis (NSF) in renal impaired patients. This situation triggered multiple academic and regulatory evaluations, involving the pharma industry to define the risk benefit of using GBCA's depending on its safety profile, plus new warning regulations and classification for this agents issued by the FDA, EMA and ACR. New evidence of Gadolinium deposition in the brain, specifically locate at Dentate Nucleus and Globus Pallidus, after multiple GCBA's injections in patients with normal kidney function was recently published (2014), and gives again new evidence of the potential harmful effect of Gadolinium in tissues. This situation brought a new regulatory environment with different approach by the FDA and EMA, as well as a new challenge for the MRI practice worldwide.

#### **SPSP21J Preguntas/Q&A**

#### **SPSP21K Clausura/Closing**

##### Participants

Jose L. Criales, MD, Huixquilucan, Mexico (*Presenter*) Nothing to Disclose

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SSE01

## Breast Imaging (Risk and Density)

Monday, Dec. 2 3:00PM - 4:00PM Room: E450A

BR SQ

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

FDA Discussions may include off-label uses.

### Participants

Ritse M. Mann, MD, PhD, Nijmegen, Netherlands (*Moderator*) Researcher, Siemens AG Researcher, Seno Medical Instruments, Inc Researcher, Identification Solutions, Inc Researcher, Micrima Limited Researcher, Medtronic plc Scientific Advisor, ScreenPoint Medical BV Scientific Advisor, Transonic Imaging, Inc Stockholder, Transonic Imaging, Inc  
Despina Kontos, PhD, Philadelphia, PA (*Moderator*) Research Grant, Hologic, Inc

### Sub-Events

#### SSE01-01 Use of Comprehensive Health Records to Improve Breast Cancer Risk Prediction

Monday, Dec. 2 3:00PM - 3:10PM Room: E450A

### Participants

Michal Chorev, PhD, Haifa, Israel (*Presenter*) Researcher, IBM Corporation  
Adam Spiro, Haifa, Israel (*Abstract Co-Author*) Nothing to Disclose  
Michal Guindy, MD, Tel Aviv, Israel (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

To evaluate the efficacy of a machine learning model to predict 1-year risk of breast cancer on the basis of complete electronic health records (EHR).

### METHOD AND MATERIALS

We collected EHR data of 68,342 women who underwent a screening mammogram between April 2013 and February 2017, to predict the risk of cancer developing within 1 year of the screening. We developed a gradient boosting machines model based on 17,651 clinical factors. We compared our model against Gail model. Based on sequential factor selection, we have identified the factors most contributing to the prediction. All models were evaluated using area under the ROC curve (AUC) values and DeLong's 95% confidence interval.

### RESULTS

The cohort comprised the clinical records of 68,342 women, of which 1,478 (2%) women were diagnosed with breast cancer within 12 months, 5,495 (8%) women had a negative biopsy within 12 months, 1,260 (2%) women had a BI-RADS 3 exam without a follow-up biopsy, and 60,109 (88%) women had at least two years of normal (BI-RADS 1 or 2) exams. We split the women's records to 51,256 (75%) in the train set and 17,086 (25%) in the test set. The model obtained AUC of 0.74 (95% CI, 0.72-0.77) and 0.73 (95% CI, 0.70-0.76) on the test set, based on the 17,651 factors and the top 40 factors, respectively. Gail model obtained AUC of 0.55 (95% CI, 0.51-0.58) on the test set, while a model based on factors from Gail's and other common risk models obtained an AUC of 0.66 (95% CI, 0.63-0.69). In addition to the traditional factors, the model identified factors concerning thyroid function, the immune system, indications of metabolic syndrome, iron deficiency, as well as others.

### CONCLUSION

Based on complete EHR data, our model showed an improved 1-year cancer risk assessment in comparison to Gail model. Limiting the model to only the 40 most contributing factors did not significantly affect its performance. We identified additional factors that improve breast cancer prediction.

### CLINICAL RELEVANCE/APPLICATION

A machine learning model based on health records for 1-year breast cancer risk outperformed state-of-the-art risk assessment models, and shed light on additional risk factors linked to breast cancer.

#### SSE01-02 The Correlation between the Breast Density, Body Mass Index, and the Risk of Breast Cancer Development in Relation to the Menopausal Status

Monday, Dec. 2 3:10PM - 3:20PM Room: E450A

### Participants

Rasha M. Kamal, MD, Cairo, Egypt (*Presenter*) Nothing to Disclose  
Salma Mostafa III, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Rasha W. Abdelhamid, MD, PhD, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
Sherif Mokhtar, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose

Norran H. Said, MD, FRCR, Cairo, Egypt (*Abstract Co-Author*) Nothing to Disclose  
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**PURPOSE**

To evaluate the correlation between the breast density, body mass index and the risk of breast cancer development in relation to the menopausal status.

**METHOD AND MATERIALS**

The study included 30,443 screened females who were classified into cancer and non-cancer groups and each group was sub-classified into pre- and post-menopausal groups. All patients performed mammography examination. The breast density was classified according to the 2013 ACR BI-RADS breast density classification. The weight and height were measured and the BMI was calculated. Independent t test was carried to compare the means of BMI among cancer and non-cancer groups as well as among pre- and post-menopausal groups. The correlation between breast density and breast cancer in the pre and post-menopausal groups was carried using Chi square test and Pearson's correlation. Measures of association were verified by calculating the Odds Ratio (OR) and the independence of each risk factor was verified by performing logistic regression analysis.

**RESULTS**

According to the BMI, 93.3% of the studied population were classified as over-weight and obese. A statistically significant difference was calculated between the mean BMI in the cancer and non-cancer groups ( $p = 0.027$ ) as well as between the pre- and post-menopausal groups ( $p < 0.001$ ). A positive statistically insignificant correlation was calculated between the breast density and the risk of breast cancer in the pre-menopausal group (OR: 1.062,  $p = 0.919$ ) and a negative highly significant correlation was calculated in the post-menopausal group (OR: 0.234,  $p < 0.001$ ). A highly statistical negative correlation was found between breast density and BMI ( $p < 0.001$ ) among both pre- and post-menopausal groups.

**CONCLUSION**

BMI and breast density are inversely associated with each other. This inverse relationship had an impact on the results of this study as the majority of the studied population were obese and overweight. In spite of this, both risk factors still play an independent significant role in increasing the risk of breast cancer development with variations according to the menopausal status.

**CLINICAL RELEVANCE/APPLICATION**

Identifying the modifiable breast cancer risk factors is essential in breast cancer preventive measures. In view of the results of the current study, strict weight control strategies should be implemented for post-menopausal women to decrease their risk for breast cancer development.

**SSE01-03 Changes in Breast Density Awareness, Knowledge, and Attitudes: A National Survey**

Monday, Dec. 2 3:20PM - 3:30PM Room: E450A

**Participants**

Deborah J. Rhodes, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
Sarah Jenkins, Rochester, ME (*Abstract Co-Author*) Nothing to Disclose  
Celine M. Vachon, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Carrie B. Hruska, PhD, Rochester, MN (*Abstract Co-Author*) Institutional license agreement, CMR Naviscan Corporation  
Carmen Radecki Breitkopf, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

**PURPOSE**

Recent federal breast density (BD) notification legislation requires standardization of BD communication to women after a mammogram and will supersede BD legislation now active in 37 U.S. states, but little is known about the impact of state BD legislation on women's understanding of BD. We assessed changes in BD awareness, knowledge, and attitudes over a 5-year interval.

**METHOD AND MATERIALS**

Using a probability-based web panel representative of the U.S. population, we administered an identical survey in 2012 and 2017 to women aged 40 -74 years.

**RESULTS**

Survey cooperation rate was 55% (1502/2730). Relative to 2012, more U.S. women in 2017 had heard of BD (65.8% vs 57.5%;  $P = .0002$ ) and had knowledge of BD's relationship to masking (57.9% vs. 48.6%;  $P < .0001$ ) and breast cancer risk (58.8% vs. 53.2%;  $P = .01$ ). Of those aware of BD in 2017, 47.3% had discussed BD with their provider (4.2% increase from 2012;  $P = .13$ ). After multivariable adjustment, factors significantly ( $p < .01$ ) associated with BD awareness in 2017 included white non-Hispanic race, income, education, and having >5 mammograms. As compared to women residing in state(s) without at least 1 year of legislation, those with legislation in effect were more likely to know the masking effect of BD in 2012 (89.9% vs 71.2%,  $p < .001$ ) and to know the associated breast cancer risk in 2017 (68.3% vs 58.3%,  $p < .001$ ); however, BD awareness was not associated with legislation status in 2012 or 2017. Similar to 2012, 62.5% would want to know their BD even in the absence of supplemental screening consensus. Fewer women reported that knowing their BD would make them feel confused in 2017 as compared to 2012 (35.9% vs 43.0%,  $p = 0.002$ ); however there was no change from 2012 in the proportion that would feel anxious or informed to make breast health decisions (44.8% and 89.7%, respectively). The majority (78.8%) felt that the federally mandated letter sent to women after a mammogram should include BD information.

**CONCLUSION**

Although BD awareness, knowledge, and discussions with providers have increased since 2012, there are few differences by state legislation status. Fewer than half of women acknowledged that knowing their BD would cause anxiety or confusion, while more than three-quarters want to know their BD, would feel empowered to make decisions, and would support federal BD notification legislation.

#### CLINICAL RELEVANCE/APPLICATION

BD awareness and knowledge is increasing, although the proportion of women who have discussed their BD with a healthcare provider is not. Important disparities in BD awareness remain by race, income, and education. The federal BD notification legislation presents an opportunity to clarify BD information to improve awareness and knowledge and to encourage BD conversations with providers.

#### SSE01-04 Background Parenchymal Uptake on MBI and Risk of Future Breast Cancer Diagnosis: A Cohort Analysis

Monday, Dec. 2 3:30PM - 3:40PM Room: E450A

##### Participants

Carrie B. Hruska, PhD, Rochester, MN (*Presenter*) Institutional license agreement, CMR Naviscan Corporation  
Jennifer R. Geske, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Amy Lynn Connors, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Dana H. Whaley, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Deborah J. Rhodes, MD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Michael K. O'Connor, PhD, Rochester, MN (*Abstract Co-Author*) Royalties, Gamma Medica, Inc  
Rickey E. Carter, PhD, Jacksonville, FL (*Abstract Co-Author*) Nothing to Disclose  
Celine M. Vachon, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

Background parenchymal uptake (BPU), which describes the intensity of radiotracer uptake in fibroglandular tissue relative to fat on molecular breast imaging (MBI), was associated with breast cancer (BC) in case-control studies. Here, we performed the first cohort analysis to examine association of BPU and risk of future BC.

#### METHOD AND MATERIALS

Women undergoing MBI with Tc-99m sestamibi and a dedicated gamma camera from 2004-2015 without BC diagnosis before MBI or <180 days after MBI were analyzed. BPU on baseline MBI exam was assessed as photopenic, minimal, mild, moderate, or marked; mammographic density was assessed according to BIRADS 5th edition categories. Follow up was performed via tumor registry linkage, record review, and patient survey. Multivariable proportional hazards models of time from baseline MBI until BC diagnosis or most recent negative breast imaging exam were employed.

#### RESULTS

Of 2987 women, 122 (4.1%) had future BC (86 invasive, 34 DCIS, 2 unknown). Mean time from baseline MBI to BC diagnosis was 48 months (range 6-115 months); mean follow-up in women without BC was 75 months (range 6-151 months). There were 66 BC cases in 2143 (3.1%) women with photopenic/minimal BPU, 27 cases in 434 (6.2%) with mild BPU, and 29 cases in 410 (7.1%) with moderate/marked BPU. 102 of 122 (84%) cases and 2300 of 2865 (80%) women without BC had dense breasts (BIRADS c or d). Relative to photopenic/minimal BPU, age and BMI-adjusted hazard ratios (HR) with 95%CI were 2.4 (1.5,3.7) for mild and 3.1 (1.9,4.9) for moderate/marked BPU ( $p < 0.0001$ ). Additional adjustment for BI-RADS density and hormone use minimally impacted HRs: 2.6 (1.6,4.2) for mild, 3.2 (2.0,5.2) for moderate/marked ( $p < 0.0001$ ). In 1827 postmenopausal women with 84 cases, HR was 3.5 (2.1,6.0) for mild and 5.0 (2.6,9.4) for moderate/marked ( $p < 0.0001$ ). In 1160 premenopausal women with 38 cases, HR was 1.3 (0.5,3.3) for mild and 2.0 (1.0,4.2) for moderate/marked ( $p = 0.18$ ).

#### CONCLUSION

BPU on MBI is associated with future BC and this risk remains after adjustment for mammographic density. Postmenopausal women with moderate/marked BPU have 5-fold risk of those with photopenic/minimal BPU and similar age, BMI, breast density, and hormone use.

#### CLINICAL RELEVANCE/APPLICATION

Postmenopausal women with high BPU on MBI should be informed of this risk association. Future studies are needed to examine the role of supplemental screening and prevention strategies in this group.

#### SSE01-05 Application of Machine Learning in the Calculation of Breast Density Using Transmission Ultrasound: A Comparison with Automated Mammographic Assessment

Monday, Dec. 2 3:40PM - 3:50PM Room: E450A

##### Participants

Bilal Malik, PhD, Novato, CA (*Presenter*) Employee, QT Ultrasound Labs  
Sanghyeb Lee, PhD, Novato, CA (*Abstract Co-Author*) Employee, QT Ultrasound  
James Wiskin, PhD, Salt Lake City, UT (*Abstract Co-Author*) Employee, QT Ultrasound Labs  
Rajni Natesan, MD, MBA, Houston, TX (*Abstract Co-Author*) Officer, QT Ultrasound Labs

#### PURPOSE

Increased mammographic density has been found to be an important input into breast cancer risk models. Current breast density assessments rely upon 2D projections or a 3D model consisting of 2D reconstructed images, which may not fully capture the topologically complex nature of the breast. In this study, we (1) describe and compare threshold- and clustering-based algorithms that use transmission ultrasound (TU) for the calculation of breast density, and (2) compare Quantitative Breast Density (QBD) with

automated mammographic density calculations.

## **METHOD AND MATERIALS**

Retrospective data was used from all women screened at a single breast center between April 2017 and November 2018 for a total of 309 breast scans. Within a 3-month interval, each subject received both a digital screening mammogram with tomosynthesis and TU of the breast. Mammographic breast density values were provided by VolparaDensity 3.1 (Volpara Health Technologies). QBD algorithms (1) segment breast tissue from water using attenuation, and (2) segment fibroglandular tissue by both thresholding based on the speed of sound, and clustering into fibroglandular tissue and fat. The ratio of fibroglandular tissue to total breast volume is calculated as QBD. QBD values were correlated with mammographic breast density scores and BI-RADS breast composition categories using Spearman's correlation coefficient ( $r$ ), where  $p < 0.05$  was considered significant. We discuss the variability of QBD as affected by iterative image reconstruction schemes.

## **RESULTS**

We found strong correlations between automated breast density values from TU and mammography (Spearman  $r=0.93$ , 95% CI: 0.91-0.94,  $p < 0.01$ ), and between QBD and BI-RADS breast composition categories (Spearman  $r=0.88$ , 95% CI: 0.86-0.91,  $p < 0.01$ ). The machine learning-based QBD was less sensitive to variability (by 65%) than the threshold-based QBD.

## **CONCLUSION**

We provide evidence that QBD calculations derived from TU are strongly correlated with automated mammographic breast density assessments. Further, machine learning-based QBD calculation is more robust and repeatable than threshold-based methods.

## **CLINICAL RELEVANCE/APPLICATION**

The presence of dense breast tissue is an independent risk factor for breast cancer. An accurate calculation of breast density is critical for risk stratification in screening for breast cancer.

## **SSE01-06 Breast Cancer Development During Postoperative Surveillance for Women Treated for Atypical Ductal Hyperplasia (ADH): Analysis Evaluating Predictive Factors Including Clinical and Radiologic Features**

Monday, Dec. 2 3:50PM - 4:00PM Room: E450A

### **Participants**

Hee Jung Moon, MD, Seoul, Korea, Republic Of (*Presenter*) Nothing to Disclose  
Jung Hyun Yoon, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Hye Sun Lee, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Eun-Kyung Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Min Jung Kim, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose  
Vivian Y. Park, MD, Seoul, Korea, Republic Of (*Abstract Co-Author*) Nothing to Disclose

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## **PURPOSE**

To evaluate cancer development rates and the clinicopathological factors associated to them during surveillance after surgery for atypical ductal hyperplasia (ADH) in the current era.

## **METHOD AND MATERIALS**

From November 2003 to December 2014, 205 women (mean age:  $47.1 \pm 11.2$  years) diagnosed as ADH via excisional biopsy were included. Preoperative breast images of the proven ADH were analyzed and grouped as follows: 1) negative, lesions not detectable on either mammography or ultrasonography (US), 2) lesions with calcifications detected on either mammography and/or US, 3) lesions without suspicious calcifications. Cox regression analysis was performed to evaluate clinical and radiological factors associated to breast cancer development after excision for ADH.

## **RESULTS**

Of the 205 women, 15 (7.3%) had developed either ductal carcinoma in situ (DCIS) or invasive breast cancer during surveillance (mean follow-up interval:  $63.9 \pm 40.8$  months). Symptomatic ADH was significantly associated to breast cancer during postoperative surveillance, 2.091 (95% confidence interval 0.008, 4.289,  $P=0.039$ ). None of the other clinicopathologic features were associated to breast cancer development after excision for ADH (all  $P > 0.05$ , respectively). Among the imaging features, the presence of calcifications detected on preoperative mammography/US did not show significant association to breast cancer development ( $P=0.268$ ).

## **CONCLUSION**

Breast cancer development rate during surveillance after excision for ADH was 7.3%. Presence of symptoms may have association to breast cancer development after excision for ADH.

## **CLINICAL RELEVANCE/APPLICATION**

Breast cancer development rate during surveillance after excision for ADH was 7.3%, in which symptomatic patients diagnosed with ADH may have higher association with breast cancer development after excision for ADH.

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SSE02

## Breast Imaging (Ultrasound Screening)

Monday, Dec. 2 3:00PM - 4:00PM Room: E451B



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Jung Min Chang, MD, Seoul, Korea, Republic Of (*Moderator*) Nothing to Disclose  
H. Carisa Le-Petross, MD, FRCPC, Houston, TX (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSE02-01 Assessing Real-World Contribution of Ultrasound and Clinical Data to Breast Cancer Screening Accuracy

Monday, Dec. 2 3:00PM - 3:10PM Room: E451B

### Participants

Michal Chorev, PhD, Haifa, Israel (*Abstract Co-Author*) Researcher, IBM Corporation  
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### PURPOSE

To evaluate the contribution of supplemental breast ultrasound performed regularly in addition to mammography as part of breast screening regime, as well as to assess machine learning model based on clinical information from electronic health records (EHR) in further optimizing personalized screening.

### METHOD AND MATERIALS

We extracted data of 32,058 women who underwent ultrasound examination as part of their regular breast cancer screening procedure between April 2013 and February 2017 (median age of 58 years). We utilized 17,651 clinical factors from the women's EHR and developed a gradient boosting machines model to predict breast cancer within one year based on mammogram BI-RADS, ultrasound BI-RADS, and their combination.

### RESULTS

The cohort comprised the clinical records of 32,058 women, of which 1,087 (3%) were diagnosed with breast cancer within 12 months, 12,362 (39%) had high breast density and 19,696 (61%) had low breast density. Adding ultrasound to screening increased sensitivity from 77% to 93% while decreasing biopsy positive predictive value (PPV) from 40% to 24%. For women with dense breasts, ultrasound increased sensitivity from 67% to 92% and decreased biopsy PPV from 34% to 16%. In order to examine whether EHR data can further improve our results by lowering the false positive rate, we developed a machine learning model, trained on 75% of the data and tested on 25%. Using an operation point of 87% sensitivity, the model's true negative rate (TNR) increased from 66% when using only mammogram BI-RADS to 82% when using mammogram BI-RADS combined with EHR data. Using an operation point of 95% sensitivity, the TNR increased from 68% when using mammograms and ultrasound BI-RADS to 78% when adding EHR data. This effect was more prominent in the high-density sub-population, where TNR improved from 43% to 70%.

### CONCLUSION

Supplementing ultrasound examination increased sensitivity, while increasing false positives by increasing biopsy rates. Use of clinical data improved specificity and therefore may reduce unnecessary biopsies. Further analysis may elucidate when ultrasound would be beneficial.

### CLINICAL RELEVANCE/APPLICATION

In a population that undergo ultrasound examination as part of their breast cancer screening regime, ultrasound increased sensitivity but reduced specificity. Using comprehensive EHR data can compensate for this reduction, and reduce unnecessary biopsies.

#### SSE02-02 Is There Value to Screening Breast Ultrasound as a Supplement to Mammography in Women at Average Risk in Comparison to Those with Known Risk Factors?

Monday, Dec. 2 3:10PM - 3:20PM Room: E451B

### Participants

Stamatia V. Destounis, MD, Scottsville, NY (*Presenter*) Advisory Committee, Hologic, Inc; Medical Advisory Board, iCad, Inc  
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**PURPOSE**

To review the outcomes of screening breast ultrasound performed in women dense breast tissue and no other known risk factors and compare with women with dense breasts and at least one known risk factor.

**METHOD AND MATERIALS**

Retrospective review of 24778 screening ultrasound (US) exams performed during period of 2013-2017 revealed 8415 (34%) exams in patients with no known risk factors (average risk), and 16364 (66%) with one or more known risk factors. All patients undergoing screening US also had screening mammography either on the same day, or within 1 year of the screening US exam. Cases given a BI-RADS 4 or 5 are the focus of further analysis.

**RESULTS**

There were 550 findings in patients with known risk factor(s) of which 395 were BIRADS 4 or 5 (2.4%). 103 findings were seen on both mammography and US (with 41 invasive cancers diagnosed), and 27 were on mammography only (3 invasive cancers diagnosed). Lesions were detected on US only in 265 (67%); 56 positive biopsies resulted from US only findings of which 50 were invasive breast carcinoma; 70% grade 1 or 2, 6 lymph node positive, and average size at excision of 1.4cm. There were 243 findings from exams performed in patients with no known risk factors; 168 were BIRADS 4 or 5 (2.0%). 13 were on mammography only (1 invasive cancer diagnosed) and 45 on both mammography and US (with 19 invasive cancers diagnosed). 109 US only findings resulted in diagnosis of 14 malignancies; 12 were invasive breast carcinoma, 100% grade 1 or 2, all node negative, and an average size at excision of 1.2cm. US only cancer detection was 3.2/1000 in those with known risk factors, and 1.4/1000 for those with no known risk factors.

**CONCLUSION**

Screening breast US in patients at average risk can identify invasive malignancy missed on screening mammography, though at a lower rate compared with those with one or more known risk factors (1.4/1000 v. 3.2/1000, respectively). Similar biopsy rates were observed in those with no risk factors compared with those with risk factors (2.0% v. 2.4%). The cancers visualized on US only in the average risk patients were all lower grade, node negative, and averaged 1.2cm, demonstrating there may be value of US in this population.

**CLINICAL RELEVANCE/APPLICATION**

Determining the optimal screening regimen for women at average risk is an area of continued investigation. Screening US may provide value when used as a supplemental tool with mammography.

**SSE02-03 Update on Population Level Supplemental Whole Breast Screening Ultrasound in Women with Dense Breasts**

Monday, Dec. 2 3:20PM - 3:30PM Room: E451B

**Participants**

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**PURPOSE**

Since 2009, we have offered technologist-performed hand-held whole breast screening (WBUS) as supplemental screening for women with dense breasts. With new federal breast density notification legislation recently passed, more women with dense breasts may seek supplemental screening. Understanding the performance outcomes of this adjuvant screening exam is of importance.

**METHOD AND MATERIALS**

An IRB-approved retrospective search of the breast imaging electronic database (PenRad, MN) was performed for a one-year period (10/1/17 - 9/30/18) for all supplemental WBUS after a normal tomosynthesis screening mammogram. All cases were performed at 3 out-patient satellite offices of a large academic practice by mammography technologists cross-trained in breast sonography using hand-held ultrasound. The final BI-RADS (BR) assessment of WBUS exams was recorded. The lesion size, type and outcome of BR 3 and 4 cases were recorded. Pathology outcomes of all biopsies were reviewed. For malignant cases, cancer size, type and stage was assessed.

**RESULTS**

A total of 5742 WBUS exams were performed. Final BR assessment was BR1/2 5585 (97.2%), BR3 136 (2.4%), BR4 21 (0.4%). Of 20 biopsies performed (1 cancelled), 2 cases were initially found malignant, PPV 10%. Two BR3 cases showed change on 6 month follow up and were found to be malignant for a total cancer detection 4 (0.7 per 1000). All cancers were 1cm or less, 2 were moderately and 2 were well-differentiated invasive ductal carcinoma. Three were irregular masses and 1 was a 5mm round mass.

Three had negative axillary lymph nodes, but the 5mm round mass had lymphovascular invasion and 2 positive nodes. Reasons for BR3 included: oval mass (58), clustered or complicated cysts (24), likely fibroadenoma (22), multiple masses (9), prominent axillary nodes (6), round mass (5), lobulated mass (4), dilated ducts (4), other (4). All BR3 and BR4 oval masses were all found to be benign on follow up or biopsy.

## CONCLUSION

After normal tomosynthesis mammograms, the majority of WBUS cases were found to be normal, with only a small proportion of cases requiring follow up or biopsy. All BR3 and 4 oval masses were found to be benign, suggesting these may be considered BR2. The supplemental cancer detection rate is found to be low.

## CLINICAL RELEVANCE/APPLICATION

With experience, the false positive rate of supplemental screening with WBUS over time is low but the supplemental cancer detection is also low.

### SSE02-04 BI-RADS 3 on Dense Breast Screening Ultrasound after Digital Mammography versus Digital Breast Tomosynthesis

Monday, Dec. 2 3:30PM - 3:40PM Room: E451B

#### Participants

Elizabeth H. Dibble, MD, Barrington, RI (*Presenter*) Nothing to Disclose  
Tisha M. Singer, MD, Barrington, RI (*Abstract Co-Author*) Nothing to Disclose  
Grayson L. Baird, PhD, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
Ana P. Lourenco, MD, Foxboro, MA (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

Compare BI-RADS 3 rate and follow-up of dense breast ultrasound (US) screening following digital mammography (DM) vs digital breast tomosynthesis (DBT)

#### METHOD AND MATERIALS

For this IRB-approved, HIPAA compliant study, we retrospectively searched databases at two tertiary breast imaging centers and an office practice staffed by the same fellowship-trained breast radiologists for BI-RADS 3 screening US examinations performed 10/1/14-9/30/16. All patients had at least two years of follow-up. Prior DM versus DBT, number and timing of patients lost to follow-up, downgrade rate and timing, upgrade rate and timing, and any pathology results were recorded. Differences between DM and DBT were compared using Chi Square and Fisher's Exact Tests.

#### RESULTS

3189 screening US examinations were performed, 1434/3189 (45%) after DM and 1674/3189 (52%) after DBT. 81/3189 (2.5%) had no prior mammogram available. 201/1434 (14%) had BI-RADS 3 results after DM and 179/1674 (11%) after DBT ( $p=0.006$ ). 95% of US screening exams were initial US screening exams. BIRADS 3 rate was 75/624 (12.0%) (42/317 (13%) for DM and 33/307 (11%) for DBT) during the first year of US screening and 75/624 (12.0%) (159/1117 (14%) for DM and 146/1367 (11%) for DBT) during the second year, a small but significant increase ( $p=0.0162$ ). Median follow-up time after DBT was 13 months (IQR 9, 24) versus 12 after DM (IQR 6, 23),  $p=0.0027$  (Figure 1). 73/375 (19.5%) of patients were lost to follow-up (38/198 (19%) after DM (26/38 (68.4%) no follow-up after initial exam) and 35/177 (20%) after DBT (19/35 (54.3%) no follow-up after initial exam) 5/375 (1.3%) elected biopsy (3/198 (1.5%) after DM and 2/177 (1.1%) after DBT). 282/375 (75.2%) patients were downgraded (149/198 (74%) after DM and 133/177 (75%) after DBT). 5/198 (2.5%) were upgraded after DM and 1/177 (0.6%) after DBT,  $p=.6866$  Median time to upgrade was 6 months after both DM and DBT. 1/375 (0.3%) patients with BI-RADS 3 results had cancer on follow-up.

#### CONCLUSION

The BI-RADS 3 rate of screening US was lower after DBT compared to DM. Many patients were lost to follow-up. Median follow-up time was longer after DBT vs DM. The cancer rate of BI-RADS 3 findings was 0.3%.

#### CLINICAL RELEVANCE/APPLICATION

Patients with prior DBT have the benefit of a lower risk of encountering probably benign findings on screening US that require follow-up imaging, and probably benign findings on screening US have a very low rate of being cancer.

### SSE02-05 Added Value of Supplemental Screening Breast Ultrasound Following Digital Breast Tomosynthesis Screening

Monday, Dec. 2 3:40PM - 3:50PM Room: E451B

#### Participants

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#### PURPOSE

To evaluate the added value of screening breast ultrasound (US) following digital mammography (DM) combined with digital breast tomosynthesis (DBT) (DM/DBT).

#### METHOD AND MATERIALS

This institutional review board approved retrospective review included 958 asymptomatic women (mean age, 54 years; range, 33-

81 years) who underwent screening DM/DBT and whole-breast screening US simultaneously at our health care center between March 2016 and October 2017. On the basis of the findings from DM and DBT, supplemental screening US was performed by one of 5 experienced radiologists using a handheld device, and they reported the DM/DBT and US findings separately. The cancer detection rate (CDR), sensitivity, specificity, and positive predictive value (PPV) of DM/DBT and DM/DBT combined with US were compared to those from histological examinations and to 12-month follow-up data, as a reference standard.

## RESULTS

Among 958 women, the breast density was almost entirely fatty in 6.5%, scattered areas of fibroglandular density in 23.9%, heterogeneously dense in 46.6%, and extremely dense in 23.1%. Seven cancers (6 invasive ductal cancer [IDC] and 1 ductal carcinoma in situ [DCIS]) were diagnosed, and the mean size of the invasive cancer was 1.6 cm (range, 0.3-3.3 cm). Four cases of cancer were detected on both DM/DBT and DM/DBT combined with US (4 IDCs), and the other three cases of cancer (2 IDCs and 1 DCIS) were detected when US was added to DM/DBT. All three US-detected cancers were node-negative, and the T stages of the 2 IDCs were T1 and T2, respectively. The sensitivities were 57.1% (95% confidence interval [CI]: 0.25-0.84) for DM/DBT and 100% (95% CI: 0.60-1.00) for DM/DBT combined with US ( $p=0.25$ ). Supplemental screening US detected additional 3.1 cancers per 1000 screens (95% CI: 0.6-9.6). Regarding specificity, DM/DBT had a 99.4% (95% CI: 0.99-1.00) specificity, whereas the specificity on addition of US was 96.4% (95% CI: 0.95-0.97) ( $P<0.0001$ ). The PPV was 40.0% (95% CI: 0.17-0.69) for DM/DBT, and the addition of US decreased the PPV to 17.5% (95% CI: 0.08-0.32).

## CONCLUSION

The addition of screening US resulted in minor increased CDR, however, increased the number of false-positive results.

## CLINICAL RELEVANCE/APPLICATION

Supplemental screening US can detect cancers that may not have been detected on DM/DBT screening; however, it increases the number of false-positive results, leading to recall examinations and biopsies.

## SSE02-06 Second Reading DBT versus Supplemental Screening US in Dense Breasts: Interim Analysis from the DBTUST

Monday, Dec. 2 3:50PM - 4:00PM Room: E451B

### Participants

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## PURPOSE

To determine the supplemental cancer detection rate from double reading tomosynthesis (DBT) compared to addition of technologist-performed whole breast handheld screening ultrasound (US).

## METHOD AND MATERIALS

In an IRB-approved, HIPAA-compliant protocol, 6258 women age 40-75 with heterogeneously dense or extremely dense breasts consented to annual technologist-performed US after DBT for three years at one of three sites in western Pennsylvania. Each modality was independently interpreted in opposing order by two radiologists who were MQSA qualified and met ACRIN 6666 US experience criteria. An interim analysis was performed of 6258 prevalence and 7616 incidence screens through 12/31/18.

## RESULTS

Median patient age was 53 years. Among 13,874 analyzable screens, 91 women were diagnosed with cancer (CDR 6.6 per 1000, median invasive size 1.5 cm): 68 (74.7%) detected by reader 1 on DBT; 9 (9.9%) only by reader 2 on DBT (one of which was also visible on US by the primary radiologist, and one of which was dismissed, detected due to symptoms); 12 (12.2%) only on US; 1 (1.1%) by MRI performed for other reasons, and 1 (1.1%) only because of symptoms (interval cancer). Nineteen cancers were DCIS, 18 seen only on DBT (2 only on double reading); 72 were invasive (median size 13 mm), 7 only on DBT double reading (median size 10 mm, 6/7 node negative) and 12 seen only on US (median size 10 mm, 10/12 node negative). Supplemental cancer detection rate of second reading DBT was 0.65/1000 vs. 0.9/1000 for US ( $p=0.37$ ). Supplemental recall rates were 36.9/1000 for double reading DBT vs. 50.4/1000 for US ( $p<0.001$ ); PPV 5.27% vs. 5.33%; NPV 99.89 vs. 99.92%. Of note, 6 cancers detected by reader 1 on DBT in year 1 had been missed on clinical reading of DBT in a subset of 3876 women prior to study entry: if attributed to double reading DBT, yield would be 15/13,874 or 1.1/1000 for double reading.

## CONCLUSION

In women with dense breasts, there is a significant yield from supplemental screening with technologist-performed US even after DBT, albeit with sizable increase in recall rate. Double reading DBT increases recall rate less than US. Additional cancers detected by double reading DBT vs. adding US were mostly nonoverlapping and invasive.

#### **CLINICAL RELEVANCE/APPLICATION**

The adequacy of screening DBT for women with dense breasts is uncertain. Noninvasive methods to improve cancer detection, including double reading and screening US, merit consideration.

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SSE13

## Health Service, Policy and Research (Trends and Utilization)

Monday, Dec. 2 3:00PM - 4:00PM Room: E261



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Jonathan James, BMBS, Nottingham, United Kingdom (*Moderator*) Nothing to Disclose  
Aran M. Toshav, MD, New Orleans, LA (*Moderator*) Speakers Bureau, Koninklijke Philips NV  
Kathryn Lowry, MD, Seattle, WA (*Moderator*) Research Grant, General Electric Company

### Sub-Events

#### SSE13-01 Medical Radiation Exposure of Patients in the United States

Monday, Dec. 2 3:00PM - 3:10PM Room: E261

### Participants

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Donald Miller, MD, Silver Spring, MD (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

This work reports the medical radiation exposure of patients in the United States. The report is an update 10 years after the publication of NCRP report 160 (2009) and is focused on 2016 data for radiation doses to patients from medical exposures.

### METHOD AND MATERIALS

Data on the type & number of procedures were obtained from a number of sources including commercial surveys, the US Medicare billing data, & other governmental & regulatory agencies, professional societies & published literature. Data on effective dose (E) per procedure were obtained from UK National Radiation Protection Board, International Commission on Radiological Protection (ICRP), American College of Radiology, State & Federal surveys & peer-reviewed literature. E was used as a dose metric & since E requires use of "tissue weighting factors" (wt) defined by ICRP Publications 60 (1990) and 103 (2007), E was computed using wt based on ICRP 60 & 103 to allow for comparison with previous reports. E-60 was computed for 2006 data & 2016 data & E-103 was computed for 2016 data for various sources of medical radiation. The collective effective dose (S) was estimated using different ICRP wt values, referred to as S-60 & S-103, & represented as percentages of collective doses for various modalities.

### RESULTS

The largest contributor of collective dose is CT. In 2016, there were nearly 84 million CT scans (25% higher than the previous report). The US population was 323 million in 2016, so the estimated annual individual effective dose (E-US 60 and E-US 103) from CT was ~1.4 to 1.5 mSv. In 2016, there were nearly 13.5 million nuclear medicine procedures (20% decrease from previous report). The estimated E-US 60 and E-US 103 from nuclear medicine was ~0.41 to 0.32 mSv. Collective effective dose (S) was also computed for radiography & fluoroscopy & for cardiac and non-cardiac interventional fluoroscopy.

### CONCLUSION

The 2016 estimates for S & E-US indicate a decline of ~15-20% from 885,000 (2006) to 717,000 & 755,000 person-Sv (S-103 & S-60) and approximately from 3.0 (2006) to 2.3 & 2.2 mSv (E-US 60 & E-US 103) respectively.

### CLINICAL RELEVANCE/APPLICATION

This report provides insight into the radiation exposure of patients in the United States and describes changes compared to the previous decade. These changes may be due to radiation dose optimization efforts, technological innovations and education and awareness about patient exposure.

#### SSE13-02 Trends and Independent Predictors of Imaging Utilization in Stroke: A Nationwide Analysis of

## Emergency Department and Inpatient Encounters between 2006 and 2014

Monday, Dec. 2 3:10PM - 3:20PM Room: E261

### Awards

#### Trainee Research Prize - Resident

#### Participants

Anna Trofimova, MD, PhD, Atlanta, GA (*Presenter*) Nothing to Disclose  
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### PURPOSE

To assess nationwide trends and independent predictors of neuroimaging utilization in stroke patients during emergency department (ED) and inpatient encounters between 2006 and 2014.

### METHOD AND MATERIALS

The largest U.S. all-payer ED and inpatient encounter databases (The Healthcare Cost and Utilization Project Nationwide Emergency Department Sample and National Inpatient Sample) were used to identify ED and inpatient visits with a primary diagnosis of cerebral artery occlusion between 2006 and 2014. Longitudinal trends and independent predictors of neuroimaging utilization were determined using logistic regression.

### RESULTS

An estimated total of 3,075,906 ED (mean age 70.4; 52.6% female) and 3,021,099 inpatient (mean age 70.9; 53.5% female) weighted cohorts were identified. Urban settings accounted for 47.3% of ED and 33.1% of inpatient encounters. Neuroimaging tests were performed in 8.5% of ED and 9.4% of inpatient encounters. In the ED setting, the most commonly performed imaging test was a non-contrast CT head (8.2%), followed by brain MRI (1.2%). In the inpatient setting, head CT was performed in 4.7% and brain MRI in 6.7% of encounters. Utilization of neuroimaging tests in the ED increased from 2006 (14,685, 4.5%) to 2014 (53,174, 13.9%). Imaging utilization in the inpatient setting was highest in 2007 (12.6%) and lowest in 2014 (7.3%). Independent predictors of higher ED imaging utilization were year after 2010 (OR 2.2); weekend admission (OR 1.1); private insurance (OR 1.2). Independent predictors of higher inpatient imaging utilization were non-elective admission (OR 1.7) and urban location (OR 1.3). Independent predictors of lower imaging utilization in both groups were: age > 55 (OR 0.8 (ED) and 0.9 (inpatient)) and female gender (OR 0.9 (ED and inpatient)). Urban location was an independent predictor of lower ED imaging utilization (OR 0.6). (All  $p < 0.05$ ).

### CONCLUSION

In the setting of stroke, patterns of imaging utilization and their predictors differed between the ED and inpatient settings. In 2014, imaging utilization in the ED was highest (13.9%), but lowest in the inpatient setting (7.3%), suggesting that imaging is increasingly being "frontloaded" earlier in stroke care.

### CLINICAL RELEVANCE/APPLICATION

Further research is needed to identify drivers of disparities and changing imaging utilization in the setting of stroke.

### SSE13-03 National Trends in Modalities of Entry to Colorectal Cancer Screening - What is the Current Application of CT Colonography?

Monday, Dec. 2 3:20PM - 3:30PM Room: E261

#### Participants

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Joseph Canner, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Bashar Safar, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Chady Atallah, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

Colorectal cancer is the third leading cause of cancer-related deaths in the US population. However, despite effective screening options, nearly one-in-three eligible adults have not undergone screening. Given the potential implications on assessments of policy efficacy and targeted educational initiatives, we aimed to determine the current national trends in first-time colorectal cancer screening in the outpatient setting.

### METHOD AND MATERIALS

Using a National Commercial Claims database, we identified the first outpatient visit of commercially insured patients between 50-55 years of age across all US states between 2010 and 2016. These were identified by ICD9 code V76.51 or ICD-10 code Z12.11 (screening for malignant neoplasms of colon). Patients with family history of gastrointestinal neoplasm and/or personal history of colonic polyps were excluded. Logistic regression analysis was used to estimate the annual change in the rate of imaging before and after controlling for covariates.

### RESULTS

896,789 individual first time patient encounters met inclusion criteria. Mean age 55, 52% were female. Across the study time period, 616,789 (68%) patients underwent colonoscopy as their screening modality. 277,147 (31%) patients underwent a fecal test, 2,166

(0.24%) underwent sigmoidoscopy, and only 678 (0.08%) underwent CT Colonography. The use of colonoscopy significantly increased over time, whereas the use of fecal testing decreased ( $p < 0.001$ ). The use of CT colonography did not significantly change.

## CONCLUSION

We found that the use of colonoscopy as the initial colorectal cancer screening modality represents the majority of screening and significantly increased with time in our national population sample. In contrast, the use of fecal tests decreased. The relative use of CT colonography has remained stable and represents less than 1% of initial screening, likely due to continued challenges for insurance coverage and fear of radiation.

## CLINICAL RELEVANCE/APPLICATION

Improving public awareness and commercial insurance coverage of CT colonography is required to increase its use and screening rates for persons who do not wish to undergo an invasive colonoscopy.

### SSE13-04 Associations Over Time Between Paid Medical Malpractice Claims and Imaging Utilization in the United States

Monday, Dec. 2 3:30PM - 3:40PM Room: E261

#### Participants

Alexander Villalobos, MD, Atlanta, GA (*Presenter*) Nothing to Disclose  
Michal Horny, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Danny Hughes, PhD, Reston, VA (*Abstract Co-Author*) Nothing to Disclose  
Sydney Cohen, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Richard Duszak JR, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

Little research has evaluated the association between medical imaging and the medicolegally unpredictable environment in the United States. This study explores state level relationships over time between the incidence and amount paid for malpractice claims and Medicare imaging utilization and spending in the United States.

## METHOD AND MATERIALS

Using claims data from a 5% national sample of Medicare beneficiaries for years 2004-2016, we calculated population-adjusted annual Medicare imaging utilization and spending by state. For each year and state, we calculated a population-adjusted lagged three-year rolling average paid malpractice claims frequency and payout amount using data from the National Practitioner Data Bank. Associations between paid malpractice claims and imaging utilization were assessed using a multivariate regression analysis with a log-log specification controlling for a secular trend and state effects.

## RESULTS

Between 2004 and 2016, Medicare fee-for-service imaging utilization and spending declined by 31.1% and 34.1%, respectively (from 418,618 to 288,559 examinations and \$27,954,457 to \$18,428,151 USD per 100,000 beneficiaries). Overall paid malpractice claims and payouts declined 46.9% and 29.3%, respectively (from 5.37 to 2.85 claims and \$1,488,243 to \$1,051,537 USD per 100,000 population). After controlling for secular trends, imaging utilization and spending were both positively associated with paid malpractice claims and payouts. Each 1% increase in paid malpractice claims was associated with a 0.14% increase in imaging utilization ( $p = 0.0001$ ) and a 0.10% increase in imaging spending ( $p = 0.0015$ ). Moreover, each 1% increase in malpractice payouts was associated with a 0.07% increase in imaging utilization ( $p = 0.0015$ ) and a 0.07% increase in imaging spending ( $p = 0.0015$ ).

## CONCLUSION

In recent years, Medicare imaging utilization and paid medical malpractice claims in the United States have both declined. Imaging utilization and spending are positively correlated with rates of paid malpractice claims and associated payouts.

## CLINICAL RELEVANCE/APPLICATION

The use of medical imaging is positively correlated with paid malpractice claims, supporting the contention that physicians utilize medical imaging as a "defensive medicine" strategy in the United States.

### SSE13-05 Risk of Anaphylactoid Reactions to Iopromide After Intra-Arterial versus Intra-Venous Administration: A Nested Case-Control Analysis of 133,331 Patients

Monday, Dec. 2 3:40PM - 3:50PM Room: E261

#### Participants

Jan Endrikat, Berlin, Germany (*Presenter*) Researcher, Bayer AG  
Alexander Michel, MD, PhD, Basel, Switzerland (*Abstract Co-Author*) Employee, Bayer AG  
Ralf Koelbach, MS, Berlin, Germany (*Abstract Co-Author*) Employee, PAREXEL International Corporation  
Philipp Lengsfeld, PhD, Berlin, Germany (*Abstract Co-Author*) Employee, Bayer AG  
Kai Vogtlaender, PhD, Wuppertal, Germany (*Abstract Co-Author*) Employee, Bayer AG

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## PURPOSE

To better understand the pathomechanisms of anaphylactoid reactions: Nested-case control analysis of 133,331 patients comparing intra-arterial (i.a.) with intra-venous (i.v.) to administration.

## METHOD AND MATERIALS

Four observational studies were pooled. Almost half of the study population (48.1%) was from Europe, and one quarter each from China (27.6%) and other Asia countries (24.1%). All patients received iopromide either i.a. or i.v. for angiographic procedures

(mostly cardioangiography) or contrast enhanced computed tomography. A nested case-control analysis, including a multivariate logistic regression model, was performed. Cases were defined as patients with typical and unequivocal anaphylactoid reactions, controls were patients without any recorded reactions. The primary target variable was the Odds ratio of having an anaphylactoid reaction after i.a. vs. i.v. administration.

## RESULTS

A total of 133,331 patients met the inclusion criteria, 27,871 and 105,460 patients received iopromide i.a. or i.v., respectively. For 822 patients anaphylactoid reactions were recorded, 132,509 patients served as controls. Major risk factors for anaphylactoid reactions were i.v. injection (vs. i.a.), age 18- <50 years (vs.  $\geq 65$  years), history of allergy or previous contrast media reaction (all  $p < 0.001$ ) and bronchial asthma ( $p = 0.005$ ). A total of 56 patients (0.2%) and 766 patients (0.7%) were recorded with anaphylactoid reactions after i.a. or i.v. administration, respectively ( $p < 0.0001$ ). Adjusted Odds ratio (i.a. vs. i.v.) was 0.23 (95 % C.I. 0.16 - 0.32).

## CONCLUSION

Anaphylactoid reactions to iopromide were significantly less frequently recorded after i.a. administrations. This could likely be related to the delayed and diluted arrival of the contrast medium in the lungs.

## CLINICAL RELEVANCE/APPLICATION

This study confirmed the hypothetical lower risk of anaphylactoid reactions after i.a. vs. i.v. administration of iodine contrast agents.

## SSE13-06 Which Radiology Subfield has the Greatest Amount of Specialization? A Generalizable Method for Quantifying Specialization within Radiology, and Its Results

Monday, Dec. 2 3:50PM - 4:00PM Room: E261

### Participants

Brian Haas, MD, San Francisco, CA (*Presenter*) Nothing to Disclose  
David McCoy, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Brian Trinh, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Evan D. Calabrese, MD, PhD, San Francisco, CA (*Abstract Co-Author*) Private interest, Qspin LLC  
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## PURPOSE

To develop methodology to measure specialization within radiology, and to apply it to Medicare claims data to study specialization.

## METHOD AND MATERIALS

The IRB approved this study under exempt review. We accessed the Medicare Physician and Other Supplier Public Use File for 2015, and searched for all diagnostic radiologists. All diagnostic radiology CPT codes were mapped into one or more subfields according to conventional anatomic designations: abdominal and pelvic, breast, chest, musculoskeletal, and neurologic. Within each subfield, a bundle of "advanced imaging" studies was designated, which consisted of those studies that benefit the most from a specialist interpretation. Each radiologists' total work RVU (wRVU) and wRVU within each radiology subfield were calculated, and based on these calculations, radiologists were labeled as either a specialist or a non-specialist for each subfield. The labeling of radiologists as specialists was done by comparing each radiologist's wRVU in a subfield against the average of radiologists who spend about 30% of their wRVU in that subfield. Finally, the percent of "advanced imaging" wRVU interpreted by a specialist versus a non-specialist in each subfield was calculated. Code for querying the database and statistics were performed in Python.

## RESULTS

A total of 28,851 radiologists billed Medicare for 48,431,278 wRVU in calendar year 2015. Of this wRVU, 96.67% falls within one of the areas of specialization. The number of specialists within each subfield varied from a high of 9,437 (33% of all radiologists) in abdominal and pelvic to a low of 1,559 (5% of all radiologists) in musculoskeletal. The amount of specialization is greatest within neuroradiology (84% of advanced imaging wRVU read by specialists), followed by abdominal and pelvic (78%), breast (55%), musculoskeletal (37%), and lastly chest (31%).

## CONCLUSION

It is possible to measure specialization within radiology with generalizable methodology that can be applied broadly across all subfields in radiology. This methodology demonstrates that specialization within radiology is greatest in neuroradiology and least in chest radiology.

## CLINICAL RELEVANCE/APPLICATION

We describe a method for measuring degree of specialization of the radiology marketplace. The methods can be used to assess individual radiology practices, or regional or national samples.

Printed on: 10/29/20



SSE14

## Informatics (Artificial Intelligence: Triage, Screening, Quality)

Monday, Dec. 2 3:00PM - 4:00PM Room: S406B

AI IN SQ

AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Nabile M. Safdar, MD, Milton, GA (*Moderator*) Nothing to Disclose  
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Neil Tenenholtz, PhD, Boston, MA (*Moderator*) Employee, Microsoft Corporation

### Sub-Events

#### SSE14-01 Automated AI Detection and Measurement of Midline Shift on Head CT Scans in an Emergency Teleradiology Set Up: Its Contribution to Critical Value Communication

Monday, Dec. 2 3:00PM - 3:10PM Room: S406B

### Participants

S S. Jayadeepa, MBBS, MD, Bangalore, India (*Presenter*) Nothing to Disclose  
Arjun Kalyanpur, MD, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose  
Anjali Agrawal, MD, Delhi, India (*Abstract Co-Author*) Nothing to Disclose  
Prashant Akhawat, MBA, MSc, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose

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### CONCLUSION

The immediate detection and accurate measurement of midline shift on head CT examinations is key to prompt patient triage and management in the emergency setting. An AI algorithm demonstrated promising results in both detection and quantification of midline shift, thereby allowing for prioritization of radiologist review, accelerated critical value communication and enhanced patient care.

### Background

To evaluate the efficiency of an artificial intelligence (AI) program using complex neural networks and deep learning algorithms for the detection and measurement of midline shift on non-contrast computed tomography examination of the head. Also, to determine feasibility of deploying such an algorithm in the emergency Teleradiology setup to promote earlier detection and facilitate work flow prioritization.

### Evaluation

The retrospective study was HIPAA compliant and performed with the approval of the institutional review board. A representative sample set of curated data comprising 163 non-contrast pre-operated noncontrast computed tomography examination of the head were used for validation constituted by 93 cases positive for midline shift and 70 cases negative for midline shift. AI throughput was processed with convolutional neural network for midline shift detection and measurement.

### Discussion

AI tool demonstrated, for the midline shift detection model, accuracy at 95.15% with sensitivity of 92.63%(88 out of 93), (confidence interval CI-85.41%-96.99%) and specificity of 98.57%(69 out of 70)(CI-92.3%-99.96%), with area under the receiver operating characteristic curve(AUC) of 0.956. AI tool demonstrated, for the midline shift measurement model compared to radiologist ground truth reports, accuracy at 91.41% with sensitivity of 91.95%(80 out of 93) (confidence interval CI-84.12%-96.7%) and specificity of 90.79%(69 out of 70)(CI-81.94% to 96.22%), with area under the receiver operating characteristic curve(AUC) of 0.914.

#### SSE14-02 Utilizing Machine Learning to Improve ED and In-Patient Throughput in Cases of Acute Intracranial Hemorrhage by Non-Contrast Head CT

Monday, Dec. 2 3:10PM - 3:20PM Room: S406B

### Participants

Melissa A. Davis, MD, Atlanta, GA (*Presenter*) Stockholder, Nines Radiology  
Balaji Rao, MBBS, FRCR, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Paul Cedeno, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Atin Saha, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Vahe M. Zohrabian, MD, Norwalk, CT (*Abstract Co-Author*) Nothing to Disclose

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## CONCLUSION

Increases in patient volume have been accompanied by increases in ED and inpatient imaging volume, which have led to higher demands for shorter report TAT in an effort to streamline throughput and decrease healthcare expenditures. Integrating a ML software tool in the radiologist workflow allows for more rapid diagnosis and reporting of acute pathologies, which can enhance triage of patients to the appropriate level of care.

## Background

From order scheduling to report generation, ML is slowly revolutionizing radiology work processes. Demonstrating how algorithms ultimately add value and improve patient outcomes remains of importance. Here, we determine the impact on throughput of a ML platform in cases of acute intracranial hemorrhage (ICH) by non-contrast head CT at a large, busy tertiary care center. We hypothesize that utilization of ML software trained to detect ICH leads to a reduction in report turnaround time (TAT) and length of stay (LOS) in both ED and in-patient populations.

## Evaluation

A ML platform based on a convolutional neural network model was incorporated across CT scanners at 2 imaging sites in January 2018. Report TAT and LOS were derived for reports and patients, respectively, between July 2017 and December 2017 (pre-ML) and compared to those between January 2018 and June 2018 (post-ML). 26,249 cases were evaluated in 2017 (pre-ML) and 25,544 cases in 2018 (post-ML). Report TAT decreased from 53 min to 46 min for head CT cases positive for ICH ( $p < .001$ ). In-patient LOS for positive cases decreased from 9950 min to 8870 min ( $p > .05$ ). ED LOS decreased from 567 min to 508 min ( $p < .001$ ).

## Discussion

The rapid detection of ICH in patients with acute neurological symptoms is critical and delays in diagnosis are costly. Here, we demonstrate that adoption of a ML software platform was associated with a statistically significant decrease in report TAT for cases positive for ICH as a function of the software prioritizing those scans for radiologist interpretation. The implementation of a ML platform was also associated with a statistically significant decrease in LOS for ED patients, but not for inpatients, presumably as those patients with ICH were expeditiously transferred out of the ED.

## SSE14-03 Contemporaneous Use of AI as The Third Eye In a Teleradiology Setup for CT Evaluation of Subtle Intracranial Hemorrhages in An Emergency Teleradiology Setup

Monday, Dec. 2 3:20PM - 3:30PM Room: S406B

### Participants

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Anjali Agrawal, MD, Delhi, India (*Abstract Co-Author*) Nothing to Disclose  
Prashant Akhawat, MBA, MSc, Bangalore, India (*Abstract Co-Author*) Nothing to Disclose

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## CONCLUSION

Contemporaneous use of AI as a second reader on critical scans holds promising results towards improvised patient care by increasing the accuracy rates of reading radiologists in a teleradiology setup.

## Background

With increasing workloads in radiology, the number of scans reported by teleradiologists is ever increasing. AI as the third eye may enhance accuracy on critical scans in a teleradiology setup to optimize work efficiency. The aim of this study was to evaluate if AI algorithm can help reduce errors in evaluation of subtle critical findings such as intracranial hemorrhages in head CT scans in an emergency teleradiology setup.

## Evaluation

Retrospective analysis of 22 cases of intracranial hemorrhages missed by the radiologists from a denominator of 50,782 CT heads read in an emergency teleradiology setup were selectively run through AI models designed specifically for detection of intracranial hemorrhage. We then compared this bleed detection AI model with an enhanced model designed specifically to detect small and subtle hemorrhages for improved accuracy.

## Discussion

The AI algorithm was able to pick up intracranial hemorrhages 11 out of 22 missed bleed critical scans with 59.62% sensitivity and 91.07% specificity, and accuracy of 89.8% accuracy with an AUC of 0.753 on slice-wise detection of the routine bleed detection model. The AI algorithm demonstrated higher sensitivity at detection of subtle intracranial hemorrhages at 14 out of 22 critical scans with an AUC of 0.789, 69.23% sensitivity and 88.64% specificity, and slightly decreased accuracy at 87.85%, due to increased false positives as a trade-off on the enhanced bleed detection model. The performance of bleed detection model was also run against a random selection of 367 pre-operated, non-contrast head CTs with accuracy for ICH at 91.55% with sensitivity of 93.16% (150 out of 161) (confidence interval CI-88.10% to 96.64%) and specificity of 90.29% (186 out of 206) (CI-85.40% to 93.97%), with area under the receiver operating characteristic curve (AUC) of 91.55% (88.22% to 94.19%).

## SSE14-04 Utility of Artificial Intelligence Tool as a Prospective Radiology Peer Reviewer -Detection of Unreported Intracranial Hemorrhage

Monday, Dec. 2 3:30PM - 3:40PM Room: S406B

### Participants

Balaji Rao, MBBS, FRCR, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Vahe M. Zohrabian, MD, Norwalk, CT (*Abstract Co-Author*) Nothing to Disclose  
Paul Cedeno, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose  
Atin Saha, MD, New Haven, CT (*Presenter*) Nothing to Disclose  
Jay K. Pahade, MD, Southport, CT (*Abstract Co-Author*) Consultant, General Electric Company  
Melissa A. Davis, MD, Atlanta, GA (*Abstract Co-Author*) Stockholder, Nines Radiology

## CONCLUSION

AI solution can serve as a prospective peer review tool for non-contrast head CT scans to identify ICH and thus decrease false negatives.

## Background

Misdiagnosis of intracranial hemorrhage (ICH) can adversely impact patient outcome. Increasing workload on the radiologists may increase the chance of error and compromise quality of care provided by the radiologists.

## Evaluation

We used a FDA approved artificial intelligence (AI) solution based on convolutional neural network (CNN) to assess the prevalence of ICH in scans which were reported as negative for ICH. We retrospectively applied the AI solution to all consecutive non-contrast computed tomography (CT) head scans performed at 6 imaging sites affiliated to our institution. In the 6565 non-contrast CT head scans, which met the inclusion criteria, 5585 scans were reported to have no ICH ("negative-by-report" cases). We applied AI solution to these "negative-by-report" cases. AI solution suggested there were ICH in 28 of these scans ("negative-by-report" and "positive-by-AI solution"). After consensus review by three neuroradiologists, 16 of these scans were found to have ICH which was not reported (missed diagnosis), with false negative rate of radiologists for ICH detection at 1.6%.

## Discussion

Our study demonstrates that AI solution can help radiologists to diagnose ICH and thus decrease error rate.

## SSE14-05 Diagnostic Assessment of a Deep Learning System For Detecting Missed Pulmonary Nodules On Computed Tomography

Monday, Dec. 2 3:40PM - 3:50PM Room: S406B

### Participants

Kueian Chen, Taoyuan, Taiwan (*Presenter*) Nothing to Disclose  
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## CONCLUSION

Use of DLS-assisted automated detection as a second reader for missed pulmonary nodules on computed tomography (CT) may potentially enhance the performance of radiologists.

## Background

We aim to evaluate the diagnostic performance of a deep learning system (DLS) for automated detection of missed pulmonary nodules on computed tomography (CT) as a second reader to enhance the performance of radiologists.

## Evaluation

This single-center retrospective study screened 21150 consecutive chest CT studies from September 2018 to February 2019. Axial chest CT images were transferred to the DLS for automated detection of pulmonary nodules if the associated report was negative. Pulmonary nodules detected by the DLS but not mentioned in the initial radiology report were flagged. Flagged images were then reviewed by four board-certificated radiologists with five years of experience. All flags were scored according to ACR RADPEER 2016 scoring guidelines. Nodules marked as score 2 ("understandable miss") or 3 ("should not be missed") were then separated as clinically insignificant (2a or 3a) or clinically significant (2b and 3b) in accordance with Fleischner 2017 guideline for pulmonary nodules. The miss rate was defined as the total number of studies receiving score 2 or 3, divided by total screened studies.

## Discussion

Among 140 studies flagged by the DLS, 73 (52 %) were confirmed by radiologist review, and further categorized as 2a in 33 studies (24 %), 2b in 13 studies (9 %), 3a in 14 studies (10 %), and 3b in 13 studies (9%). For identifying clinically significant findings (2b/3b), the system's overall specificity was 18%. Missed pulmonary nodules were identified in 0.3% of total chest CT scans, and one-third of these had clinical implications.

## SSE14-06 Using Out of Distribution Detection to Fix Nearly All AI Models in Medical Imaging

Monday, Dec. 2 3:50PM - 4:00PM Room: S406B

### Participants

David Eng, Stanford, CA (*Presenter*) Founder, Bunkerhill Health  
Nishith Khandwala, Palo Alto, CA (*Abstract Co-Author*) Founder, Bunkerhill Health  
Daniel L. Rubin, MD, Stanford, CA (*Abstract Co-Author*) Consultant, F. Hoffmann-La Roche Ltd

## PURPOSE

Nearly all AI models for medical imaging behave unpredictably and fail silently on input data dissimilar from data used to train them, which hampers their safe clinical use. To address this problem, we introduce a simple modification to the standard AI training procedure that teaches AI models to produce confidence estimates along with their original task predictions, which radiologists can use to determine how reliable the AI model believes its task predictions to be.

## **METHOD AND MATERIALS**

Our approach separates the AI model output into task and confidence components. We use the original loss for the task term, but introduce a new loss that encourages the model to ask for hints on inputs for which it has lower confidence. This modification produces models with higher confidence for inputs resembling the training set ('in distribution') and lower confidence otherwise ('out of distribution') at inference time. To evaluate our approach, we trained AI models for two previously studied tasks: chest abnormality detection and bone age estimation. For each task, we reused previous model architectures for the task prediction and introduced our approach to the training procedure for the confidence estimate.

## **RESULTS**

For both tasks, our approach successfully distinguished between unseen 'in distribution' and 'out of distribution' inputs ( $p < 0.05$ ). For our classifier that predicts normal or abnormal on AP/PA chest radiographs, our confidence estimate yields AUC of 0.76 for filtering lateral view chest radiographs and 0.86 for filtering out upper extremity radiographs, while maintaining a task AUC of 0.89, which does not differ significantly from the AI model trained without the confidence term ( $p = 0.38$ ). For our regressor that predicts bone age from hand radiographs, our confidence estimate yields an AUC of 0.997 for filtering out other upper extremity radiographs, while maintaining a task MAD of 5.6 months, which does not differ significantly from the model trained without the confidence term ( $p = 0.34$ ).

## **CONCLUSION**

Our promising results in two clinical tasks suggest that our approach could enable radiologists to determine when AI models for medical imaging are likely to produce correct or incorrect predictions.

## **CLINICAL RELEVANCE/APPLICATION**

Similar to how rads express uncertainty when interpreting outside their specialty, our method permits AI models to express uncertainty on inputs outside of the narrow task for which they were trained.

Printed on: 10/29/20



SSE26

## Vascular/Interventional (Education and Safety)

Monday, Dec. 2 3:00PM - 4:00PM Room: E260



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Lisa H. Kang, MD, Sacramento, CA (*Moderator*) Nothing to Disclose  
Gloria M. Salazar, MD, Boston, MA (*Moderator*) Consultant, Medtronic plc

### Sub-Events

#### SSE26-01 Endovascular Simulation Training: A Tool to Increase Enthusiasm for Interventional Radiology Among Medical Students

Monday, Dec. 2 3:00PM - 3:10PM Room: E260

### Participants

Roman Kloeckner, MD, Mainz, Germany (*Presenter*) Advisory Board, Guerbet SA; Advisory Board, Bristol-Myers Squibb Company; Advisory Board, Sirtex Medical Ltd; Speaker, Guerbet SA; Speaker, Sirtex Medical Ltd; Speaker, BTG International Ltd  
Fabian D. Stohr, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Sebastian Schotten, MD, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
Christoph Dueber, MD, Mainz, Germany (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Interventional radiology (IR) is a growing field. However, in most medical schools it is underrepresented in the curriculum. Therefore, we aimed to test whether endovascular simulator training improves the attitude towards IR among medical students.

### METHOD AND MATERIALS

This prospective study is conducted at two university medical centers. In both, a dedicated 90-minute course on IR is given to 4th year medical students; in center A in two weeks in February 2019 on a daily basis, in center B once per week between March and May 2019. The course is split into two halves: One theoretical 45-minute part about IR and one practical 45-minute part using endovascular simulators. Questionnaires are completed before the course, after the theoretical part, and after the practical part using smartphones/tablets. Students are asked to rate their knowledge of IR, their interest in IR, the attractiveness of IR, and their willingness to potentially work in IR in the future on a 7-point Likert scale. To prevent position effect-bias, the study was conducted in a crossover design, i.e. 50% of the students heard the theoretical part first followed by the practical training, the other 50% vice versa.

### RESULTS

As of the abstract deadline, 211 students completed all three questionnaires. Seminar and simulator led to an increase in knowledge about IR (pretest: 2.7 vs. post-seminar/post-simulator: 5.11/5.36), interest in IR (5.16 vs. 5.54/5.69), attractiveness of IR (4.55 vs. 4.76/4.85), and the likelihood to choose IR in the future (3.33 vs. 3.75/3.9) (all  $p < 0.05$ ). Although both parts led a significant improvement, the effect was significantly stronger for the simulator part compared to the theoretical part regarding all items (all  $p < 0.05$ ).

### CONCLUSION

Endovascular simulator training in medical school significantly increases the knowledge about IR and the willingness to potentially choose IR in the future. In May 2019 the second part will be completed in center B, hopefully confirming these initially positive results.

### CLINICAL RELEVANCE/APPLICATION

Implementing dedicated IR-courses in medical school can help to fight recruitment problems in IR; a practical simulator training further increases students' motivation.

#### SSE26-02 Burnout and Moral Injury Among Interventional Radiologists

Monday, Dec. 2 3:10PM - 3:20PM Room: E260

### Participants

Jacob J. Bundy, MD, MPH, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
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**PURPOSE**

To characterize burnout among Interventional Radiologists.

**METHOD AND MATERIALS**

An anonymous, Institutional Review Board-exempt, 34-question online survey was distributed to practicing Interventional Radiologists through the Society of Interventional Radiology Open Forum, Twitter, Facebook, and LinkedIn. The survey consisted of demographic and practice environment questions, and the 22-item Maslach Burnout Inventory (MBI). Interventional radiologists with high scores on EE ( $\geq 27$ ) or DP ( $\geq 10$ ) MBI subscales were considered to have at least one manifestation of physician burnout. STROBE reporting guidelines were followed.

**RESULTS**

339 surveys were completed over ten days starting on January 7, 2019. 263 (77.6%) respondents identified as men, 75 (22.1%) as women, and 1 (0.3%) as trans-male. The respondents were Interventional Radiologists practicing at academic (136; 40.1%), private (145; 42.8%), and hybrid (58; 17.1%) centers. Respondents worked an estimated  $>40$  hours (15; 4.4%), 40-60 hours (225; 66.4%), 60-80 hours (81; 23.9%), and  $>80$  hours (18; 5.3%) per week. 307 (90.6%) reported taking call, with most respondents taking 1-5 (116; 34.2%) or 6-10 (158; 46.6%) calls per month. Mean MBI scores for EE, DP, and personal achievement were  $29.7 \pm 12.9$ ,  $10.7 \pm 7.0$ , and  $39.7 \pm 6.8$ . Burnout among respondents was 72.0% (244 Interventional Radiologists). Identifying as a woman was significantly associated with burnout (odds ratio 2.4;  $P=0.009$ ). Compared to respondents who worked  $<80$  hours per week, working  $>80$  hours per week was significantly associated with burnout (odd ratio 7.0;  $P=0.030$ ). Practice level ( $P=0.553$ ), practice setting ( $P=0.557$ ), diagnostic radiology duties ( $P=0.588$ ), practice size ( $P=0.232$ ), years' post-graduate ( $P=0.373$ ), age ( $P=0.856$ ), and amount of call taken ( $P=0.110$ ) were not significantly associated with burnout.

**CONCLUSION**

Burnout is prevalent among Interventional Radiologists. Identifying as a woman and working more than 80 hours per week were strongly associated with burnout. Strategies to reduce burnout within interventional radiology should consider improving gender equity and work hours among Interventional Radiologists.

**CLINICAL RELEVANCE/APPLICATION**

Strategies to reduce burnout within interventional radiology should consider improving gender equity and work hours among Interventional Radiologists.

**SSE26-03 Hand Motion Analysis of Radiologists Performing Simulated Radial Arterial Access: Discerning Differences in Operator Experience Using Kinematic Analysis**

Monday, Dec. 2 3:20PM - 3:30PM Room: E260

**Participants**

Jeffrey Weinstein, MD, Wellesley, MA (*Presenter*) Nothing to Disclose  
Fady El-Gabalawy, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Ammar Sarwar, MD, Boston, MA (*Abstract Co-Author*) Stockholder, Agile Devices, Inc; Scientific Advisory Board, Agile Devices, Inc; Grant Support, Sirtex Medical Inc  
Olga R. Brook, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Salomao Faintuch, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Michael Hsu, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Seth J. Berkowitz, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Matthew R. Palmer, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Muneeb Ahmed, MD, Boston, MA (*Abstract Co-Author*) Research Grant, General Electric Company Stockholder, Agile Devices, Inc  
Scientific Advisory Board, Agile Devices, Inc

**PURPOSE**

To perform a pilot evaluation of the ability of electromagnetic hand motion sensor technology to determine differences in the kinematic profile of operators based on their practice experience with radial artery access.

**METHOD AND MATERIALS**

Six fellowship-trained, right-handed attending interventional radiologists with 1-13 years of experience performed simulated arterial access on a commercial phantom. Two of the attendings reported limited radial arterial access experience ( $<50$  cases), two reported significant experience obtaining palpatory radial artery access ( $>100$  cases), and two had experience with radial artery access under ultrasound (US) guidance ( $>100$  cases). The task involved placing a 21-gauge needle into the phantom radial artery and threading a wire into the artery. The phantom had tubing with red fluid and a squeeze-bulb to simulate a radial artery with blood and arterial pulsations. Each operator performed the task 5 times with an electromagnetic sensor affixed to the dorsum of each hand between the second and third metacarpals. Total time and total distance the sensors traveled (path length) were measured. Statistical analysis was performed using paired T-tests.

**RESULTS**

The radiologists with significant palpatory radial artery access experience had both a shorter time to complete the task and path

length compared to those who had limited radial artery experience ( $91 \pm 13$ s vs.  $143 \pm 32$ s,  $p < 0.01$  and  $141 \pm 18$  cm vs.  $239 \pm 100$  cm,  $p = 0.012$ ). Those with ultrasound experience had a shorter time to complete the task than those with limited radial access experience ( $105 \pm 11$ s vs.  $143 \pm 32$ s,  $p = 0.012$ ) but their path length was not significantly shorter ( $168 \pm 35$ cm vs.  $239 \pm 100$ cm,  $p = 0.063$ ). When comparing only the palpatory and US groups, the time to complete the task was not significantly different ( $91 \pm 13$ s vs.  $105 \pm 11$ s,  $p = 0.079$ ) but the path length was shorter for the palpatory group ( $141 \pm 18$  cm vs  $168 \pm 35$ cm,  $p = 0.042$ ).

## CONCLUSION

Kinematic analysis of hand motion using electromagnetic motion tracking was successful in distinguishing variability of operator experience with radial artery access. Further exploration of this technology may determine if the kinematic profile correlates with proficiency in completing a procedural task.

## CLINICAL RELEVANCE/APPLICATION

Electromagnetic motion sensor technology can determine subtle differences in experience between trained operators for a given manual task and help determine areas for further development.

### SSE26-04 Comparison of a New Material-Specific Contrast-to-Noise Ratio-Based Exposure Control with a Regular-Dose Dependent Exposure Control in a Clinical Angiographic System

Monday, Dec. 2 3:30PM - 3:40PM Room: E260

#### Participants

Thomas Werncke, MD, DIPLPHYS, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Sabine Maschke, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Jan Hinrichs, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Frank K. Wacker, MD, Hannover, Germany (*Abstract Co-Author*) Nothing to Disclose  
Bernhard C. Meyer, MD, Hannover, Germany (*Presenter*) Research Consultant, Pro Medicus Limited

#### PURPOSE

The purpose of this phantom study was to evaluate the skin-dose reduction potential of a material specific contrast-to-noise ratio based exposure control (CEC) in comparison to a regular detector based exposure control (DEC) in a clinical angiographic system.

#### METHOD AND MATERIALS

A standardized 3D-printed phantom with an iron, tantalum and platinum foil and cavities for contrast material (iodine, barium, carbon dioxide) was developed in order to investigate the dependency of a spatial frequency dependent CNR on image acquisition settings. This phantom was placed into a stack of polymethylmethacrylate and aluminum plates, simulating a patient equivalent thickness (PET) of 2.5cm-40cm. Fluoroscopic (FL) and diagnostic radiograph (DR) images were acquired using a clinical angiographic system with material-specific CEC (iron, tantalum, platinum, carbon dioxide, iodine barium) and regular DEC protocols implemented. The CNR of the CEC protocols were adjusted to the CNR of the DEC protocols in order to allow for a comparison. The possible skin radiation dose reduction for material specific CEC protocols compared to DEC protocols was estimated while the CNR was maintained.

#### RESULTS

Material specific CEC demonstrated a substantial skin dose reduction potential compared to DEC protocols. For platinum and tantalum the possible mean skin radiation dose reduction while maintaining CNR was  $59 \pm 21\%$  (max. 91% at 30cm) and  $65 \pm 18\%$  (max. 92% at 30cm) for DR and  $58 \pm 23\%$  (max. 84% at 30cm) and  $58 \pm 23\%$  (max. 87% at 27.5cm) for FL, respectively. For carbon dioxide imaging the possible mean skin radiation dose reduction was  $52 \pm 19\%$  (max. 87% at 30cm). For barium, iodine and iron the mean skin radiation dose reduction while maintaining CNR was  $32 \pm 19\%$ ,  $33 \pm 17\%$ ,  $34 \pm 17\%$  for DR and  $18 \pm 12\%$ ,  $19 \pm 18\%$  and  $18 \pm 11\%$  for FL. For these materials highest skin dose reduction of approx. 40% for FL and 50% for DR at 27.5-30cm.

## CONCLUSION

The use of a material specific contrast-to-noise ratio based exposure control bears a substantial skin dose reduction potential compared to the regular detector dose dependent exposure control.

## CLINICAL RELEVANCE/APPLICATION

Material specific CEC allows for a substantial radiation dose reduction without loss of image quality as compared to DEC. In particular, the dedicated imaging of tantalum and platinum might help to considerably reduce the radiation exposure of the patient and staff.

### SSE26-05 Demonstration of a Real-Time Scattered Radiation Display for Staff Dose Management during Fluoroscopic Interventional Procedures

Monday, Dec. 2 3:40PM - 3:50PM Room: E260

#### Participants

Jonathan L. Troville, MS,BS, Buffalo, NY (*Presenter*) Research support, Canon Medical Systems Corporation  
Chao Guo, MS, Amherst, NY (*Abstract Co-Author*) Research support, Canon Medical Systems Corporation  
Stephen Rudin, PhD, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation  
Daniel Bednarek, PhD, Buffalo, NY (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation

#### For information about this presentation, contact:

jltrovil@buffalo.edu

#### PURPOSE

To facilitate staff dose management during long fluoroscopic interventional procedures, our group has developed a real-time, virtual reality (VR) scattered radiation display system (SDS). A demonstration of how the SDS works using data from clinical procedures is presented.

#### METHOD AND MATERIALS

The SDS provides a VR representation of a patient graphic, the c-arm gantry, patient table, and a color-coded overlay that displays the spatial distribution of scattered radiation in the room as well as the scatter dose rate at a staff member's location using a circular indicator. Update of the staff indicator position occurs in real-time via body tracking using a Microsoft Kinect V2 depth camera. To demonstrate its use, cardiovascular interventional cases were retrospectively analyzed under IRB approval using log files of all exposure events obtained from Canon's Dose Tracking System (DTS). The log file data for each clinical case was read into the SDS for selection of the appropriate pre-calculated scatter distributions during playback for each procedure. The real-time SDS has been developed in Matlab using the Python controller area network (CAN) interface module to facilitate inflow of geometric and exposure messages from a Canon Biplane Angiography system. A virtual CAN bus using the Python interface was utilized to play back the clinical log files for this demonstration.

## RESULTS

For each cardiovascular case, VR scatter distribution displays were generated showing variations with changes in each of the geometric and exposure parameters read in from the system. A staff member indicator was placed on-screen to display the changing dose-rates during the intervention. The magnitude of the change in scatter is shown as the procedures progressed. Simultaneously, patient skin dose distributions and entrance dose rates were displayed with the DTS.

## CONCLUSION

A real-time scattered radiation display can enable staff members to make informed decisions throughout the procedure on where to stand in the room and thus maintain staff dose as low as reasonably achievable. The SDS can be implemented in the procedure room with the DTS for a comprehensive approach to radiation safety and dose reduction.

## CLINICAL RELEVANCE/APPLICATION

A real-time scattered radiation display system can facilitate staff dose management and with Canon's real-time patient skin dose mapping system would offer a comprehensive approach to dose reduction.

## SSE26-06 A Systematic Review of 639 Patients with Biopsy-Confirmed Nephrogenic Systemic Fibrosis

Monday, Dec. 2 3:50PM - 4:00PM Room: E260

### Participants

Hanieh Attari, MD, New York, NY (*Presenter*) Nothing to Disclose

Yan Cao, CMD, Warren, MI (*Abstract Co-Author*) Nothing to Disclose

Sadjad Riyahi, MD, Sunnyside, NY (*Abstract Co-Author*) Nothing to Disclose

Martin R. Prince, MD, PhD, New York, NY (*Abstract Co-Author*) Patent agreement, General Electric Company; Patent agreement, Hitachi, Ltd; Patent agreement, Siemens AG; Patent agreement, Koninklijke Philips NV; Patent agreement, Nemoto Kyorindo Co, Ltd; Patent agreement, Bayer AG; Patent agreement, Lantheus Medical Imaging, Inc; Patent agreement, Bracco Group; Patent agreement, Mallinckrodt plc; Patent agreement, Guerbet SA; Patent agreement, Toshiba Corporation

### For information about this presentation, contact:

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## PURPOSE

To perform a systematic review of nephrogenic systemic fibrosis (NSF).

## METHOD AND MATERIALS

PubMed database was searched using 'nephrogenic systemic fibrosis' from January 2000 to February 2019 for studies in which patients with biopsy-confirmed NSF were reported. Data were pooled and authors were contacted for clarification. We used GraphPad software for statistical analysis of the data.

## RESULTS

639 biopsy-confirmed patients with NSF from 173 articles are included. Among 542 with data 292 were female and 250 were male. Age at symptom onset was available for 174 patients [mean=49, (range=6-87)] with no reports in neonates or toddlers and few reports (n=7) in the very old (>80 years). 532 patients had documented exposure to GBCA including Group I (gadodiamide=315, gadopentetate dimeglumine=49, gadoversetamide=6), Group II (gadobutrol=1, gadobenate dimeglumine=1), multiple (n=49) and unknown (n=111). All but 3 patients with GBCA exposure, received gadolinium prior to 2008. 14 patients had no prior GBCA exposure in spite of searching. For 413 patients with clinical severity data, different degrees of motion limitation were present in 291/413(70%) indicating a more severe form of the disease in contrast to 122/413(30%) with only dermatological manifestations. Having a more severe debilitating disease was significantly correlated with being on dialysis at the time of GBCA exposure (P=0.005), chronic renal failure (P=0.04), and receiving a higher cumulative GBCA dose (P=0.0004). NSF was also associated with pro-inflammatory conditions, hyperphosphatemia, beta blockers and epoetin. 48%(70/146) of patients with autoimmune data, had autoimmune disease. Face was always spared except for 3 patients. For 341 patients with follow-up, 12 were cured and 72 partially improved including one during pregnancy. In 34 of these patients, improvement of symptoms occurred following renal function restoration. 4 deaths were attributed to NSF.

## CONCLUSION

Although 639 patients with biopsy-confirmed NSF were reported, only 3 followed GBCA exposure after 2008 indicating that regulatory actions and practice changes have been effective preventive measures. Improvement and sometimes cure with renal function restoration is now possible.

## CLINICAL RELEVANCE/APPLICATION

This systematic review shows that NSF has been nearly eliminated, is no longer incurable and supports the preference for group II GBCAs in at risk patients.

Printed on: 10/29/20



## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

December 1-6 | McCormick Place, Chicago

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SPDL30

### Houston, We Have a Problem (Case-based Competition)

Tuesday, Dec. 3 7:15AM - 8:15AM Room: E451B

**CA** **GI** **GU** **MK** **NR** **OB** **PD** **PH** **SQ** **VA**

AMA PRA Category 1 Credit™: 1.00

ARRT Category A+ Credit: 0

#### Participants

Adam E. Flanders, MD, Narberth, PA (*Presenter*) Nothing to Disclose

Sandeep P. Deshmukh, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

Christopher G. Roth, MD,MS, Philadelphia, PA (*Presenter*) Nothing to Disclose

Vishal Desai, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

#### For information about this presentation, contact:

adam.flanders@jefferson.edu

#### Special Information

*This interactive session will use RSNA Diagnosis Live™. Please bring your charged mobile wireless device (phone, tablet or laptop) to participate.*

#### LEARNING OBJECTIVES

1) Be introduced to a series of radiology case studies via an interactive team game approach designed to encourage 'active' consumption of educational content. 2) Use their mobile wireless device (tablet, phone, laptop) to electronically respond to various imaging case challenges; participants will be able to monitor their individual and team performance in real time. 3) Receive a personalized self-assessment report via email that will review the case material presented during the session, along with individual and team performance.

Printed on: 10/29/20



MSQI31

## Quality Improvement Symposium: Staff Wellness and Development

Tuesday, Dec. 3 8:30AM - 10:00AM Room: S402AB

LM SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Olga R. Brook, MD, Boston, MA (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

obrook@bidmc.harvard.edu

### LEARNING OBJECTIVES

1) To learn strategies to improve staff wellness in Radiology, from fostering dignity and respect culture, reducing interruptions in your work environment, balancing productivity, emotional and physical wellness, mentoring and sponsoring and lessons learnt from long and fruitful career in Radiology.

### Sub-Events

#### MSQI31A How to Foster Dignity and Respect in Radiology

##### Participants

Bettina Siewert, MD, Boston, MA (*Presenter*) Editor, Wolters Kluwer nv; Reviewer, Wolters Kluwer nv;

### For information about this presentation, contact:

bsiewert@bidmc.harvard.edu

### LEARNING OBJECTIVES

1) Describe the impact of disrespect on work environments. 2) Describe elements of a respectful work environment. 3) Implement measures to promote dignity and respect in the work environment.

#### MSQI31B Mentoring and Sponsoring: How to Do It Right

##### Participants

Amy L. Kotsenas, MD, Rochester, MN (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

kotsenas.amy@mayo.edu

### LEARNING OBJECTIVES

1) To describe the differences between role model, mentors, coaches and sponsors. 2) To differentiate the need for role models, mentors, coaches and sponsors at various times throughout one's career. 3) To apply mentoring and sponsorship skills in developing members of your practice or team.

#### MSQI31C Reducing Interruptions in the Reading Room While Supporting Collaboration

##### Participants

Ethan A. Smith, MD, Cincinnati, OH (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

ethan.smith@cchmc.org

### LEARNING OBJECTIVES

1) Understand how frequent interruptions can affect complex tasks such as image interpretation. 2) Describe a process to understand the source of interruptions and how to optimize them. 3) Understand the importance of balancing collaboration with referring clinicians while still working towards reducing the number of interruptions in the reading room.

### ABSTRACT

Frequent interruptions in the reading room are a source of frustration for radiologists. Interruptions not only increase the stress levels in the reading room, but also may affect the ability of radiologists to perform complex tasks, most importantly image interpretation. However, it is also important to acknowledge that dealing with some interruptions, specifically those related to the needs of patients and collaboration with referring clinicians, are an important part of the radiologist's role. The goal of presentation is to describe sources of interruptions in the reading room and to propose methods for optimizing the number of interruptions while still encouraging collaboration with clinical colleagues and providing high quality clinical care for patients.

#### MSQI31D Balancing Workload, Academic Productivity, and Physical and Emotional Wellness

Participants

Matthew S. Davenport, MD, Ann Arbor, MI (*Presenter*) Royalties, Wolters Kluwer nv

**LEARNING OBJECTIVES**

1) Learn strategies for balancing competing demands. 2) Understand how synergistic activities can improve efficiency and enhance well-being. 3) Recognize that work-life alignment requires self reflection.

**MSQI31E    How I Failed and Then Succeeded: Lessons Learnt**

Participants

Desiree E. Morgan, MD, Birmingham, AL (*Presenter*) Institutional Research Grant, General Electric Company; Consultant, General Electric Company

**For information about this presentation, contact:**

dmorgan@uabmc.edu

**LEARNING OBJECTIVES**

1) Reflect on experiential inflection points, both personal and at work, to enhance capacity for professional adaptability. 2) Understand the interplay of resilience and professional growth.

**MSQI31F    Q&A**

Printed on: 10/29/20



RC324

## CT Dose Monitoring: Nuts, Bolts, and Tools... and What We Need to Build

Tuesday, Dec. 3 8:30AM - 10:00AM Room: N226

CT PD SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Donald P. Frush, MD, Menlo Park, CA (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

dfrush@stanford.edu

laurabancroftmd@gmail.com

### LEARNING OBJECTIVES

1) To learn fundamental elements of a CT dose monitoring program. 2) To review current programs (products) and resources available. 3) To understand current status, including challenges of dose monitoring in adults. 4) To be able to describe current status, including challenges of dose monitoring in children. 5) To be able to discuss potential advances in dose monitoring.

### Sub-Events

#### RC324A Fundamentals (Nuts and Bolts) and Current Products (Tools)

Participants

Sarah E. McKenney, PhD, Stanford, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Evaluate clinical needs for radiation dose monitoring within their institution. 2) Identify resources necessary to ensure a successful monitoring program. 3) Classify the different features of dose monitoring software.

#### RC324B CT Dose Monitoring Status in Adults (Including Diagnostic Reference Levels)

Participants

Kalpana M. Kanal, PhD, Seattle, WA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To discuss CT dose monitoring for adults. 2) To learn about diagnostic reference levels in CT. 3) To understand how to implement dose monitoring and diagnostic reference levels in practice.

#### RC324C CT Dose Monitoring Status in Children (Including Diagnostic Reference Levels)

Participants

Donald P. Frush, MD, Menlo Park, CA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) To understand the unique considerations in CT dose monitoring program for children. 2) To learn challenges and obstacles in CT dose monitoring programs in children. 3) To be able to discuss future opportunities for CT dose monitoring program in children.

#### RC324D Designing the Program of the Future

Participants

Ehsan Samei, PhD, Durham, NC (*Presenter*) Research Grant, General Electric Company Research Grant, Siemens AG Advisory Board, medInt Holdings, LLC License agreement, 12 Sigma Technologies License agreement, Gammex, Inc

### LEARNING OBJECTIVES

1) To understand the importance of analytics in extracting meaningful and actionable knowledge from performance data. 2) To understand the role and components of image quality characterization based on patient images. 3) To understand performance monitoring as the overarching objective of dose monitoring.

Printed on: 10/29/20



RC350

## Contrast Reaction Management: Hands-on Simulation (Hands-on)

Tuesday, Dec. 3 8:30AM - 10:00AM Room: E260

SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Carolyn L. Wang, MD, Seattle, WA (*Presenter*) Research Grant, General Electric Company  
Carina W. Yang, MD, Chicago, IL (*Presenter*) Nothing to Disclose  
Erik Soloff, MD, Seattle, WA (*Presenter*) Research Grant, General Electric Company  
Ryan O'Malley, MD, Seattle, WA (*Presenter*) Research Grant, General Electric Company  
Stephen C. O'Connor, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Patrick W. Eiken, MD, Rochester, MN (*Presenter*) Nothing to Disclose  
Richard H. Cohan, MD, Ann Arbor, MI (*Presenter*) Co-author, Wolters Kluwer nv  
Senta M. Berggruen, MD, Chicago, IL (*Presenter*) Nothing to Disclose  
Anup J. Alexander, MD, Maywood, IL (*Presenter*) Nothing to Disclose  
James H. Ellis, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Rishi Agrawal, MD, Chicago, IL (*Presenter*) Speakers Bureau, Boehringer Ingelheim GmbH  
William Masch, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Kirk G. Banerian, MD, Bloomfield Hills, MI (*Presenter*) Nothing to Disclose  
Rekha N. Mody, MD, Cleveland, OH (*Presenter*) Nothing to Disclose  
Oren Johnson, MD, Springfield, MA (*Presenter*) Nothing to Disclose

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### Special Information

New! Flipped classroom format. Please watch this 16 minute video on contrast reaction management prior to attending the hands-on simulation course to maximize your time engaging in the simulation training. <https://youtu.be/iJdPpv5QEKM>

### LEARNING OBJECTIVES

1) Recognize various types of contrast reactions and the proper management of various types of contrast reactions through simulation-based training. 2) Learn with hands-on practice the proper administration of various routes of epinephrine as well as other medications to treat the more common allergic-like contrast reactions. 3) Recognize and manage a contrast reaction in a sedated patient. 4) Recognize and practice team communication skills necessarily for high stress infrequent scenarios using simulation-based training.

Printed on: 10/29/20



RC354

## How Did I Miss That? Perceptual and Attentional Roots of Medical Errors

Tuesday, Dec. 3 8:30AM - 10:00AM Room: S404CD



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 0

### Participants

Jeremy M. Wolfe, PhD, Cambridge, MA (*Presenter*) Research collaboration, Koninklijke Philips NV; Pending research, General Electric Company

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[jwolfe@bwh.harvard.edu](mailto:jwolfe@bwh.harvard.edu)

### LEARNING OBJECTIVES

1) Attendees will learn some of the basic perceptual limitations on the analysis of medical images and potential solutions. 2) Attendees will understand some of the attentional limits on visual search (having seen a series of examples) and how these limits can impact search in radiologic images. 3) Attendees will be updated on recent research in medical image perception. 4) Finally, participants will learn about efforts to make humans and AI collaborate more effectively.

### ABSTRACT

Perceptual decisions can be hard. Images are often ambiguous, but we still need to make a diagnostic decision (e.g., is this cell abnormal or not?). We cannot simultaneously recognize every object in our field of view. As a result, even if a breast mass or a lung nodule might be clear enough when you find it, the process of finding it involves deploying attention from object to object or place to place, searching for the target. This is true whether we are looking for the cat in the bedroom or those nodules in a stack of CT images. Becoming an expert does not cause you to develop a new search engine. You become an expert on using the standard human search engine on a specific set of stimuli. Unfortunately, our search engine does not work perfectly and we sometimes fail to find what we seek. At other times, we find things that are not really there. I will give a quick tour of the basics of perceptual decision making and then we will illustrate and discuss three classes of error that occur in medical image perception: - Search errors in which the observer never looks in the right spot. - Recognition errors where the observer looks at the target but fails to code it as potentially significant. - Decision errors where the target is scrutinized but the wrong conclusion is reached. This last class of errors can be subdivided into Perceptual decision errors and Cognitive decision errors in which the observer thinks about the problem in a way that leads to the wrong answer. In some cases, these errors arise from 'cognitive heuristics', mental shortcuts can be very useful, but can sometimes lead to errors, medical and other.

Printed on: 10/29/20



MSQI32

## Quality Improvement Symposium: Patient-centered Care

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S402AB



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Bettina Siewert, MD, Boston, MA (*Moderator*) Editor, Wolters Kluwer nv; Reviewer, Wolters Kluwer nv;

### For information about this presentation, contact:

bsiewert@bidmc.harvard.edu

### Sub-Events

#### MSQI32A Patient-targeted Reports

##### Participants

Nadja Kadom, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

nkpiano@gmail.com

### LEARNING OBJECTIVES

1) Identify opportunities for patient centered result reporting. 2) Develop patient-centered reporting initiatives.

### ABSTRACT

n/a

#### MSQI32B Translating Reports to Lay Language

##### Participants

Hanna M. Zafar, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

hanna.zafar@uphs.upenn.edu

### LEARNING OBJECTIVES

1) Identify three patient barriers to radiology report access. 2) List three methods to improve patient comprehension of radiology reports. 3) Describe the goals, potential benefits and implementation challenges of PA Act 112.

#### MSQI32C Patient's Portal: Two-way Street?

##### Participants

Morgan P. McBee, MD, Charleston, SC (*Presenter*) Nothing to Disclose

### For information about this presentation, contact:

mcbeem@musc.edu

### LEARNING OBJECTIVES

1) Understand what patient portals are and their potential for increasing patient engagement. 2) Describe what qualities are necessary for a communication tool to be an effective means for patients to communicate directly with radiologists.

#### MSQI32D Closing the Loop on Follow-up Recommendations

##### Participants

Ben C. Wandtke, MD,MS, Rochester, NY (*Presenter*) Nothing to Disclose

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ben\_wandtke@urmc.rochester.edu

### LEARNING OBJECTIVES

1) Identify measures of value achieved through recommendation tracking. 2) Describe medical informatics tools used in efficient recommendation management systems.

**MSQI32E Improving Care for Vulnerable Populations**

Participants

Hannah Perry, MD, Charlotte, VT (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Understand which patient groups may be considered diverse, marginalized, and vulnerable. 2) Gain familiarity with the spectrum of knowledge necessary to provide respectful and effective care to diverse, marginalized, and vulnerable patient populations.

**MSQI32F Q&A**

Printed on: 10/29/20



SSG12

## Physics (CT Image Quality)

Tuesday, Dec. 3 10:30AM - 12:00PM Room: S501ABC

CT PH SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Moderator*) Institutional research agreement, Siemens AG  
Taly Gilat Schmidt, PhD, Milwaukee, WI (*Moderator*) Research Grant, General Electric Company; Research Consultant, General Electric Company  
Christopher P. Favazza, PhD, Rochester, MN (*Moderator*) Nothing to Disclose

### Sub-Events

#### SSG12-01 DQE of Si and CdTe Detectors for Photon-Counting CT: Impact of Object Scatter

Tuesday, Dec. 3 10:30AM - 10:40AM Room: S501ABC

#### Participants

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#### PURPOSE

Silicon (Si) and cadmium telluride (CdTe) have been proposed as detector materials for photon-counting CT, but the relative performance of these materials is incompletely understood. Previously, a linear-systems model has been used to compare the DQE of Si and CdTe detectors, but this model ignores scatter from the object. This work extends this comparison by incorporating object scatter and the anti-scatter grid, resulting in a more complete model for photon-counting detector DQE at low flux.

#### METHOD AND MATERIALS

Monte Carlo simulation was performed of a CT geometry with a water cylinder of 30 cm diameter in the isocenter and a curved detector with 79 mm isocenter coverage and sensitive absorption lengths of either 60 mm Si or 3 mm or 1.6 mm CdTe. A 1D or 2D anti-scatter grid with 25 mm high W lamellae was placed in front of the detector. From the resulting scatter-to-primary ratio (SPR) in the central 20 cm of the detector, a DQE factor could be calculated as  $(\text{geometric efficiency}) / (1 + \text{SPR})$  where SPR is the scatter-to-primary ratio. This factor was combined with the intrinsic detector DQE obtained from linear-systems models of Si and CdTe detectors incorporating intradetector scatter, fluorescence and charge sharing.

#### RESULTS

For all studied detector configurations, the optimal DQE factor is 0.79-0.81, attained for an 1D grid of 0.1 mm thick lamellae with 1 mm spacing. Combined with the linear-systems model for typical detector configurations, so far ignoring pulse pileup and signal induction crosstalk but adding object scatter, this gives the 1.6 mm CdTe detector 5-25% higher zero-frequency DQE for detection and 44-54% lower DQE for two-material quantification compared to a 60 mm Si detector with interspersed W foils.

#### CONCLUSION

A geometric efficiency of 86-90% is optimal for photon-counting detectors, in contrast to the ~70% used in current CT scanners. Including interspersed W foils in the Si detector can reduce object scatter, and together with an orthogonal 1D anti-scatter grid can give an SPR comparable to that of a 2D grid without interspersed foils. This work is an important step towards a future, complete model for detector performance incorporating pileup and improved charge transport models.

#### CLINICAL RELEVANCE/APPLICATION

Photon-counting CT detectors promise better image quality. The improved performance model presented here will help developers optimize detector design and attain the best possible imaging performance.

#### SSG12-02 Innovative Methodology to Mimic Lung Parenchyma Based on Voronoi Models: Application to 3D-Printed Anthropomorphic CT Image Quality Phantoms

Tuesday, Dec. 3 10:40AM - 10:50AM Room: S501ABC

#### Participants

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#### **PURPOSE**

To design and develop voronoi 3D-printed structures resembling lung parenchyma, to be used in realistic anthropomorphic lung vessel phantoms for CT image quality assessment.

#### **METHOD AND MATERIALS**

Voronoi grids were created using Rhino software (McNeel, Barcelona, Spain) to resemble lung parenchyma. The designs (eight samples, 2x2x1cm<sup>3</sup>) varied in number of cells and cell border thickness and were 3D printed (ProJet® MJP 2500+) with VisiJet Armor material ( $\rho=1.14 \text{ g}\cdot\text{cm}^{-3}$ ). The samples were placed in foam, inserted inside a thorax-shaped PMMA holder (300x200x2.5cm<sup>3</sup>), and scanned (Canon Aquilion Genesis CT). Comparisons were made to CT image volumes of interest (VOIs) of 3 patients parenchyma (5 samples per patient) using the same CT acquisition and reconstruction protocol (High Resolution-thorax). Analysis was performed in terms of attenuation (mean pixel value of VOIs), pixel value distribution (histograms) and visual comparison.

#### **RESULTS**

The CTDI<sub>vol</sub> for the thorax phantom was 2.1 mGy and for the 3 patients 2.1, 2.2 and 4.1 mGy. The attenuation of the voronoi samples (0.2mm cell border thickness) increased linearly with the number of cells [-972±3HU (200 cells);-953±2HU (350 cells);-941±3HU (500 cells);-921±3HU (800 cells);-916±5HU (900 cells)]. Attenuation also increased linearly with cell border thickness (samples with 350 cells) [-953±2HU (0.2mm);-924±3HU (0.3mm);-885±7HU (0.4mm);-837±5HU(0.5mm)]. For patients the average attenuation values were [(-859±7HU);(-849±5HU);(-902±4HU)]. The sample of 350 cells and 0.4mm cell border thickness resembled lung parenchyma most closely, according to visual comparison of CT images and histogram pixel distribution, by three human observers. The mean pixel value of this sample (-885±7HU) was within the HU value range for patients lung parenchyma (-870±27HU).

#### **CONCLUSION**

CT appearance and attenuation of human lung parenchyma was mimicked by CT scans of 3D printed voronoi grids. A sample of 350 cells and 0.4 mm cell border thickness showed best resemblance with patient CT images. These voronoi structures will be added to an in-house developed lung vessel phantom to create a more realistic anthropomorphic surrogate for patients in CT image quality assessment.

#### **CLINICAL RELEVANCE/APPLICATION**

Our method to 3D-print lung parenchyma (missing in most commercial CT image quality phantoms) can be used to create realistic patient surrogates, especially required with iterative reconstruction.

#### **SSG12-03 Improving Visualization of Basilar Artery Branches by Combining Spectral CT Imaging and Adaptive Statistical Iterative Reconstruction-V Algorithm**

Tuesday, Dec. 3 10:50AM - 11:00AM Room: S501ABC

#### **Participants**

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#### **PURPOSE**

Improving visualization of basilar artery branches by combining spectral CT imaging and adaptive statistical iterative reconstruction-V algorithm

#### **METHOD AND MATERIALS**

A total of 15 patients with suspected posterior cerebral circulation ischemia underwent head-neck CT angiography (CTA) using a 256-row MDCT (Revolution CT, GE Healthcare). The scanning parameter were tube voltage of 80/140kVp fast switch and GSI Assist with a noise index of 6. The contrast medium was Iohexol (370mgI/ml) with amount of 50ml and injection rate of 5.0ml/s. 100 kVp-like with FBP (group A) and 40keV monochromatic energy image with 50% ASiR-V (group B) were reconstructed. For both image sets, the CT value and contrast to noise ratio (CNR) were measured at maximum diameter of the basilar artery. maximum intensity projection (MIP) images were used for evaluation the visualization of vertebrobasilar arteries and branch vessels (post-cerebral arteries, superior cerebellar arteries, anterior inferior cerebellar artery, and posterior inferior cerebellar artery). Vessel visibility was quantified by counting the number of artery branches. A five-point scale (from 1= poor to 5 = excellent) was used to evaluate the image quality.

## RESULTS

40keV images had higher enhancement of basilar artery ( $664.95 \pm 106.11$  vs  $288.81 \pm 31.03$ ,  $P=0.001$ ) and higher CNR ( $27.36 \pm 7.01$  vs  $20.49 \pm 6.48$ ,  $P=0.009$ ) than 100 kVp-like images. A total of 165 blood vessels was visible on 40keV images, compared to 160 vessels in 100 kVp-like image. The subjective image quality of 40keV images was better than that of 100 kVp-like image ( $4.53 \pm 0.54$  vs  $3.38 \pm 0.81$ ,  $P=0.012$ ).

## CONCLUSION

Combining 40keV images and 50% ASiR-V can significantly improve image quality of basilar artery branches, compared to 100 kVp-like images.

## CLINICAL RELEVANCE/APPLICATION

Combining monochromatic image and ASiR-V can significantly improve image quality of artery. This protocol is expected to provide more reliable information for the diagnosis and treatment of patients with posterior cerebral circulation ischemia

## SSG12-04 CT Protocol Optimization in Neck Imaging Using Anatomically Realistic 3D Printed Phantoms

Tuesday, Dec. 3 11:00AM - 11:10AM Room: S501ABC

### Participants

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## PURPOSE

To simulate patient neck CT imaging with 3D printed phantoms for a systematic evaluation of CT acquisition protocol settings regarding dose and image quality.

## METHOD AND MATERIALS

Radiopaque 3D printed patient head and neck phantoms manufactured with potassium iodide doped ink were used for simulation of patient imaging. Two tube voltage settings, six tube current settings, and three pitch settings were systematically combined. Images were reconstructed with filtered back projection (FBP) and iterative reconstruction (IR). Image quality was evaluated with rater experiments (ten radiologist readers) and contrast-to-noise ratios. Dose reduction was evaluated with multiple phantoms with different anatomies and compared with patients that were retrospectively identified from our clinical database. A protocol with fixed 120 kVp, AEC (SD 7.5), a pitch of 0.8, and iterative reconstruction was used as reference to illustrate protocol optimization potential.

## RESULTS

54 data sets were acquired and analyzed. Inter-rater reliability of the image grading experiments was excellent (ICC = 0.921; 95%CI 0.882 to 0.950). The benefit-to-risk ratio in terms of achievable image quality and required dose exposure was optimal with ATVS, AEC (SD 14), a pitch of 0.8, and IR. However, image quality was limited (46% for subjective and 26% for objective image quality). An optimal balance between dose and high image quality was achieved with lower noise level AEC (SD 7.5). This protocol required 37% lower dose than the reference protocol. The retrospective analysis of patients that were imaged with different protocol settings yielded similar dose reduction.

## CONCLUSION

Patient simulation with 3D printed phantoms provides opportunities for testing and optimization of CT acquisition protocols in a clinical context. The results from this study were in good agreement with clinical observations.

## CLINICAL RELEVANCE/APPLICATION

CT protocol optimization entails significant dose reduction potential. Patient simulation with 3D printed phantoms provides opportunities for systematic and rapid protocol optimization.

## SSG12-06 Analysis of the 3D Modulation Transfer Function (MTF) of a High-Resolution Diagnostic CT Scanner

Tuesday, Dec. 3 11:20AM - 11:30AM Room: S501ABC

### Participants

Pengwei Wu, Baltimore, MD (*Presenter*) Research collaboration, Carestream Health, Inc  
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Jeffrey H. Siewerdsen, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG; Advisory Board, Siemens AG; Research Grant, Medtronic plc; Advisory Board, Carestream Health, Inc; License agreement, Carestream Health, Inc; License agreement, Precision X-Ray, Inc; License agreement, Elekta AB; ;

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**PURPOSE**

The spatial resolution characteristics of a recently introduced high-resolution diagnostic CT scanner (Precision, Canon Medical) is investigated using a multi-sphere phantom designed to probe the 3D modulation transfer function (MTF), quantifying performance among various scan protocols.

**METHOD AND MATERIALS**

The phantom presented an array of 9 acrylic spheres (25.4 mm diameter) as a basis for measurement of the oversampled edge-spread function (ESF) and presampling 3D MTF. Spherical edge profiles were converted to spherical coordinates and analyzed as a function of direction (elevation:  $\phi=0$ , axial, to  $\phi\sim 90$ , z longitudinal). Directionality was held to  $\phi \leq 80$  to avoid cone-beam sampling effects. The 3D MTF was measured for 3 detector modes [normal-res NR (0.5x0.5mmx80slice), high-res HR (0.25x0.5mmx80slice), and super-high-res SHR (0.25x0.25mmx160slice)], filtered backprojection with 3 nominal filters [smooth Fc 18, bone Fc30, and high-res Fc81], 3 focal spot settings, and 3 pitch settings (0.57-1.38).

**RESULTS**

The 3D MTF provided quantitative insight on performance, limitations, tradeoffs, and the degree to which resolution was isotropic. The SHR detector mode increased the axial MTF ( $f50=1.03/\text{mm}$ ) compared to NR ( $f50=0.84/\text{mm}$ ) and improved z-resolution ( $f50=0.91/\text{mm}$ ) compared to HR ( $f50=0.71/\text{mm}$ ) for the Fc30 filter. SHR and HR modes gave the same axial MTF, as expected. Analysis of the 3D MTF characteristics showed that the 3 nominal filters acted primarily in the axial plane, imparting non-isotropic 3D resolution characteristics. Improvement in MTF with finer focal spot was quantified, and the 3D MTF was observed to be invariant with to helical pitch.

**CONCLUSION**

A multi-sphere phantom and ESF oversampling method provided an insightful probe of 3D MTF characteristics for a recently introduced ultra-high-res CT scanner, demonstrating the resolution advantages and limitations for various scan protocols. The SHR detector mode demonstrated improved axial and z direction MTF compared to NR mode, evident in clearer depiction of anatomical structure (e.g., temporal bone).

**CLINICAL RELEVANCE/APPLICATION**

Quantitative characterization of the 3D MTF is an important aspect of technical assessment for new CT scanner technology claiming high-resolution performance beyond that of previous systems.

**SSG12-07 Whole-Body Low-Dose CT Combined with Model-Based Iterative Reconstruction Algorithm in the Follow-Up of Oncologic Patients: Image Quality and Dose Deduction**

Tuesday, Dec. 3 11:30AM - 11:40AM Room: S501ABC

**Participants**

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Davide Ippolito, MD, Monza, Italy (*Abstract Co-Author*) Nothing to Disclose  
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**PURPOSE**

To compare radiation dose and image quality of low-dose CT protocol combined with iterative model-based reconstruction algorithm (IMR) with standard-dose CT approach combined with hybrid-iterative reconstruction algorithm (iDose) in the follow-up of oncologic patients.

**METHOD AND MATERIALS**

We enrolled a hundred and thirty patients with known oncological diseases; all patients were examined, during their clinical follow-up, with both a low-dose CT performed on 256-row scanner, with 100 kV and automated mAs modulation (depending on patient weight), and a standard-dose CT performed on 256-row scanner, with 120 kV and automated mAs modulation. Images were reconstructed with IMR for the low-dose CT protocols and iDose algorithm for the standard-dose CT studies. In both studies we measured density values and image noise in liver and spleen and we calculated the signal-to-noise ratio (SNR) and the radiation dose exposure. The diagnostic quality evaluation was also performed with a 4-point scale.

**RESULTS**

Noise of images expressed as SD values, measured in liver and spleen, was significantly lower in IMR images (liver 11,63 vs 14,79,  $p<0,001$ ) whereas SNR was statistically higher (liver 10,46 vs 7,86,  $p<0,001$ ) compared to iDose reconstruction. Volumetric-CT-Dose-Index (CTDIvol) and Dose-Length-Product (DLP) were significantly lower in IMR compared to iDose studies (DLP 624,40 vs 1013,90  $\text{mGy}\cdot\text{cm}$ ,  $p<0,001$ ), with an overall dose reduction of 38,42%. The qualitative analysis did not reveal any significant differences in terms of diagnostic quality ( $p=0,04$ ).

**CONCLUSION**

mAs modulation combined with IMR algorithm and low kV setting allows dose reduction of 45,72% in whole body CT imaging without loss of diagnostic quality. Therefore, it represents a useful diagnostic approach to reduce radiation dose exposure in oncologic patients who undergo several follow-up CT studies.

**CLINICAL RELEVANCE/APPLICATION**

CT has a main role in the follow-up of oncologic patients; therefore, lowering doses is desirable, according to the A.L.A.R.A. principle. Low-kV CT with IMR allows to significantly reduce doses, offering a high diagnostic image quality.

### **SSG12-08 Machine Learning and Deconvolution to Improve the Spatial Resolution of the Adaptive Statistical Iterative Reconstruction (ASir-V) at the Same Noise Level**

Tuesday, Dec. 3 11:40AM - 11:50AM Room: S501ABC

#### **Participants**

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#### **PURPOSE**

For the same noise reduction characterized by the noise power spectrum (NPS), the machine learning approach of PixelShine (PS) by AlgoMedica preserves better the central frequency ratio (CFR) in NPS than the adaptive statistical iterative reconstruction (ASir-V) by GE. CFR was taken between the central frequencies of the NPS of the noise reduction and the baseline CT images to indicate the degree of shift in central frequency after noise reduction. Smaller CFR means more shift of the NPS curve or more image blurring. As the noise texture is highly correlated with CFR, PS may be preferred over ASir-V. The purpose of this study is to improve ASir-V by deconvolution to decrease the blurry appearance of the ASir-V while maintaining the same level of noise reduction already achieved by ASir-V.

#### **METHOD AND MATERIALS**

The homogeneous module of the ACR CT phantom (model 464, Gammex-RMI, Wisconsin) was scanned on a GE revolution HD 64-slice CT at 3.6 mGy (CTDI-16 cm). Each scan was repeated twice for NPS calculation. Radiation exposure was increased from 3.6 to 72 mGy to simulate ideal noise reduction without PS or ASir-V. We designed a set of deconvolution filters for the various strengths of ASir-V, followed by PS and name this approach as ASir-VDPS. The images of the ASir-V and ASir-VDPS settings from 10 to 100% and the PS settings of 1 to 9 were compared. Noise magnitude ratio (NMR) was taken between the areas under the NPS curve of the noise reduction and the baseline FBP images to indicate the amount of noise removed by the reconstruction. Smaller NMR means more noise reduction. A desirable noise reduction shall maintain CFR of close to 1 and a NMR of close to 0.

#### **RESULTS**

When the radiation exposure was increased from 3.6 to 72 mGy, NMR can be reduced without any change of CFR for the ideal noise reduction. At 3.6 mGy, noise reduction was better achieved by either ASir-VDPS or PS, followed by ASir-V. However, the results of ASir-VDPS (80 to 100%) demonstrated that our current design of deconvolution was not sufficient for resolution recovery introduced by ASir-V.

#### **CONCLUSION**

Combination of deconvolution and machine learning can improve ASir-V in spatial resolution or image sharpness without sacrificing the noise reduction already achieved by ASir-V.

#### **CLINICAL RELEVANCE/APPLICATION**

ASir-V blurs the CT images during noise reduction. Our approach rectifies this issue without sacrificing the noise reduction already achieved by ASir-V.

### **SSG12-09 Investigating the Relationship between Image Noise and Noise Index of Dose Modulation Behavior**

Tuesday, Dec. 3 11:50AM - 12:00PM Room: S501ABC

#### **Participants**

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#### **CONCLUSION**

Save the efforts of clinical protocol development/management and improve the operational work flow.

#### **Background**

Purpose: To evaluate the behavior of dose modulation performance for optimizing clinical image acquisition protocols. Methods: Four tissue equivalent abdominal CT dose phantoms (CIRS 007TE) were scanned using a GE Revolution CT scanner. To simulate an extra-large size patient, a 5th phantom (60cm by 40cm) was assembled from a QRM-Abdomen phantom attached to two extension rings. Abdominal CT protocol: 120kVp, 0.6s rotation time, 80mm beam width, 0.508 pitch, 2.5 mm image thickness and Large Scan Field-of-View. With Auto-mA and Smart-mA enabled, Noise Index (NI) was varied resulting in various levels of image quality. Images were reconstructed using Standard algorithm. For each phantom size/NI combination, ROI (n=3/image) and noise measurements (standard deviation of ROI) in 5 consecutive images of the central portion of the phantom were performed. The relationship of noise versus NI was plotted for each phantom size.

#### **Evaluation**

Results: For the scans of each phantom size, the achieved mA values functioned as expected to the set NI values. For each phantom size, the measured noise increased linearly as NI value increased ( $R^2 = 0.9981, 0.9978, 0.9980, 0.9963$ , for 15-yr old, small adult, medium adult, large adult, respectively). The noise values were within 7% of the mean noise values at a NI level among phantom of different sizes, indicating that the measured noise values were similar as a function of NI value regardless of the sizes of the phantoms. Moreover, the measured noise were within 12% of the 10 NI levels that were evaluated, at 2.5mm nominal image thickness; this suggests a direct correlation of the anticipated image noise to the NI value under this 2.5mm acquisition condition.

## **Discussion**

Conclusion: The same NI value produced similar noise level in images across phantoms of different sizes. Unlike the multiple patient size-based approach for optimizing protocols of other GE scanner platforms, the one-size based protocol approach on the Revolution CT could save the efforts of clinical protocol development/management and improve the operational work flow.

Printed on: 10/29/20



AI34

**AI Theater: ScanDiags-AI-driven Decision Support from Musculoskeletal MRI: Presented by Balzano AI Engineers**

Tuesday, Dec. 3 12:00PM - 12:20PM Room: AI Showcase, North Building, Level 2, Booth 10724

**Participants**

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Stefan Voser, Zurich, Switzerland (*Presenter*) Nothing to Disclose

Printed on: 10/29/20



QIE-TUA

## Quality Improvement Reports Tuesday Poster Discussions

Tuesday, Dec. 3 12:15PM - 12:45PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

FDA

Discussions may include off-label uses.

### Sub-Events

#### QI114-ED-TUA1 Evaluation of an Audiovisual Report to Enhance Traditional Radiology Reports of Musculoskeletal Urgent Cases

Station #1

##### Participants

Luis Pecci Neto SR, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Traditional radiology reports are narrative texts including description of imaging findings. Recent implementation of advanced reporting software allows the incorporation of annotated key images and hyperlinks into text reports, but these tools usually do not substitute the in-person consultations with the radiologists, especially in challenging cases. The use of on-demand audio/visual reports using screen capture software is an emerging technology, providing a more engaged imaging service. Our study evaluates a video reporting tool that utilizes PACS integrated screen capture software for musculoskeletal imaging studies in the emergency department. Our hypothesis is that referring orthopedic surgeons would find that recorded audio/video reports add value to traditional text reports, may increase engagement with the radiology staff and also facilitate the understanding of the imaging findings of urgent musculoskeletal cases.

### METHODS

In this study, we analyze 47 cases of magnetic resonance and tomography imaging of the musculoskeletal system, requested in the emergency departments of orthopedics and traumatology areas of our institution between December 2018 and January 2019. Video reports were recorded by 7 radiologists and were sent by the ordering physicians. In addition to the audio description, all image findings were also included in the traditional text version. After having received the video report, 9 ordering physicians answered an electronic questionnaire (Google Form) and gave their opinion about the material they watched. The questions included in the questionnaire were: 1. Did the audiovisual report answer the clinical suspicion?; 2. What is the complexity of this case?; 3. Did the audiovisual report make the alterations more understandable than the traditional report? 4. Would you like to receive reports in audiovisual format again? 5. In comparison to the traditional one, was the evaluation time of the audiovisual report faster, similar, indifferent or slower? 6. Would you forward this audio-visual report to the patient and family members?

### RESULTS

Over half of the cases were considered of low complexity (32 responses, 50.8%), 8 were normal (12.7%) and 23 were highly complex (36.5%). In all cases assessed, physicians fully agreed that the audiovisual report confirmed the clinical suspicion. Regarding making the changes more comprehensible compared to the traditional report, in most cases the physician fully agreed (52 observations, 82.5%), in 10 cases the physician partially agreed (15.9%) and in one case considered it indifferent (1.59%). This understanding was similar in cases of high and low complexity (86.96% of total agreement in cases of high complexity, versus 84.4% in cases of low complexity). Considering the 8 cases of normal exams (without changes), in 6 there was full agreement regarding improvement of comprehension and in 2 of them the agreement was partial. There was no association between improved understanding of the alterations and the complexity of the case ( $p = 0.668$ ). Regarding receiving reports in audiovisual format again, in 60 cases (95.2%) doctors replied that they would certainly like to receive them in this format. Considering the total of 9 physicians, 6 of them answered 'certainly', two physicians who evaluated only 1 case responded that they would probably like it (4.8%) and one doctor who evaluated 4 cases answered 'certainly' in three of them and 'probably' in one case. About the time of evaluation in this type of report compared to the traditional one, 48 considered it faster (76.2%) and 15 considered it indifferent or similar (23.8%). In 95.8% of the cases considered to be 'high complexity' they believed that the audiovisual report had a faster evaluation time than the traditional one. In cases considered 'normal', this percentage fell to 87.5%; while cases considered 'low complexity' had a faster evaluation time in only 59.4% of cases and indifferent or similar in 40.6%. This time, therefore, varies according to the complexity of the case and is more optimized in cases of high complexity. This association was statistically confirmed by Fisher's exact test ( $p = 0.002$ ).

### CONCLUSION

The use of audiovisual reports in emergency musculoskeletal cases is a new approach to evaluate possible challenging cases. These results suggest the potential of this technology to re-establish the radiologist's role as an essential member of patient care and also provide more engaging, precise and personalized reports. Further studies could streamline these methods in order to minimize

work redundancy with traditional text reporting or even evaluate the acceptance of using only audiovisual radiology reports. Additionally, a widespread adoption would require integration with the entire radiology workflow including non-urgent cases and other medical specialties.

### **QI116-ED- Reclaiming Hands-on Ultrasound for Radiology TUA3**

Station #3

#### **Participants**

Krista E. Weiss, MD, Chestnut Hill, MA (*Presenter*) Nothing to Disclose  
Heejae Yang, Providence, RI (*Abstract Co-Author*) Nothing to Disclose  
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#### **PURPOSE**

Hands-on ultrasound training is included in the curriculum of many medical specialties, including emergency medicine and obstetrics/gynecology, and is increasingly incorporated into medical school curricula. Despite published curricula for ultrasound training in these training programs, there remains a dearth of such programs for radiology residency programs. At our institution, there has been a perceived decline in ultrasound scanning comfort and skill in trainees. The purpose of this project was to assess the utility and efficacy of a hands-on simulation-based ultrasound course for radiology residents in their first year of training.

#### **METHODS**

First year radiology residents were enrolled in a two-week simulation-based course for the instruction of hands-on ultrasound training. After assessing various simulation devices, a user-friendly, customizable commercial simulation software platform was selected, providing modules covering many radiologic subspecialties (including GI/GU, obstetrics, small parts, etc). As the course provides a comprehensive introduction to ultrasound anatomy, pathology and technique for those with no or little prior exposure, first year residents were chosen. The ultrasound course consisted of 19 didactic modules, 16 virtual simulations, and 10 phantom scans over a two week rotation. A dedicated simulation center with scanning models and computer-based software was provided to all residents. The didactic modules provided an introduction to the organ or organ system. Instructive simulation scanning allowed for hands-on practice with assigned tasks to assess competency. Self-assessments and assignments provided benchmarks of performance. Residents were provided protected time during the clinical day to complete the simulation component of the course, and were instructed to complete the self-study component at home, if necessary. Attendings and senior residents were in close proximity to the simulation center in case the residents needed assistance. At course completion, a portfolio was created for each resident to document progress, exam scores, and overall time spent. All radiology residents were surveyed at the start of the academic year to assess prior experience and comfort with ultrasound scanning. First year residents were surveyed a second time upon completion of the two-week scanning course. The total cost of instituting the course is estimated at \$50,000, which includes the cost of the phantoms, course software, and physical space for the simulation lab. Funding was provided by two separate intra-departmental grants.

#### **RESULTS**

Initial survey results of all resident years (fig 4) showed a high percentage of residents feeling unprepared to technically assist a sonographer should a problem arise (45%) or to independently complete an ultrasound exam (90%). All residents agreed that ultrasound training and technique are important for radiology residency training. According to survey results of first year residents after completing the course, first year residents felt that both the course modules and simulation cases were helpful for their level of training. Perceived knowledge of sonographic anatomy and technique improved following the course. The course did not affect the residents' feeling of being able to assist a sonographer who encounters a problem during an exam. Comments provided by residents suggested that the most helpful components of the course were the instructional videos paired with virtual simulations, course quizzes, instruction on ultrasound basics and artifacts, and clinical cases. Least helpful components of the course were time provided for scanning practice (without tasks assigned) and areas of repetition.

#### **CONCLUSION**

Pre- and post-survey responses suggest that participation in the two-week ultrasound scanning course contributed to an improvement in perceived scanning knowledge and comfort for participating residents. Our study has several limitations. First, we do not have a true control group for our study. In order to benefit as many residents as possible, all first year residents were enrolled in the course. A second limitation of our study is the lack of long-term follow up. Additional surveys of the residents who have completed the course will help us to assess long-term outcomes. While residents did not always have an attending immediately present to answer questions as they arose, the ability of the course to stand on its own allows for improved resident education without being excessively burdensome to attending physicians. Based on our initial experience, the scanning curriculum presented here provides a comprehensive introductory course for first year radiology residents both for ultrasound anatomy and for scanning technique.

### **QI117-ED- Transforming Healthcare and Outcomes Using Medical Imaging as The Driver for Change (TOHETI): TUA4 Transformation Program in a Central London NHS Trust**

Station #4

#### **Participants**

JoAnna Turville, London, United Kingdom (*Abstract Co-Author*) Nothing to Disclose  
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#### **PURPOSE**

The Transforming Outcomes and Health Economics Through Imaging (TOHETI) programme comprises a research initiative aimed at

improving clinical pathways using value based healthcare and health economics principles. It is recognized that by deploying imaging resources at the right time, right place in a pathway, we can bring efficiency at the point of care. Hence, the purpose of the programme is to provide a platform of improvement for clinical pathways that relies on the new or novel use of medical imaging as the driver for change. The three key transformational components of this programme were: (i) to improve accessibility to imaging and streamlining diagnostic pathways; (ii) keeping at the forefront of technology; and (iii) transforming our ways of working. The programme's vision is to make evidence based changes to service provision.

## **METHODS**

The TOHETI programme is a research and service transformation initiative conducted at a central London NHS Trust funded by a local charity. The programme has run in three phases: First phase focused on identifying key challenge areas for the hospital and NHS as a whole, including colon cancer, lung cancer, scaphoid injury, chronic headache, acute chest pain and fibroids. Each pathway has specific research question that need to be answered. Second phase focused on designing research studies, obtaining ethics approval and recruitment of patients into research studies. Third phase focused on data analysis, publication of results and rolling out of pathways in clinical services. Two studies and a service improvement project are summarized in this abstract, a randomized clinical trial a prospective observational study and a service improvement project that involved patient led initiative to create a patient information video for patients referred for fibroid treatment.

## **RESULTS**

The results of two innovative models of care are summararily presented in the interest of space. If selected, a detailed results section will be presented. First, a pragmatic, randomized, single-center controlled trial evaluated the use of Magnetic Resonance (MRI) in the Emergency Department (ED) in the management of suspected scaphoid fractures compared to standard of care based on radiographs only in the ED. The intervention is associated with improved clinical, particularly diagnostic accuracy in the diagnosis of any bone fracture (98.5% vs 84.6%), and economic outcomes as the MRI intervention dominated the conventional model with an average 6-month cost difference per participant of £266 ( $p=0.047$ ). Second, a pragmatic, prospective single-center study compared the two clinical pathways used in the management of chronic headache following referral from GPs that differed in the first appointment, either a Neurology appointment or a MRI brain scan. The MRI group improved access to care (39.2 and 70.4 days from referral to MRI scan and report, respectively) compared to the Neurology group (110 days) ( $p<0.001$ ). TOHETI alongside clinical staff across gynecology and interventional radiology facilitated a joint clinical approach for patient assessment, referrals and follow-up across the two services for patients who are referred for fibroid treatment. This piece of work is now embedded in delivery of care and leads an example of patients' led change. The charity funded TOHETI programme is unique in its conception due to i) complete engagement from primary and tertiary clinicians who are involved in the patient pathway ii) research led initiatives with appropriate study design iii) value based healthcare and health economic principles. In addition, all work streams included patient engagement to understand value to patients.

## **CONCLUSION**

The findings from scaphoid study led to the development of a new pathway that incorporates immediate MRI as part of the management of all patients with suspected scaphoid fracture and the increase in the workload of chronic headache patients being referred to a direct brain MRI scan. Ultimately, the TOHETI programme contributed to improving clinical outcomes at patient level whilst supporting the NHS financial sustainability agenda. Patient engagement during the fibroid work highlights that there is a potential to improve how and what we communicate to patients, in terms of treatment options, and they would prefer to be offered all options so that they can make an informed choice. The programme introduced a culture of change and further funding has been secured to campaign change that is based upon empirical evidence, across the whole organisation. Shrinking budgets in the NHS implies that organisations need to invest in scientific methodology to bring change and this programme has demonstrated just that.

## **Q1030-EB-TUA Augmenting Patient - Radiologist Communication Through Government Mandate: Initial Results from an Implementation to Address the Patient Test Result Information Act**

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### **Participants**

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William W. Boonn, MD, Penn Valley, PA (*Abstract Co-Author*) Former Chief Medical Information Officer, Nuance Communications, Inc; Shareholder, Nuance Communications, Inc

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## **PURPOSE**

While electronic patient access to diagnostic testing was part of the ARRA stimulus for meaningful use, providing a means for patients to better understand when the results of an imaging test are important to their continued care has never been part of the requirements. Last Fall, the Pennsylvania State Legislature passed the Patient Test Result Information Act 112 (PA112). This law was the first of its kind that requires radiology practices to inform patients when a clinically significant finding exists on their imaging study that a reasonably prudent person would need to follow up within 90 days. The purpose of this project is to describe how our health system implemented a solution within the 60 day window mandated by this new law using existing off-the-shelf IT solutions, provide preliminary results of the frequency of alert triggers derived from a large corpus of reports, and relate lessons learned and enhancements for the upcoming year.

## **METHODS**

Our mandate was to implement a workable solution for patient notification within 60 days when no existing commercial solution existed. While PA112 does not stipulate sending the actual report or the pertinent results, it does require that a communication be sent directly to the patient within 20 days after finalizing the report. Notification is limited to outpatient studies only. Radiography, obstetrical ultrasound and mammography are excluded from the requirements. Our solution consisted of a "belt and suspenders"

approach using both a commercially available natural language processing (NLP) engine and a follow-up management and workflow application to meet the specific requirements of the law. Pre-built manual macros were also created that a radiologist could voluntarily insert into a report that would also trigger generation of a patient letter. The goal was to principally rely on the NLP engine to automatically identify criteria that met the government mandate (e.g. a follow up exam within 90 days) but also provide the latitude for the radiologist to make the decision through use of a macro. Either the NLP ("belt") or the manual macro ("suspenders") would queue a custom letter for the patient. PA112 stipulates that patients can be informed in person, by mail, FAX or direct messaging through a PHR. Conventional mail was chosen as the primary communication method that would accommodate to the heterogeneity of our clinical practice. One to two daily scheduled mailings occur each day from a pre-populated print queue based upon the logic built into the NLP.

## RESULTS

This new program began on schedule with 61,783 reports passing through the system in the first three months of operation. The majority of the reports (43,132, 69.8%) were not relevant to the PA112 inclusion criteria (e.g. inpatient/ED, radiographs, OB ultrasound, mammography). Of the 18,651 potential reports that fell into inclusion criteria, only 3,123 (5%) actually contained a recommendation of some type in the text. When stratified, only 372 (12%) of these met criteria for PA112 with 2751 excluded. Review of the 372 that met criteria included 9 false positives and 2 false negatives. Interestingly, 690 patient letters were triggered during this period. Therefore, 318 letters were manually triggered by the radiologist whether or not the findings actually fell within the PA112 criteria. Manual trigger of patient letters were not evenly distributed across the practice, with some radiologists using this new communication process more liberally than others. In the first three months only three complaints were logged; one for incorrect contact information, two for false positive triggered letters. Modifications were made to mitigate against any similar issues.

## CONCLUSION

Despite initial concerns, the inclusion of this new process into the radiologist workflow was not particularly onerous or time-consuming. Reservations about needlessly alarming patients and inundating ordering providers with patient phone calls were unfounded. Moreover, calls to the radiology department requesting reports and clarification were minimal and appropriate. Initial trends would suggest that radiologists overwhelmingly prefer to trigger a patient communication when they judge it may be beneficial to the patient beyond the PA112 requirements. This suggests that the criteria for the legislation is too restrictive and from a practical standpoint should be expanded to all imaging and all recommendations regardless of time limitation. This simple first step is fostering an environment for improved radiologist-patient interaction. We anticipate that other states may adopt similar legislation and other healthcare systems may also voluntarily replicate a similar workflow. We hope that our experience will inform other healthcare delivery systems on best practices.

## Q1011-EB- TUA Tele-Ultrasound: A New Tool For Quality Control and Medical Support in Large and Public Radiology Practice

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### Participants

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Mariana Mendieta, BA, MSc, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

Diagnostic ultrasound is an imaging method which was consolidated over the years as an essential tool in medicine. It is closely related to the physician who performs it, and hence, in many cases, requires a second medical opinion or support. The mission to improve the quality of a large-scale radiology practice is extremely challenging, yet necessary, particularly within our institution, where the volume of examinations performed is very high, and both patients' profile and deteriorated work conditions make the execution of this service extremely difficult. Tele-ultrasound has allowed effective remote performance of diagnosis, and the aim of our work is to demonstrate how tele-ultrasound serves as a useful and innovative tool not only to improve ways to remotely support physicians during ultrasound examinations, but also to improve the quality of medical reports and results performed in large and public radiology practice.

## METHODS

Our quality improvement project started in March 2016 and nowadays covers 13 hospital unities, and monitors a total of 32 ultrasound examination rooms. Expert physicians are physically present at an Ultrasound Support room, where they monitor the execution of both examination and its medical report, remotely performed by local physicians in the health units. The applied technology follows both an analogue and digital standard, and the resources deployed to capture data transmission include the use of ultrasound equipment and specific systems. Through a DVR device installed in the US equipment and PC monitors, the exams and the medical reports are transmitted in real time from the local health unity to the practitioners based at the Support room. The contact between local and remote physicians is done by live chat, at any time and in real time. The expert physician based at the Support room must fill an evaluation form during the examination. This form was carefully and objectively designed by experienced ultrasound practitioners with solid academic background, and it was developed for each kind of ultrasound examination. According to each question marked in the evaluation form, the system provides an automated score, which classifies the examination into 5 categories: 1) Excellent, 2) Appropriate, 3) Satisfactory, 4) Unsatisfactory, 5) Unacceptable. The data generate both quantitative and qualitative information, as well as performance indicators that are used for quality control purposes and decision-making on training and further medical education.

## RESULTS

The main data collected from the evaluations, transformed into analytic graphs, include, for example, the evolution of results (figure 1), volume of examinations and quality indicators in general and per health unit (figures 2 and 3), the main errors generally observed and distribution of errors by physician (figure 4), and the mapping of physicians' performance vs. the quality goal we established for our institution, which is 80% of satisfactory exams (figure 5). Since the beginning of the project, our institution performed over 1.2 million ultrasound examinations, of which more than 32.000 were monitored by the Ultrasound Support room (over 2.6% of total

volume). At the outset (first 3 months), the overall percentage of unsatisfactory exams was 41%, with a number of 9 monitored examination rooms and 2.635 evaluated exams. Today, after 3 years of the project start, the percentage of unsatisfactory exams is 23% in a total of 32 monitored rooms, with 195 evaluated physicians, within a universe of 280 physicians. In one of the units we monitor, the number of satisfactory exams was lower than the 80% desired during the first year of our project's implementation. Some factors that could contribute to this result were identified and discussed, from the technical deficiencies of the professionals involved to flaws in the physical structure of the unit. After medical education actions on specific themes that we identified from the most frequent errors performed, added to improvements in the physical environment, this unit went from 60% of excellent and satisfactory exams to 86% in the third month after the actions.

## CONCLUSION

The experience from our project demonstrates that tele-ultrasound is an innovative tool in remote assessment of ultrasound examinations in real time, providing constant support to the practitioners, assisting and improving the quality of the examination at all stages, and providing a solid base for the creation of health policies, education and further medical support actions.

## Q1003-EB- TUA **Implementation of Guideline-Appropriate Follow-Up Recommendations in Radiology Reports for Incidentally Discovered Abdominal Aortic Aneurysms on Routine CT**

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### Participants

Osigbemhe Iyalomhe, MD, PhD, Philadelphia, PA (*Presenter*) Nothing to Disclose  
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Stephanie H. Kim, MD, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Steven M. Borislow, MD, Berwyn, PA (*Abstract Co-Author*) Nothing to Disclose  
Tessa S. Cook, MD, PhD, Philadelphia, PA (*Abstract Co-Author*) Speaker, RadPartners AI; Speaker, AImed Radiology  
Hanna M. Zafar, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Ruptured abdominal aortic aneurysms (AAA) are a significant public health concern resulting in approximately 4500 deaths per year in the United States. Monitoring of incidentally discovered AAAs on routine abdominal CTs can decrease mortality from rupture as one study has shown a death rate of 7.6 events per 100-person years for unfollowed AAAs. Our objective was to determine the effect of including appropriate follow-up guidelines in abdominal CT reports when AAAs are incidentally discovered in our health system.

## METHODS

A multidisciplinary team of radiologists and vascular surgeons from our main teaching hospital and community practice iteratively created and approved a standardized reporting language for AAA on routine abdominal CT examinations. The language was embedded into all routine abdominal CT templates and included explicit specialty society guideline-appropriate management recommendations based on size, gender, and relevant imaging features. Radiology trainees and abdominal imaging staff radiologists at our main teaching hospital and community practice were educated on use of the macro and AAA measurement during January 2019. A manual review of all routine abdominal CT exams was performed during baseline (October - December 2016) to identify all patients with reported AAA. Our primary outcome was the presence of guideline appropriate follow-up AAA recommendations within the report and our secondary outcome was documentation of an AAA in the electronic medical record and relevant follow-up (i.e. repeat imaging, surgery) within two years. Patients who died within 2 years of the index routine abdominal CT, who had a known malignancy, or significant comorbidities precluding repair were excluded.

## RESULTS

At baseline the frequency of AAAs was 0.4% (out of 12150 routine abdominal CTs) after exclusion. Mean patient age of AAAs was 74 years (range 53-94) and mean AAA size was 3.9 cm (range 3.0 cm - 6.1 cm). A single report (1/52, 1.9%) included guideline-appropriate follow-up recommendations. Only a third of patients (15/52, 28.8%) were followed: 80% (12/15) with repeat imaging, and 47% (7/15) with surgery of which 3 proceeded directly to surgery without imaging. Aneurysm size was associated with follow-up; mean size of AAAs with no follow-up was 3.6 cm compared to 4.6 cm with follow-up ( $p < 0.001$ ). The frequency of AAAs in the first two months following the intervention (February-March 2019) was 0.5% (42 / 8046). Mean patient age was 75 years (range 57-96) and mean AAA size was 3.8 cm (range 3.0 cm - 5.6 cm). All 42 reports (100%) included guideline-appropriate follow-up recommendations.

## CONCLUSION

Although AAA on routine abdominal CT exams are rare, only 30% of patients with AAA receive follow-up when no guideline-appropriate management recommendations are issued within radiology reports. Embedding specialty society guideline-appropriate management in report templates improves compliance with explicit recommendations by AAA size. Further data is needed to see if inclusion of guideline-appropriate management recommendations is associated with higher rates of guideline-appropriate follow-up.

Printed on: 10/29/20



## 105<sup>TH</sup> Scientific Assembly and Annual Meeting

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LL23

### Lunch and Learn: Where the AI 'Rubber' Meets the Road: Making Deep Learning Technology Clinically Safe and Operationally Impactful for Breast Screening: Presented by Kheiron Medical Technologies (RSVP-required)

Tuesday, Dec. 3 12:30PM - 1:30PM Room: S403A

#### Participants

Bonnie N. Joe, MD, PhD, San Francisco, CA (*Presenter*) Nothing to Disclose

Christopher P. Hess, MD, PhD, San Francisco, CA (*Presenter*) Research, Siemens AG; Consultant, General Electric Company;

Sharmila Majumdar, PhD, San Francisco, CA (*Presenter*) Research Grant, General Electric Company

Tatiana Kelil, MD, San Francisco, CA (*Presenter*) Nothing to Disclose

Peter D. Kecskemethy, PhD, London, United Kingdom (*Presenter*) CEO, Kheiron Medical Technologies

#### Program Information

Breast cancer screening remains one of the most promising areas in medical imaging to deliver the impact of AI at scale. However, building a clinically robust solution deemed safe to deploy on diverse screening populations, that also generates meaningful outcomes for radiologists and patients, remains a challenge. Join Kheiron Medical Technologies and a panel of leading breast imaging experts, researchers and radiology leaders to discuss a framework for selecting and deploying safe and impactful AI into your screening program. *RSVP is required; adding this session to your agenda does not secure your seat in this session. Click the link below to RSVP.*

#### RSVP Link

<https://www.eventbrite.co.uk/e/rsna-2019-lunch-and-learn-where-the-ai-rubber-meets-the-road-registration-75265971547>

Printed on: 10/29/20



QIE-TUB

## Quality Improvement Reports Tuesday Poster Discussions

Tuesday, Dec. 3 12:45PM - 1:15PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI118-ED-TUB1 **Implementation of Measuring and Monitoring of Patient Safety Framework to Improve Peritoneal Dialysis Catheter Failure Rate: Lessons Learned from the Clinical Improvement Team**

Station #1

#### Participants

Nicolette R. Sinclair, MD, Saskatoon, SK (*Presenter*) Nothing to Disclose  
Tiffany Blair, Saskatoon, SK (*Abstract Co-Author*) Nothing to Disclose  
Paul S. Babyn, MD, Saskatoon, SK (*Abstract Co-Author*) Nothing to Disclose

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#### PURPOSE

As part of the Saskatchewan Health Authority's sustainability plan, Kidney Health and Medical Imaging/Interventional Radiology (IR) collaborated to achieve best practice for peritoneal dialysis (PD) catheter insertions by providing a minimally invasive and timelier alternative to current surgical PD catheter means of insertion. Current pressures for operating time have created wait times for peritoneal catheter insertion. A more responsive IR program promotes greater patient access, provides a less invasive procedure, and reduces the need for temporary vascular access and hemodialysis. Nationally, the target for primary failure (inability of the PD catheter to support adequate inflow and/or outflow, patient not able to train) for PD catheter insertions is <10% at 3 months. PD catheter failure rates are associated with significant burden and hardship to the patient, and an overall increase in cost to the health system due to additional procedures/tests to diagnose and correct complications. Current methods of PD catheter insertion have resulted in high failure rates (surgical and interventional radiology (IR) combined, insertions within 3 months): 2016 1° and 2° failure rate 31/62 (50.0%); 2017 1° and 2° failure rate 23/71 (32.4%), and 2018 1° and 2° failure rate 11/50 (22.0%). Although a 28.0% reduction in PD catheter failure rate has been achieved, current efforts are focused on closing this performance gap.

#### METHODS

The interdisciplinary clinical improvement team (CIT) participated in the Canadian Patient Safety Institute Measuring and Monitoring for Patient Safety Framework (MMSF) national collaborative. The team was challenged to improve the quality and safety of patient care with clinical pathways, overcome traditional 'department' boundaries, and better capture and understand the patient and family care experience. The CIT oversees the development, monitoring, and continuous improvement of clinical pathways drawing upon evidence based best practice. This team employed a holistic approach and involves staff, clinicians, and patients and families at all levels. The MMSF served to translate real time data so it is useful to take action, gap analysis for process improvement, identifying strengths and weaknesses, and promoting a culture of safety and continuous improvement: PD patient flow (from selection criteria, referral, procedure, training, home); PD catheter failure rate; mapping of PD patient safety indicators by dimension to determine core data set; and cultural appropriateness (staff level).

#### RESULTS

Through focused efforts, the CIT has reduced PD catheter failure rate by from 31/62 (50.0%) in 2016, to 11/50 (22.0%) in 2018. Process improvements implemented were standard workflow and PD assessment, exit site marking for interventional radiology only, standard room set up, patient safety questionnaire, quarterly review of metrics and reporting, ongoing case reviews, and lead time reduction (time to referral, assessment, PD insertion, and PD train). Single centre experience, with a single Interventional Radiologist has allowed for standardization of technique, but also poses challenges in terms of peer-to-peer support and enhancing insertion technique learning. The CIT was awarded a leading practice from the Health Standards Organization and Accreditation Canada, for excellence in patient and family engagement.

#### CONCLUSION

Peritoneal dialysis is an important model of home based therapies to avert or delay the need for hemodialysis. Strategies to increase uptake of home based therapies to date are not well documented. It is important to identify best practice, implement solutions to ameliorate cause-specific technique failure, and optimize clinical practice. Extending technique survival on PD and home hemodialysis remains a major challenge to optimizing outcomes for patients while increasing utilization.

#### QI119-ED-TUB2 **Decreasing Time to Report Critical Results at a Single, Urban, County Hospital**

Station #2

#### Participants

Brian Trinh, MD, San Francisco, CA (*Presenter*) Nothing to Disclose  
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Soonmee Cha, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Mark W. Wilson, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose  
Brian Haas, MD, San Francisco, CA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Diagnostic radiology aims to report all critical findings within 60 minutes of exam completion. Critical results are defined as results which mandate immediate physician to physician verbal communication with documentation of the time, content, and participants of the communication in the final report. In the calendar year of 2017, 68% of critical results were reported with documentation within 60 minutes of exam completion. The purpose of this project was to increase rates for communicating critical results within 60 minutes to 80% by July 1, 2019.

## METHODS

At our county hospital, critical findings are tracked based on the radiologists' discretion. At the time of final signing of the report, the radiologists are directed to categorize each report as 'critical', 'new and reportable finding(s)', or 'no new or reportable finding(s)'. Prior to the start of this project, all reports flagged with 'critical' findings within six consecutive months prior to intervention (November 2017 - April 2018) were retrospectively reviewed. Data including time of study completion, time of communication, report content, and responsible participants were recorded. Based on this data, three targeted interventions were developed. The first action required education amongst the radiology residents and attendings. A short power point presentation outlined the process for tracking a 'critical' finding from preliminary read to final sign. This material was presented at the monthly resident meeting at the beginning of the year and then posted onto a resident webpage for reference. The second action was to revise and update a concise list of critical findings which could be displayed at all radiology workstations. From the review of data from months past, it was clear the radiologists did not refer to a universal list of critical findings. An updated list of critical findings with input from current radiology section chiefs was compiled and sent for approval by the emergency department section chief. A finalized list of 'critical' findings was then laminated and posted at each radiology workstation for reference. The third action was to streamline the process of correctly documenting the time, content, and participants in all reports with critical findings. A 'Macro' in Powerscribe was distributed to all radiologists and used as the official method for documenting verbal communication with the ordering providers. In order to accurately track the progress of our targeted interventions, a more comprehensive dataset was collected, including: patient location at time of imaging order (emergency room, inpatient, or outpatient), time of day the study was completed (8AM-12PM, 12PM-5PM, 5PM-10PM, 10PM-2AM, 2AM-8AM), and imaging modality.

## RESULTS

From the months of November 2017 to April 2017, prior to any intervention, there were a total of 868 reports flagged as critical, of which 591 (68%) were communicated with correct documentation to the ordering provider within 60 minutes of study completion. Of the 277 critical results that were not compliant, 221 (80%) lacked correct documentation, and 56 (20%) contained proper documentation but was communicated to the ordering provider >60 minutes after study completion. Due to the high rate of incomplete documentations, three targeted interventions were initiated in June 2018. From the months of July 2018 to November 2018, there were 477 critical results. 81% of which were reported with documentation within 60 minutes of study completion. 56% were either emergency room or urgent care patients, 40% were inpatients, and 4% were outpatients. Critical results communicated with documentation within one hour was highest in the ED/urgent care patients (84.9%), and inpatients (78.1%). Of note: only 4 cases were communicated within 60 minutes but lacked proper documentation of the communication. 70 (19%) reports with critical findings were not communicated with documentation within 60 minutes. Of these, 30 (43%) were reported within 61-120 minutes after exam completion, 19 (27%) were reported within 121-240 minutes, and 21 (30%) took longer than 240 minutes to report. Of the 21 reports which were reported more than 240 minutes after study completion, 9 (42%) were examination completed between the hours of 5 PM and 10 PM.

## CONCLUSION

Compliance rates for reporting and documenting critical findings within 60 minutes of imaging study completion was improved from 68% to 81% with directed resident education, development of a concise listing of critical findings, and by distributing a universal 'macro' in Powerscribe to all radiologists for documentation of a critical finding. Follow-up data suggests that potential areas for continued improvement at our county hospital are with patients scanned during the hours of 5 PM and 10 PM and for patients outside of the ED.

## Q1120-ED-TUB3 Implementation of AI Structured Reporting to Smooth Workflow in Radiology Department Daily Practice

Station #3

Participants

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## PURPOSE

To evaluate the workflow of structured reporting with integration of AI in routine radiology practice.

## METHODS

1. Workflow of structured reporting Since Sep. 2016, structured reporting has been used in radiology department. During reporting, the radiologists performed the following procedures to complete a report: 1) Open the structured reporting software interface from the Patient List of RIS. 2) Click to choose the icons for a finding, or select from a drop-down menu to define the image features that was detected. 3) Type in the editing boxes to input the measurements of the observation, such as diameters and CT values. 4) Capture a screen snapshot for the significant finding and save it as the key image. 5) Input the final diagnosis and submit the report. 2. Workflow of structured reporting + AI Since April 2018, AI algorithms were integrated to the workflow of structured reporting, some reporting sections were generated automatically by AI, including selection of the findings, input of the measurements and capture of the key images. Sometimes the final diagnosis will be concluded by predefined logic script. During reporting, the radiologists performed the following procedures to complete a report: 1) Open the structured reporting software interface from the Patient List of RIS. 2) Check the contents that had already completed by AI, revise it when needed. 3) Check the final diagnosis and submit the report. 3. Study of the quality improvement by the AI workflow The acceptance rate of AI results was evaluated from the log file of the software. The average interpretation and reporting time was calculated for the whole institute. Questionnaire survey was collected to evaluate the experiences of the radiologists in the new workflow.

## RESULTS

The following reports were almost fully automatically generated by AI: chest X ray, plain head CT and prostate mpMRI. The following reports were partially automatically generated by AI: LI-RADS reports of CT and MR, BI-RADS report of mammography, TNM report of RCC, renal stone, and renal cyst. The acceptance rate of AI results was 84.3%-100% for detection the image features and the key images, 93.5%-100% for measurements of diameters and CT values, and 40.1-78.3% for the final diagnosis. Specifically, in 15.4-36.8% cases, the reports were totally generated by AI and accepted by the radiology without change of one word. The average interpretation and reporting time reduced 8.9%-56.1%. In questionnaire survey, 96.9% radiologists considered the workflow of structured reporting with integration of AI was better than the traditional reporting workflow.

## CONCLUSION

The workflow of structured reporting with integration of AI in routine practice can be well accepted by the radiologist.

### Q1121-ED- TUB4 Keeping it Real: The Benefits of Using Standardized Patients and High Fidelity Simulations in In-situ Simulations in Contrast Reaction Management Training

Station #4

#### Participants

Sean P. Wagner, MD, Chapel Hill, NC (*Presenter*) Nothing to Disclose  
Ellie R. Lee, MD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose  
Benny Joyner, MD, MPH, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose  
Sheryl G. Jordan, MD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose  
Katrina A. McGinty, MD, Chapel Hill, NC (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To assess the feasibility and effectiveness of using standardized patients and high fidelity simulations in in-situ simulations to train radiology residents and fellows in contrast reactions and extravasations management.

## METHODS

23 radiology residents and 6 radiology fellows participated in a contrast reaction management program. The participants attended a didactic lecture on managing contrast reactions and extravasations by an attending physician. This was followed by standardized simulations of 4 different commonly encountered contrast related scenarios: mild, moderate, and severe contrast reactions as well as mild contrast extravasation. Each simulation was proctored by an attending radiologist, an attending anesthesiologist and a CT technologist. These simulations took place in situ within the patient holding area, patient treatment room or CT scanner areas utilizing standardized patients. The standardized patients were given a script to follow and the observing attendings adjusted vital signs during the simulation using a simulation monitor. This allowed the standardized patients to interact with the participants and give real-time simulated clinical responses in response to the trainees' interventions. The severe contrast reaction scenario utilized a high fidelity mannequin, which allowed adjustments in vital signs that the participants would have to immediately act on. An individual debrief occurred at the end of each simulation with feedback from the observing attending physicians, the CT technologists and the standardized patient. Simulation topics of discussion included, but were not limited to, appropriate patient communication, medication dosages, proper EpiPen administration, and institutional/ACR management guidelines. A group debrief with all participants occurred at the end of all four scenarios. Additionally, a survey was sent to all participants 6 months following training to gauge perceived effectiveness of the training.

## RESULTS

The most frequently observed deficits were in patient communication and institution specific knowledge. The majority of residents selected an appropriate treatment regimen in the clinical scenarios. However, the standardized patients communicated that in more than half of the simulations, the resident did not communicate effectively with them. Also, in a significant portion of the simulations, the trainees were not familiar with all the resources available to them in the scanner (i.e. location of monitor, stethoscope and medication box). Additionally, there were deficits in communication to the treating team and underutilization of the CT technologist as a member of the treating team. 6 months following the training, participants were surveyed as to whether or not they had participated in the treatment of a contrast reaction or extravasation and to ask about their perception of the training and its relative value to their education, specifically regarding the role of didactic lectures, standardized patients, use of mannequins and in situ simulations. Of the 29 participants, 27 responded to the survey. 97% of respondents agreed or strongly agreed that in situ training was an effective training tool and 93% agreed or strongly agreed that standardized patients were an effective training tool, as opposed to 81% for mannequins and 70% for didactic lectures. When asked to rank the four components of training from most helpful to least helpful, 38% ranked standardized patients as most helpful, 38% ranked in situ training as most helpful, 19% ranked mannequins as most helpful and only 15% ranked didactic lectures as most helpful. An ordinal logistic regression was applied and found that the ratings by group for standardized patients was higher than didactic lectures (OR = 5.075, p = 0.0015). There was not evidence for a difference in ratings between the other measured metrics (in situ simulations or high fidelity mannequins). Most importantly, 68% and 75% of respondents had participated in the treatment of an actual contrast reaction and contrast extravasation, respectively, at the time of the survey.

## CONCLUSION

Utilizing standardized patients in an in-situ training scenario can be a feasible strategy for teaching these important contrast reaction and extravasation management skills and is an effective realistic training tool when used in conjunction with other educational modalities. Specifically, the benefits of this type of training being performed with standardized patients and in clinically used areas over high-fidelity mannequin training in simulation labs include the ability to develop effective patient communication, gaining familiarity with staff and environment, and the discovery of both general and institutional-specific knowledge gaps. Additionally, a survey of participants following training demonstrated that in situ training and use of standardized patients are perceived as valuable and effective ways to learn how to treat contrast reactions and extravasations.

### Q1023-EB- TUB Improving ED CT Patient Flow

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#### Awards

## Quality Improvement Reports Award Identified for RadioGraphics

### Participants

Pratik V. Rachh, MD,MBA, Decatur, GA (*Presenter*) Nothing to Disclose  
Phuong-Anh T. Duong, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Tarek N. Hanna, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Andrew Pendley, MD,MBA, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
Nataisia Terry, MD,MBA, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

Emergency Department (ED) visits have increased at twice the rate of the United States' population growth, while the number of ED facilities across the nation has declined, resulting in widespread ED overcrowding. Overcrowding leads to delays in patient care, raises costs and creates patient flow challenges across the hospital system. Approximately 60% of our ED visits involve imaging, with CT as the most common imaging modality. As part of improving overall flow of patients through the ED, our team attempted to improve CT turnaround times. The goal of this project is to improve CT exam order to exam complete turnaround time (TAT) from 61% to 71% by March 2019.

### METHODS

A multidisciplinary team of leaders and frontline clinicians from Radiology and Emergency Medicine was formed, and the project was facilitated by the Radiology Process Improvement Manager. Project scope included all ED patients scanned on any of the three CT scanners at our hospital. Three 2-hour facilitated workshops were held from November thru December which included gemba walks, technologist workflow time studies, process maps, cause and effect analysis and brainstorming of counter measures. As part of baseline analysis, technologist workflow time studies and staffing ratios indicated demand (number of exams ordered) and capacity (available technologists) mismatch occurred at around 11am during ED surge, and around 6pm when technologist transporter left for the day. Cause and effect analysis revealed broad categories: Barriers to first pass yield (challenges that result in technologists fixing orders before fetching patient), Communication challenges (when and how to request for help from ED nurses for difficult intravenous lines or moving help), Exam Prioritization challenges (optimize clinical acuity versus ED length of stay), System challenges (variation in patient volume). Based on these categories our team brainstormed solutions and grouped them into three categories: Just-Do-It's, Requires Planning and Parking Lot ideas. Some of the Just-Do-It's included updating electronic medical record orders to match radiology protocols thereby preventing tech rework of canceling and reordering exams, walkie-talkies for improved communication between ED nurses and Radiology technologists, and bi-annual ED and radiology faculty collaboration meetings to optimize exam orders and utilization. Require Planning interventions included: 1.) Complete redesign of the CT contrast screening form with subsequent policy change, 2.) Development of CT Passport (document completed by ED physician at order which serves as a patient education tool and also as a checklist for downstream clinicians), 3.) Completion of CT contrast screening form while patients are waiting for their exam, 4.) Revision of CT Stroke workflow to minimize stroke standby time (time between stroke notification and patient arrival) and, 5.) Reconfiguration of CT head without contrast patient flow by seating patients closer to ED scanner.

### RESULTS

At baseline (August thru December 2018), CT exam order to complete TAT less than 120 minutes averaged 61%. Several tests of change were incrementally introduced from January thru March 2019 of which CT passport and patient completed CT contrast screening form were widely adapted by staff and were effective in reducing exam TAT. Reconfiguration of CT head without contrast patient flow test of change led to patient and staff dissatisfaction, and was abandoned after a few weeks of testing. Post-implementation data (January thru March 2019) showed on average 65% of CT exams were completed in less than 120 minutes (see Figure 1). In addition, median exam TAT decreased from a range of 130- 150 minutes pre-implementation to 93 minutes in February and 87 minutes March 2019 (see Figure 2). Though our goal of 71% for CT exam order to complete less than 120 minutes by March 2019 was not met, in the short three months of testing changes, post-implementation data indicate we are moving in the right direction.

### CONCLUSION

ED patient flow is very complex and involves various value streams. Multidisciplinary teamwork is critical for improving processes. Some interventions did not work as planned and team learned from them. Technologist workflow time studies and staffing analysis determined need to reallocate technologist resources to better meet exam surge and lunch time coverage. We are sharing our findings with hospital leadership about better resource allocation during time of high ED patient volumes and technologist lunch hours, and exploring hiring medical assistants to help with non-value added essential tasks such as transporting patients, taking patients on and off the scanner, and placement of IVs. As next steps, we aim to continue refining standard work processes for CT passport and stroke patient flow.

## Q1024-EB- Know It to Fix It: A Quality Improvement Evaluation to Improve Turnaround Times in the TUB Interventional Radiology Suite

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### Participants

Carlos B. Ortiz, BS, Houston, TX (*Presenter*) Nothing to Disclose  
Kamlesh U. Kukreja, MD, Bellaire, TX (*Abstract Co-Author*) Nothing to Disclose  
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Gregory C. Gardner, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
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## **PURPOSE**

Process mapping can be used to identify workflow issues and implement actionable changes. We created a process map of pediatric interventional radiology (IR) workflow for inpatients undergoing procedures with general anesthesia to identify delays in patient care and improve turnaround times.

## **METHODS**

A fourth-year medical student was assigned to observe and record key events during coordination of inpatient IR procedures at a tertiary care children's hospital. This observation was set as an initial 2-week observation followed by a 1-week observation 6 months after implementation of changes. We restricted our study to inpatient procedures using general anesthesia. The medical student began following a single patient at initiation of transfer from the inpatient floor until the patient exited the IR suite. Predetermined variables were recorded for each patient observation. Following the initial observation, data was reviewed to identify areas of improvement with immediate implementation of changes. The impact of these changes was measured after the second observation.

## **RESULTS**

In the initial and second observations, 14 and 10 inpatient procedures were fully tracked, respectively. Initially, we found notable intervals in patient transport times (mean 38 mins, range 22-68 mins, n=9) and patient preparation (mean 22 mins, range 13-31 mins). Preoperative/PACU space availability was also identified to cause delays in 2 cases (14%). Estimated time for procedure duration in the IR suite (mean 68.5 mins, range 60-120 mins) was shown to be an underestimate when compared to the measured procedure duration (mean 77 mins, range 31-181 mins). With all members of the IR team, including IR nurses and radiology technologists, a process map was created to map the roles of each team member. We found our team to be efficient in preparing the patient for the procedure with most of our delays being attributable to PACU bed availability and the patient not being present in the pre-operative evaluation area when needed. Results from the observation were discussed at a team meeting to implement the following actionable changes: 1) standardizing the time for initiation of patient transport; 2) increasing the time allotted per procedure; 3) primary IR nurse transport for patient transfer, and 4) utilization of other spaces in the radiology department for pre-operative evaluation. After the 2nd observation, we noted the following: improved transport times from 38 minutes to 30 minutes ( $p=0.32$ ), increased time for pre-operative evaluation from 31 to 64 minutes ( $p<0.05$ ), and stable intraprocedural intervals. No delays due to PACU space were noted during the 2nd observation.

## **CONCLUSION**

By analyzing our workflow, causes of delays in coordination of patient care were identified and improved. Implementation of targeted changes at our institution lead to improved efficiency. This process can be used by other IR departments to improve their workflow.

Printed on: 10/29/20



MSQI33

## Quality Improvement Symposium: Quality Program in Radiology

Tuesday, Dec. 3 1:30PM - 3:00PM Room: S402AB



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Lane F. Donnelly, MD, Palo Alto, CA (*Moderator*) Nothing to Disclose

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### ABSTRACT

None - not a speaker, just moderating.

### Sub-Events

#### MSQI33A Developing a QI Leader

##### Participants

David B. Larson, MD, MBA, Stanford, CA (*Presenter*) Grant, Siemens AG Grant, Koninklijke Philips NV

#### MSQI33B Avoiding Pitfalls When Starting a Quality and Safety Program

##### Participants

Jennifer C. Broder, MD, Burlington, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Describe obstacles that may impede the development of a Q/S program. 2) Identify activities which can help avoid those obstacles. 3) List resources that can be used to support the development of a radiology Q/S program.

### ABSTRACT

Physician leaders face common obstacles in quality and safety program development and management. Prospective awareness of those shared challenges, understanding of potential solutions, and knowledge of available resources can help programs avoid pitfalls and succeed.

#### MSQI33C Development of Operational Plan for Quality

##### Participants

Alex Towbin, MD, Cincinnati, OH (*Presenter*) Author, Reed Elsevier; Grant, Guerbet SA; Grant, Cystic Fibrosis Foundation; Consultant, Reed Elsevier; Advisory Board, IBM Corporation; Advisory Board, KLAS Enterprises LLC;

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### LEARNING OBJECTIVES

1) List three differences between strategic planning and operational planning. 2) List three differences between operational planning and project planning. 3) Describe a process for operational planning.

### ABSTRACT

Creating a yearly operational plan provides departmental employees with a roadmap for the upcoming year and helps to tie their daily activities to the larger strategic vision of the organization. In this lecture, the differences between a strategic plan, an operational plan, and a project plan will be discussed followed by a step-wise process for building an operational plan.

#### MSQI33D Branding Quality and Value Added

##### Participants

Samir B. Patel, MD, Granger, IN (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Describe quality in the context of a radiology value-added matrix for non-interpretative radiologist activities. 2) Provide examples of branding of the quality and value-added activities performed by radiologists.

### ABSTRACT

Quality can be defined in many ways but is a critical component of the many non-interpretative activities performed by radiologists. A radiology value-added matrix is a way to define and categorize non-interpretative activities performed by radiologists. Once quality and other non-interpretative radiology activities are performed, branding is essential to demonstrate the value-added actions of radiologists.

**MSQI33E** **Q&A**

Printed on: 10/29/20



SSJ08

## Gastrointestinal (CT Dose and Abbreviated MR Screening Techniques)

Tuesday, Dec. 3 3:00PM - 4:00PM Room: S401CD



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

### Participants

Jessica B. Robbins, MD, Madison, WI (*Moderator*) Nothing to Disclose  
Jeong Hee Yoon, MD, Seoul, Korea, Republic Of (*Moderator*) Research Grant, Bayer AG Speaker, Koninklijke Philips NV Speaker, Bayer AG

### Sub-Events

#### SSJ08-01 Diagnostic Performance and Image Quality of Low-Tube Voltage and Low-Contrast Agent Dose Protocol for Hepatic Dynamic Computed Tomography

Tuesday, Dec. 3 3:00PM - 3:10PM Room: S401CD

### Participants

Shintaro Ichikawa, MD, PhD, Chuo, Japan (*Presenter*) Nothing to Disclose  
Utaroh Motosugi, MD, Chuo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tatsuya Shimizu, MD, Yamanashi, Japan (*Abstract Co-Author*) Nothing to Disclose  
Marie-Luise Kromrey, MD, Greifswald, Germany (*Abstract Co-Author*) Nothing to Disclose  
Yoshihito Aikawa, RT, Chuo, Japan (*Abstract Co-Author*) Nothing to Disclose  
Hiroshi Onishi, MD, Yamanashi, Japan (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To evaluate diagnostic performance and image quality of low-tube voltage and low-contrast agent dose protocol for hepatic dynamic computed tomography (CT).

### METHOD AND MATERIALS

This retrospective study, held between January and May 2018, included 424 patients (mean age, 70.5±10.1 years; 289 men, 135 women). They underwent hepatic dynamic CT using one of two protocols: tube voltage, 80 kVp; contrast dose, 360 mgI/kg, and iterative reconstruction (n=180) and tube voltage, 120 kVp; contrast dose, 600 mgI/kg, and filtered back projection (n=224). Two radiologists independently scored lesion conspicuity and image quality using 5- and 3-point scales, respectively. Another radiologist measured CT number of abdominal organs, muscles, and hepatocellular carcinoma (HCC) in each phase. Lesion detectability, diagnostic ability for HCC, image quality of the arterial phase, CT number including lesion-to-liver ratio, and radiation dose were compared between protocols.

### RESULTS

Both protocols showed high lesion detectability (sensitivity, 86.1%-92.5%; specificity, 94.6%-97.3%; accuracy, 92.8%-95.0%) and diagnostic ability for HCC (sensitivity, 85.7%-93.3%; specificity, 93.6%-98.6%; accuracy, 93.3%-96.6%). The 120-kVp protocol showed better image quality for the arterial phase than the 80-kVp protocol (P<0.0001 for both); however, the ratio of fair image quality was not significantly different (P=0.3161 and 0.4084). CT number of abdominal organs and muscles was higher in the 80-kVp protocol than in the 120-kVp protocol in each phase (P<0.0001-0.0357) for all structures, except portal vein in the arterial phase and renal medulla in the portal venous phase (P=0.1760 and 0.1280). Lesion-to-liver ratio was not significantly different for all phases (P=0.2108-0.8653). Volume CT dose index and dose-length product in the arterial phase were significantly lower for the 80-kVp protocol than for 120-kVp protocol (15.2±3.6 vs 32.1±9.3 mGy and 397.3±122.2 vs 880.2±312.7 mGy·cm, respectively, P<0.0001 for both).

### CONCLUSION

The 80-kVp protocol has diagnostic performance and image quality, equivalent to the 120-kVp protocol, with lower radiation and contrast agent doses.

### CLINICAL RELEVANCE/APPLICATION

Low-tube voltage with iterative reconstruction for hepatic dynamic CT may decrease radiation and contrast agent doses, with equivalent diagnostic performance and image quality than the 120-kVp protocol.

#### SSJ08-02 Pilot Study to Assess Feasibility of Fast Whole Body MRI Imaging in Oncologic Screening

Tuesday, Dec. 3 3:10PM - 3:20PM Room: S401CD

### Participants

Maryam Ghadimi, MD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Pallavi Pandey, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Ankur Pandey, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Bita Hazhirkarzar, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Mounes Aliyari Ghasabeh, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose

Pegah Khoshpouri, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
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Roya Rezvani Habibabadi, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Mohammadreza Shaghaghi, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Li Pan, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Vikash Gupta, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Ihab R. Kamel, MD, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Siemens AG

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#### **PURPOSE**

Assess the feasibility of whole-body MRI imaging in 30 minutes in oncologic applications.

#### **METHOD AND MATERIALS**

Our IRB approved this HIPPA-compliant prospective study. Twenty-six adult patients assessed for metastatic diseases were scanned with WB-DWI methods using a 3T MRI scanner. Axial fat-suppressed T2-weighted (T2WI), DWI, precontrast T1-weighted (T1WI) followed by post contrast FS T1WI in the arterial, portal venous and delayed phases were acquired (gradient time of 30 minutes). A single reader utilizing a five-point-scale recorded image quality of each WB-MRI study. Findings on whole-body MRI were recorded. The number of lesions was compared to those detected on CT or PET-CT studies, performed with 12 months of whole-body MRI if available. The WB-MRI, CT, and PET-CT were divided into standard anatomical location including chest, abdomen, and pelvis. The number of lesions within each anatomic location was compared in all three modalities.

#### **RESULTS**

Our study included 14 males and 12 females with the mean ( $\pm$ standard deviation) age of 55( $\pm$ 14) years. All whole-body MRI examinations were successfully obtained in the median time of 35 (IQR, 29-39) minutes. There were 17,21 and 8 lesions detected from chest, abdomen and pelvis, respectively in CT studies (N=19). Additionally, total of 0, 3, 2 lesions were detected in the chest, abdomen and pelvis respectively by assessing PET-CT studies (N=5). The WB-MRI detected 15 Lesions in chest, 38 Lesions in abdomen and 8 lesions in pelvis. All lesions detected on PET-CT were also detected on WB-MRI. Four lesions (16%) detected on WB-MRI in abdomen parts were missed on CT, while WB-MRI missed 2 lesions (11%) detected by CT in the chest parts; all were less than 10 mm. These two studies are comparable in detecting lesions in the pelvis. The overall image quality of whole-body MRI was 4/5.

#### **CONCLUSION**

We have demonstrated that fast multiparametric WB-MRI may be preformed in approximately 30 minutes, with relatively high image quality. Lung lesions <10mm may not be readily detected by WB-MRI.

#### **CLINICAL RELEVANCE/APPLICATION**

Whole-body MRI might be an acceptable alternative for CT or PET, in staging, assessment and monitoring of treatment response in oncologic applications.

#### **SSJ08-03 Assessment of Noise Reduction Potential and Image Quality Improvement of a Deep Learning-Based Image Reconstruction Algorithm in Abdomen CT**

Tuesday, Dec. 3 3:20PM - 3:30PM Room: S401CD

#### **Participants**

Xiaohu Li, MD, Hefei, China (*Presenter*) Nothing to Disclose  
Jianying Li, Beijing, China (*Abstract Co-Author*) Employee, General Electric Company  
Huayang Liu, MD, Beijing, China (*Abstract Co-Author*) Employee, General Electric Company  
Yongqiang Yu, MD, Hefei, China (*Abstract Co-Author*) Nothing to Disclose

#### **PURPOSE**

To evaluate the image quality improvement and noise reduction in routine dose, non-enhanced abdomen CT imaging by using a deep learning-based image reconstruction algorithm in comparison with ASIR-V .

#### **METHOD AND MATERIALS**

9 patients who underwent routine dose, abdomen CT using GE Revolution CT (GE Healthcare, Waukesha, WI) were included . After scanning, all scans were reconstructed with the recommended level of 40% ASIR-V and for comparison purpose and deep learning-based image reconstruction algorithm (TrueFidelityTM, GE Healthcare).DLIR-L, DLIR-M, DLIR-H. The CT attenuation values and SD of the subcutaneous fat, back muscle and descending aorta were measured at the level of tracheal carina of all reconstructed images. The signal-to-noise ratio (SNR) was calculated with SD representing image noise. The subjective image quality was independently evaluated by two experienced radiologists.

#### **RESULTS**

For all DLIR images, the objective image noise (SD) of fat, muscle and aorta decreased and SNR increased along with DLIR-L, DLIR-M, DLIR-H. The SD of DLIR images were significantly lower than that of 40% ASIR-V. In terms of subjective image evaluation, all DLIR reconstructions and 40% ASIR-V had good diagnostic acceptability. However, DLIR-M, DLIR-H showed significantly superior visibility of small structures when compared with the 40% ASIR-V and DLIR-L, and DLIR-H was the best series of TrueFidelity images, with a highest subjective image quality, at the same time the image sharpness was not significantly decreased in DLIR-H images.

#### **CONCLUSION**

In routine dose, non-enhanced abdomen CT, DLIR show greater potential in reducing image noise and artefacts and maintaining image sharpness when compared to the recommended level of 40%ASIR-V algorithm. Combining both the objective and subjective evaluation of images, non-enhanced abdomen CT images reconstructed with DLIR-H have the highest image quality.

## CLINICAL RELEVANCE/APPLICATION

Recently a deep learning-based image reconstruction algorithm has been introduced . This image reconstruction technique employs deep CNN-based models, including millions of trained parameters, to improve the image quality with natural image texture, lower image noise, and high-resolution

### SSJ08-04 Deep-Learning-Based Abdominal CT Denoising: Impact of Changes in Reconstruction Parameters Relative to Training Data

Tuesday, Dec. 3 3:30PM - 3:40PM Room: S401CD

#### Participants

Nathan Huber, Rochester, MN (*Presenter*) Nothing to Disclose  
Andrew Missert, PHD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Shuai Leng, PHD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Lifeng Yu, PHD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose  
Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

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#### PURPOSE

Deep-learning-based CT denoising methods are typically trained on images using a single set of reconstruction parameters. However, reconstruction parameters vary considerably between abdominal CT exam types and practices. This work aimed to quantify the performance of a convolutional neural network (CNN) denoising algorithm when applied to abdominal CT images with reconstruction parameters different from the training data.

#### METHOD AND MATERIALS

A CNN with 36 convolutional layers was trained on 250,000 image patches clipped from ten contrast-enhanced abdominal CT scans reconstructed with a Siemens' D30 kernel, 3 mm image thickness, and 275 mm field of view (FOV). Supervised learning was used for training, with simulated quarter dose images used as inputs, full dose images as the ground truth, and a mean-squared-error loss function. Six patients were reserved for testing the network. Baseline performance was evaluated with test data that had the same reconstruction parameters as the training data. Without retraining, the network was then applied to data with a range of reconstruction settings: FOV from 100 mm to 450 mm, kernel strength from D10 to D50, and image thickness from 1 to 5 mm. Performance was evaluated by visual assessment, root mean square error, noise level, and spatial resolution. Percent noise reduction was calculated as the difference in noise level from quarter dose to CNN output divided by quarter dose noise level.

#### RESULTS

The CNN demonstrated 73±6 % noise reduction relative to quarter dose at baseline, with no degradation of spatial resolution (i.e., when test data reconstruction = training data reconstruction). CNN denoising efficacy was decreased, to only 47±5 % noise reduction, when FOV was decreased by 50 mm ( $p = 0.0004$ ), or to only 60±7 % noise reduction, when a smoother (D20) kernel was used ( $p = 0.001$ ). Resolution loss was noted (visual and line profile inspection) when the network was applied to larger FOVs or sharper kernels. CNN performance was largely maintained when applied to test data with different image thicknesses.

#### CONCLUSION

Performance of the evaluated CNN-based CT denoising method varied significantly with FOV and kernel strength, but not with image thickness.

## CLINICAL RELEVANCE/APPLICATION

While impressive noise reduction can be obtained using CNNs, reconstruction parameters must be carefully considered. Improvements in generalizability are therefore necessary.

### SSJ08-05 Hepatocellular Carcinoma Screening with Abbreviated MRI: Comparison of Noncontrast, Dynamic-Contrast Enhanced and Hepatobiliary Phase Protocols Post Gadoteric Acid

Tuesday, Dec. 3 3:40PM - 3:50PM Room: S401CD

#### Participants

Naik Vietti Violi, Lausanne, Switzerland (*Presenter*) Nothing to Disclose  
Sara Lewis, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
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Miriam Hulkower, MD, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose  
Gabriela Herandez-Meza, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Katherine Smith, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
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Maxwell Segall, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Jonathan Rosenblatt, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Mary Sun, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Dillan Villavisanis, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Raphael Golaz, Lausanne, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Keith Sigel, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Bachir Taouli, MD, New York, NY (*Abstract Co-Author*) Research Grant, Bayer AG; Research Grant, Takeda Pharmaceutical Company Limited; Research Grant, Regeneron Pharmaceuticals, Inc; Consultant, Alexion Pharmaceuticals, Inc; Consultant, Bayer AG; ;

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**PURPOSE**

To compare the performance of reconstructed abbreviated MRI (AMRI) protocols derived from a full gadoteric acid-enhanced MRI for HCC screening in an at risk population.

**METHOD AND MATERIALS**

This retrospective study included 237 consecutive eligible patients (M/F 146/91, mean age 58y) with chronic liver disease (cirrhosis or HBV without cirrhosis) who underwent gadoteric acid MRI in 2017 for HCC screening. Patients with history of HCC/other malignancies, liver transplantation and acute liver disease were excluded. Three reconstructed AMRI sets were assessed separately by 3 independent radiologists: non contrast (NC-AMRI: T2WI HASTE+diffusion weighted imaging (DWI)), Dynamic-AMRI (Dyn-AMRI: T2WI+Dynamic T1WI) and EOB-AMRI (T2WI+DWI +T1WI hepatobiliary phase). Lesions were characterized using a composite scoring system for NC-AMRI and EOB-AMRI [negative, subthreshold (<10mm), positive] and LI-RADS v2018 algorithm was used for Dyn-AMRI. Only LI-RADS5 lesions were considered HCC. A preliminary cost-effectiveness analysis was performed comparing each AMRI set to published ultrasound (US) sensitivity in USA (60%).

**RESULTS**

The reference standard demonstrated 13/237 patients with HCC (incidence 5.5%, mean size 33.7±30mm, range:10-120mm). Inter-reader agreement was substantial for NC-AMRI and EOB-AMRI (k=0.76 and 0.75) and excellent for Dyn-AMRI (k=0.86). Pooled per-patient sensitivities were 61.5% for NC-AMRI [CIs: 34.4-83%], 84.6% for Dyn-AMRI [60.8-95.1%] and 80.8% for EOB-AMRI [53.6-93.9%], without significant difference between sets (p-values range:0.06-0.16). Pooled per-patient specificities were 95.5% [92.4-97.4%], 99.8% [98.4-100%] and 94.9% [91.6-96.9%], respectively, with a significant difference between Dyn-AMRI and the other sets (p<0.01). All AMRI methods were cost-effective compared to US. Dyn-AMRI was the most cost-effective with incremental cost-effectiveness ratios (ICER) of \$11,253 and life-year gain of 11months compared to US.

**CONCLUSION**

We observed limited sensitivity of NC-AMRI protocol for HCC detection. EOB-AMRI and Dyn-AMRI showed a similar sensitivity with a slightly better specificity and cost-effectiveness for Dyn-AMRI. Further confirmation in a larger study is needed.

**CLINICAL RELEVANCE/APPLICATION**

Non contrast abbreviated MRI (AMRI) showed low diagnostic performance for HCC screening. AMRI with dynamic T1 (Dyn-AMRI) showed higher specificity and better cost effectiveness compared to AMRI with hepatobiliary phase.

**SSJ08-06 Accuracy of an Abbreviated Screening MRI Protocol without Contrast Media for Patients at Risk for Hepatocellular Carcinoma**

Tuesday, Dec. 3 3:50PM - 4:00PM Room: S401CD

**Participants**

Julia Noschang, MD, Sao Paulo, Brazil (*Presenter*) Nothing to Disclose  
Fernando I. Yamauchi, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Thais Mussi, MD, PhD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Cassia F. Tridente, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Ronaldo H. Baroni, MD, Sao Paulo, Brazil (*Abstract Co-Author*) Nothing to Disclose

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**PURPOSE**

To evaluate the accuracy of an abbreviated screening MRI protocol without contrast media for patients at risk for hepatocellular carcinoma (HCC).

**METHOD AND MATERIALS**

This retrospective study was approved by our institutional review board. Four-hundred and twenty eight MRI exams were performed at our institution in patients with increased risk for hepatocellular carcinoma , from January 2015 to December 2015. Exclusion criteria were: history of treated HCC (166 cases) and subsequent studies of the same patient (123 cases). A total of 139 MRI cases were anonymized without post-contrast series (abbreviated protocol) and retrospectively analysed by three radiologists with different levels of experience (10, 8 and 1 year of experience with abdominal MRI). Later, one senior radiologist re-evaluated the full protocol as the reference standard, using LI-RADS v.2018. The abbreviated protocol included T2 weighted, fat-saturated T2 weighted, diffusion-weighted and GRE in/out-of-phase sequences. The following criteria were evaluated: presence of nodule suspicious for HCC, lesion size, lesion location and presence of nodule on each MRI sequences of the abbreviated protocol.

**RESULTS**

One-hundred and thirty nine patients were included, 38 women and 101 men, with an average age of 54.1 years. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy of abbreviated protocol for detection of nodules categorized as LI-RADS 4 and 5 (reference standard) were: 88.3%, 77.2%, 74.6%, 89.7% and 82.0% (most experienced reader), 85.0%, 78.5%, 75.0%, 87.3% and 81.3% (intermediate experienced reader) and 85.0%, 73.4%, 70.8%, 86.6% and 78.4% (less experienced reader), respectively. Interobserver agreement was moderate for lesion detection (weighted K= 0.57, CI=0.41-0.78). The sensitivity of each MRI sequence was 71.7%, 73.3% and 76.7% on T2-weighted, 68.3%, 75.0% and 73.3% in fat-saturated T2-weighted, 76.7%, 75.0% and 73.3% in in/out-of-phase and 63.3%, 70.0% and 68.3% in DWI for most experienced, intermediate experienced and less experienced readers, respectively.

**CONCLUSION**

The abbreviated MRI protocol demonstrated high sensitivity for hepatocellular carcinoma screening in risk patients.

**CLINICAL RELEVANCE/APPLICATION**

HCC is the most common primary malignancy of the liver and a common cause of death from cancer worldwide. Abbreviated MRI protocol possibly allows more cost-effective, high sensitivity imaging for HCC screening.

Printed on: 10/29/20



RC423

## Evolving Perspectives on Ultrasound Safety

Tuesday, Dec. 3 4:30PM - 6:00PM Room: E353A

PH SQ US

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

J. Brian Fowlkes, PhD, Ann Arbor, MI (*Coordinator*) Equipment support, Koninklijke Philips NV; Equipment support, General Electric Company; Equipment support, Canon Medical Systems Corporation; Research collaboration, Sonetics Inc; Stockholder, HistoSonics, Inc; Founder, HistoSonics, Inc

### For information about this presentation, contact:

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### LEARNING OBJECTIVES

1) Understand the physical principles related to ultrasound safety and the potential for biological effects of ultrasound. 2) Utilize ultrasound in a safe and effective manner in clinical practice. 3) Increase their knowledge and understanding of the regulatory environment associated with medical ultrasound.

### Sub-Events

#### RC423A Ultrasound Safety: Understanding the Potential Bioeffects

##### Participants

J. Brian Fowlkes, PhD, Ann Arbor, MI (*Presenter*) Equipment support, Koninklijke Philips NV; Equipment support, General Electric Company; Equipment support, Canon Medical Systems Corporation; Research collaboration, Sonetics Inc; Stockholder, HistoSonics, Inc; Founder, HistoSonics, Inc

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### LEARNING OBJECTIVES

1) Understand the physics associated with the potential bioeffects of ultrasound. 2) Increase basic knowledge of the controls and operator feedback related to ultrasound safety. 3) Be sufficiently proficient to utilize on-screen displays related to ultrasound safety. 4) Identify additional resources for understanding the physical effects of ultrasound.

### Active Handout: J. Brian Fowlkes

[http://abstract.rsna.org/uploads/2019/17000402/Active\\_RC423A.pdf](http://abstract.rsna.org/uploads/2019/17000402/Active_RC423A.pdf)

#### RC423B Ultrasound Safety: What the Clinician Should Know

##### Participants

Jacques S. Abramowicz, MD, Chicago, IL (*Presenter*) Author with royalties, Wolters Kluwer nv; Medical Advisory Board, Samsung Electronics Co, Ltd

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### ABSTRACT

Ultrasound is, arguably, one of the most common diagnostic procedures in clinical obstetrics. Its use for over more than 60 years has not been associated with fetal scientifically-proven harmful effects. Ultrasound, however, is a form of energy with potential rise of temperature and mechanical effects in insolated tissues. Knowledge of end-users on bioeffects of ultrasound and how to keep it safe is grossly lacking, but slowly improving, thanks to the efforts of various professional organizations. When a clear medical indication exists and the scan is performed by a professional knowledgeable in ultrasound bioeffects and safety and with respect to the As Low As Reasonably Achievable (ALARA) principle, risks to the fetus are minimal, if at all present. Education of clinical end-users continue to be of major importance, particularly given the ever-increasing use of new ultrasound technologies, such as Doppler and three/four-dimensional ultrasound.

#### RC423C Ultrasound Safety: What You Should Know About Therapeutic Ultrasound

##### Participants

Kenneth Bader, Chicago, IL (*Presenter*) Nothing to Disclose

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baderk@uchicago.edu

## **LEARNING OBJECTIVES**

1) An overview of the physical principles by which ultrasound can be utilized for therapeutic benefit will be reviewed. 2) Image guidance methods and metrics for evaluating treatment efficacy will be outlined. 3) An overview of potential off-target effects will be discussed in the context of As Low As Reasonably Achievable (ALARA) principle.

## **ABSTRACT**

Ultrasound is known most ubiquitously as a diagnostic imaging modality. High-intensity insonation conditions can be utilized for therapeutic benefit, generally categorized as ablation or enhanced permeability.

Printed on: 10/29/20



RC429

**MRI Safety Course (Gadolinium and Pacemakers) (Interactive Session) (The In-Person Session is Supported in part by an Unrestricted Educational Grant from Bayer)**

Tuesday, Dec. 3 4:30PM - 6:00PM Room: E350

**MR** **SQ**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

**FDA** Discussions may include off-label uses.

**Sub-Events**

**RC429A MRI in Patients with Pacemakers/Cardiac Devices**

Participants

Robert J. Russo, MD, PhD, La Jolla, CA (*Presenter*) Nothing to Disclose

**LEARNING OBJECTIVES**

1) Differentiate an MRI-conditional pacing system from a non-MRI-conditional system. 2) Assess the risks associated with MRI for patients with non-MRI-conditional pacemakers and defibrillators. 3) Integrate the performance of clinically indicated MRI in patients with pacemakers and defibrillators into the practice of radiology, cardiology, neurology, neurosurgery, and orthopedics. 4) Understand the current 2017 Heart Rhythm Society (HRS) Guidelines for performing MRI with an implanted cardiac device, as well as the Centers for Medicare and Medicaid Services (CMS) Decision Memo for Magnetic Resonance Imaging (MRI) (CAG-00399R4). 5) Utilize the current research results and clinical guidelines regarding MRI in patients with pacemakers and defibrillators for the establishment of a cardiology-radiology collaboration with the purpose of improving patient access to MRI.

**RC429B Gadolinium Deposition: What Do I Tell Patients, Referring Physicians, Other Radiologists, and Attorneys?**

Participants

Emanuel Kanal, MD, Pittsburgh, PA (*Presenter*) Consultant, Medtronic plc; Consultant, Bracco Group; Consultant, General Electric Company;

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ekanal@pitt.edu

**LEARNING OBJECTIVES**

1) Provide an overview of the history of the long term safety effects of gadolinium based contrast agents regarding both nephrogenic systemic fibrosis (NSF) as well as gadolinium retention, and specify similarities as well as significant clinical differences between these two concerns. 2) Explain mechanisms how gadolinium based contrast agents, which do not cross the blood brain barrier, is believed today to be successfully transported from the vascular lumen to the parenchyma of the brain. 3) List similarities as well as differences among the various types of gadolinium based contrast agents relative to gadolinium retention/deposition as well as NSF. 4) Describe how the FDA's response to gadolinium retention concerns differs from that the European regulatory agencies. 5) Identify what we definitively know today - and what we still don't know - about the safety of retained gadolinium in the brain.

**ABSTRACT**

2006 was accompanied by the discovery of a relationship between the intravenous administration of at least some gadolinium based contrast agents (GBCA) and the development of nephrogenic systemic fibrosis (NSF) in patients with significant renal disease. Roughly 8 years later GBCAs were found to deposit or leave a very small amount of their administered intravenous dose in the brain as well as other tissues/organs of its recipients that can be found months or even year following its initial administration. This time, however, this finding was present even in those with normal renal function, although it did seem more pronounced in patients with renal disease. In the more than 5 years that have passed since this discovery was first publicized, there is much that we have learned - and a great deal that we still have not determined - about gadolinium retention. Still being investigated are such issues as similarities versus differences between individual GBCAs with respect to gadolinium retention and potential high risk patients or populations for gadolinium retention. Perhaps the single main question that remains, however, is whether there is any significant clinical consequence or harm as a result of such deposition, and if that potential consequence is the same in type and incidence for all GBCA. This presentation will attempt to provide a succinct summary of the more salient issues and facts that we know regarding retained gadolinium, and will at the same time stress what we still do NOT confidently know or understand regarding the safety of gadolinium retention in humans today.

**RC429C Establishing an Efficient Workflow for MRI Safety**

Participants

Bradley N. Delman, MD, New York, NY (*Presenter*) Consultant, Bayer AG Speaker, Bayer AG

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**LEARNING OBJECTIVES**

1) Assess current MRI environment in critical aspects of safety. 2) Understand key structures of MRI safety oversight, including current consensus models for management. 3) Define potential risks in MRI suites to patients, personnel and visitors. 4) Explain considerations in special populations. 5) Establish a reliable method of response in emergent situations. 6) Identify resources for optimizing the safety program.

**RC429D Q&A**

Participants

Robert J. Russo, MD, PhD, La Jolla, CA (*Presenter*) Nothing to Disclose

Emanuel Kanal, MD, Pittsburgh, PA (*Presenter*) Consultant, Medtronic plc; Consultant, Bracco Group; Consultant, General Electric Company;

Bradley N. Delman, MD, New York, NY (*Presenter*) Consultant, Bayer AG Speaker, Bayer AG

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Printed on: 10/29/20



SSK12

## Health Service, Policy and Research (Value, Outcomes, and Risk)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: S104A

HP RS SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Fabian Bamberg, MD, Tuebingen, Germany (*Moderator*) Speakers Bureau, Bayer AG Speakers Bureau, Siemens AG Research Grant, Siemens AG

Hanna M. Zafar, MD, Philadelphia, PA (*Moderator*) Nothing to Disclose

K. Pallav Kolli, MD, San Francisco, CA (*Moderator*) Investor, Adient Medical Inc

### Sub-Events

#### SSK12-01 Patient-Reported Financial Toxicity in Multiple Sclerosis: Predictors and Association with Neuroimaging and Medication Non-Adherence

Wednesday, Dec. 4 10:30AM - 10:40AM Room: S104A

### Participants

Gelareh Sadigh, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

Neil Lava, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Jeffrey Switchenko, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Richard Duszak JR, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Elizabeth A. Krupinski, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Carolyn C. Meltzer, MD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose

Danny Hughes, PhD, Reston, VA (*Abstract Co-Author*) Nothing to Disclose

Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Abstract Co-Author*) Editor, Journal of the American College of Radiology; Support, Harvey L. Neiman Health Policy Institute; In-kind support, Reed Elsevier;

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### PURPOSE

To assess health-related financial toxicity in multiple sclerosis (MS) patients and its impact on financial coping strategies and care non-adherence.

### METHOD AND MATERIALS

Adult patients with new or established diagnoses of MS visiting an outpatient neurology clinic were prospectively recruited. Financial toxicity at study entry was measured using the Comprehensive Score for Financial Toxicity Patient-Reported Outcome Measure (COST) score (range 0-44, the lower the COST score, the worse the financial toxicity). Linear regression identified independent sociodemographic, clinical, and insurance correlates of financial toxicity. Financial coping strategies and care non-adherence within 3 months prior to study entry were assessed in those with established diagnoses.

### RESULTS

A total of 242 patients were recruited (44yo [95%CI,42-45]; 77% female; 47% White), median months from diagnosis, 62 (IQR,28-120). 94% have established diagnoses; 87% with relapsing remitting MS. The mean Expanded Disability Status Scale score among participants was 1.8 (95%CI,1.5-2.1) corresponding to the ability to walk without any aid. Mean enrollee COST score was 17 (95%CI,16-18.5), with 21% having at least one emergency department visit or inpatient hospitalization in the 3 months prior to entry. In response to financial burden, 62% used at least one financial coping strategy (see fig. 1). Medication and imaging non-adherence were reported by 30% and 13% of patients. In multivariable analyses, the key correlate of lower financial toxicity (i.e. higher COST score) was higher financial self-efficacy (e.g., having more confidence in being able to manage money to last for a lifetime) (coefficient 1.27 [95%CI, 1.02-1.52]; p<0.001). COST scores correlated with health-related quality of life, financial coping strategy use and care non-adherence (p<0.001).

### CONCLUSION

Patients with MS are at high risk for financial toxicity, which impacts quality of life, and results in adopting financial coping strategies and care non-adherence.

### CLINICAL RELEVANCE/APPLICATION

Identifying MS patients at risk for financial toxicity will help target interventions to cope with financial burden, and may improve both quality of life and treatment adherence.

#### SSK12-02 Financial Burden of Advanced Imaging in Radiology (FAIR Study)

Wednesday, Dec. 4 10:40AM - 10:50AM Room: S104A

## Participants

Paniz Charkhchi, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose

Kemi Omotoso, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

A. Mark Fendrick, MD, Ann Arbor, MI (*Abstract Co-Author*) Consultant, Abbott Laboratories Consultant, AstraZeneca PLC Consultant, sanofi-aventis Group Consultant, F. Hoffmann-La Roche Ltd Consultant, GlaxoSmithKline plc Consultant, Merck & Co, Inc Consultant, Neocure Group LLC Consultant, Pfizer Inc Consultant, POZEN Inc Consultant, Precision Health Economics LLC Consultant, The TriZetto Group, Inc Consultant, Zanzors Speakers Bureau, Merck & Co, Inc Speakers Bureau, Pfizer Inc Researcher, Abbott Laboratories Researcher, AstraZeneca PLC Researcher, sanofi-aventis Group Researcher, Eli Lilly and Company Researcher, F. Hoffmann-La Roche Ltd Researcher, GlaxoSmithKline plc Researcher, Merck & Co, Inc Researcher, Novartis AG Researcher, Pfizer Inc

Diana M. Gomez-Hassan, MD, PhD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

Ruth C. Carlos, MD, MS, Ann Arbor, MI (*Abstract Co-Author*) Editor, Journal of the American College of Radiology; Support, Harvey L. Neiman Health Policy Institute; In-kind support, Reed Elsevier;

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## PURPOSE

Imaging encounters suffer from lack of price transparency and surprise billing for patient cost share, exposing vulnerable individuals to financial harm. Financial burden contributes to medical debt and care nonadherence. Despite the need, financial fragility screening is heterogeneously implemented. We assess acceptability of financial screening and estimate financial burden among those receiving advanced imaging (CT/MRI) in outpatient imaging settings at a single institution.

## METHOD AND MATERIALS

We conducted a cross sectional anonymous survey of those  $\geq 22$  years receiving advanced imaging at outpatient imaging clinics (n=5). To assess financial burden, we queried imaging out of pocket cost (OOP) worry, use of financial coping strategies and care nonadherence due to medical cost. Logistic regression assessed effects of demographics, chronic disease, pretest OOP notification recall and imaging OOP worry on financial coping and care nonadherence. We included an interaction term for recall and worry.

## RESULTS

97% of surveys from consecutive patients had at least one question answered (Fig. 1). 66% of respondents were comfortable answering items about financial well-being in imaging clinic. 18% recalled being notified of the OOP prior to exam. 35% used at least one financial coping strategy; key correlates: test OOP worry (OR=5.2, 95%CI=2.5-11.0), worry x recall, (OR=4.7, 95%CI=1.1-19.8) income  $> \$50K$  (OR=0.3, 95%CI=0.1-0.7), any chronic disease (OR=3.7, 95%CI=1.8-7.5). 10% reported at least one nonadherence event; correlates: test OOP worry (OR=9.6, 95%CI=3.3-28) and ACA insurance (OR=19.1, 95%CI=1.2-297).

## CONCLUSION

Financial coping strategies among those who responded to financial screening is common; care non-adherence, less so. Psychological worry about OOP highly correlated with both outcomes, suggesting that screening for financial worry may identify patients at high risk for using savings or assuming debt for care. Further, OOP recall magnifies the effect of worry on financial coping. A large minority declined to answer financial questions, suggesting that screening in the imaging outpatient setting will incompletely capture financial burden in this population.

## CLINICAL RELEVANCE/APPLICATION

Outpatient imaging represents an appropriate venue for implementing financial screening and referral of financially vulnerable individuals. Price transparency interventions may intensify OOP worry.

## SSK12-03 Comparative Effectiveness of Active Surveillance for Localized Prostate Tumors With versus Without MRI: A Decision Analysis

Wednesday, Dec. 4 10:50AM - 11:00AM Room: S104A

## Participants

Stella Kang, MD,MSc, New York, NY (*Abstract Co-Author*) Royalties, Wolters Kluwer nv

Rahul D. Mali, MBBS,MPH, New York, NY (*Presenter*) Nothing to Disclose

Stacy Loeb, MD,MSc, New York, NY (*Abstract Co-Author*) Consultant, Eli Lilly and Company; Consultant, General Electric Company; Consultant, Bayer AG; Consultant, Lumenis Ltd; Equity, Gilead Sciences, Inc; Travel support, sanofi-aventis Group

## For information about this presentation, contact:

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## PURPOSE

To evaluate different active surveillance (AS) strategies for prostate tumors with versus without MRI by comparing quality-adjusted life expectancy (QALE) and life expectancy (LE), given non-uniform practice of surveillance.

## METHOD AND MATERIALS

We constructed a state-transition cohort model to compare QALE and LE of surveillance strategies in hypothetical men aged 60 years with low-grade prostate cancer. Strategies included: 1) watchful waiting (no testing; treat symptomatic disease only); 2) PSA every 6 months and annual biopsy; 3) requisite annual MRI, annual biopsy regardless of MRI result; 4) requisite annual MRI and annual biopsy only if PI-RADS score  $\geq 3$ ; 5) requisite annual MRI and biopsy only if PI-RADS score  $\geq 4$ ; 6) annual MRI only for rising PSA, and annual biopsy only if PI-RADS score  $\geq 3$ ; and 7) PSA every 6 months, MRI according to the PRIAS protocol (at years 1, 3, 7, 10, and then every 5 years), and biopsy only if PI-RADS score  $\geq 4$ . We incorporated age, comorbidity, misclassification of cancer grade, cancer progression risks, and ending surveillance at age 75. Sensitivity analysis assessed the impact of varying parameter values on results.

## RESULTS

In 60-year-old men, QALE and LE were the highest and essentially equivalent in two surveillance strategies: annual MRI with biopsy of lesions with PI-RADS  $\geq 4$ , and annual MRI with annual biopsy regardless of MRI results (both with 22.10 quality-adjusted life years; 23.05 life years). These strategies using annual MRI yielded a benefit compared with no MRI (i.e. PSA every 6 months and annual biopsy) in terms of both QALE (+12 days) and LE (+7 days). AS extended LE compared with watchful waiting at all ages. However, AS yielded higher QALE than watchful waiting only until age 62. This age threshold was driven by increasing rates and severity of treatment complications with age, and less frequent MRI using the PRIAS schedule as well as a higher PI-RADS biopsy threshold did not extend QALE over watchful waiting.

## CONCLUSION

AS with annual MRI and biopsy of only lesions with PI-RADS score  $\geq 4$  yields essentially equivalent QALE and LE compared with annual MRI and biopsy in men with low-grade prostate tumors, allowing for preference-based decisions.

## CLINICAL RELEVANCE/APPLICATION

In active surveillance of prostate tumors, annual MRI with a biopsy threshold of PI-RADS 4 provides similar effectiveness than more frequent biopsy, and greater effectiveness than surveillance without MRI.

## SSK12-04 PET/CT Utilization of Non-Small Cell Lung Cancer at Diagnosis: Does it Impact Survival?

Wednesday, Dec. 4 11:00AM - 11:10AM Room: S104A

### Participants

Rustain L. Morgan, MD, MS, Aurora, CO (*Presenter*) Nothing to Disclose  
Megan Eguchi, MPH, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Sruthi Yekkaluri, MPH, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Sana D. Karam, MD, PHD, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Cathy Bradley, PhD, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

The type of imaging utilized to stage a patient with newly diagnosed non-small cell lung cancer impacts their cancer specific survival.

## METHOD AND MATERIALS

The linked Surveillance, Epidemiology, and End Results (SEER)-Medicare database between 2007 and 2015 was used to compare patient characteristics and hospital region by initial imaging modality used for patients with non-small cell lung cancer. The primary outcome was 3-year cancer specific survival (CSS). Cox proportional hazard models adjusted for imaging, age, sex, region, education, race, cancer stage, and treatment, which were examined by backward elimination. We also explored how initial imaging use varied by patient characteristics and hospital region.

## RESULTS

Thirty-six thousand, four hundred seventy one patients with newly diagnosed non-small cell lung cancer underwent initial diagnostic imaging. Of those, 24.4% (n=8,884) received CT alone as their initial imaging modality, 2.4% (n=887) underwent only PET imaging, and 71.9% (n=26,700) of the patients' initial imaging included both a PET and CT exam. In the adjusted survival models compared by initial imaging modality, patients who underwent a PET exam with or without CT had better cancer specific survival than CT alone, (hazard ratio [HR] 0.66; 95% CI 0.638-0.682; P = <0.001) (HR 0.611 95% CI 0.55-0.678; P = <0.001) respectively. The overall survival was also significantly improved with PET and diagnostic CT or PET alone (hazard ratio [HR] 0.671; 95% CI 0.651-0.692; P = <0.001) and (hazard ratio [HR] 0.604; 95% CI 0.551-0.662; P = <0.001) respectively, when compared to patients who only received CT imaging.

## CONCLUSION

Among patients with non-small cell lung cancer, initial staging that included PET imaging was associated with improved three-year cancer specific and overall survival compared to initial staging with CT alone.

## CLINICAL RELEVANCE/APPLICATION

Utilization of PET/CT imaging at diagnosis of non-small cell lung cancer improves survival, however approximately a quarter of patients are not receiving this imaging.

## SSK12-05 Are We in Agreement? Outcomes of Pathology Results Discordant with Imaging Findings After CT-Guided Biopsy

Wednesday, Dec. 4 11:10AM - 11:20AM Room: S104A

### Participants

Andres Camacho, MD, Boston, MA (*Presenter*) Nothing to Disclose  
Andrew D. Chung, MD, Kingston, ON (*Abstract Co-Author*) Nothing to Disclose  
Mehmet Sari, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Sujithraj Dommaraju, MBBS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Elisabeth Appel, MD, Dusseldorf, Germany (*Abstract Co-Author*) Nothing to Disclose  
Alexander Brook, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Bettina Siewert, MD, Boston, MA (*Abstract Co-Author*) Editor, Wolters Kluwer nv; Reviewer, Wolters Kluwer nv;  
Muneeb Ahmed, MD, Boston, MA (*Abstract Co-Author*) Research Grant, General Electric Company Stockholder, Agile Devices, Inc  
Scientific Advisory Board, Agile Devices, Inc  
Olga R. Brook, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To assess the value of radiology review meetings (RRMs) evaluating concordance between pathology results and imaging findings of CT-guided biopsy.

## METHOD AND MATERIALS

In this HIPAA-compliant, IRB retrospective review, 926 consecutive unique body CT-guided biopsies performed between 01/15-12/17 were included. Weekly RRM was implemented in July 2016. 453 patients were reviewed in the RRM (prospective group), and results were classified as concordant or discordant with appropriate recommendations generated by radiology team. 473 patients not reviewed at RRM were retrospectively classified by an abdominal imaging clinical fellow (retrospective group). Times to re-intervention (TRI) and times to definitive diagnosis (TDD) were obtained for discordant cases: 49/453 (11%) in prospective (n=2, lost to follow-up) and 55/473 (12%) in retrospective group (n=5, lost to follow-up).

## RESULTS

CT-guided biopsy yielded a concordant result in 89% (822/926) of the cases. Re-intervention with biopsy and surgery yielded a shorter time to the definitive diagnosis compared to clinical and imaging follow up ( $p < 0.001$ ). When radiologists evaluated concordance between pathology and imaging findings and recommended re-biopsy for discordant cases, the number of biopsies performed as re-intervention is increased (50%, 11/22 vs. 13%, 4/31;  $p = 0.005$ ). Referring physicians tend to follow recommendations for re-biopsy provided by radiologists, while when no recommendations are provided by radiologists they tend to choose imaging follow-up or surgery instead (64%, 30/47 vs. 38%, 19/50;  $p = 0.011$ ). Unfortunately, 49% (23/47) of the cases were discussed by the referring physician with the patient before review at weekly RRM by radiologist. This may explain why even in the prospective group clinicians did not always pursue re-biopsy even if recommended by radiologist.

## CONCLUSION

Radiologists frequently recommend re-biopsy for cases with discordant findings on imaging versus pathology. In cases without radiology input, clinicians tend toward clinical and imaging follow-up instead of re-biopsy. Re-intervention with biopsy or surgery results in shorter time to diagnosis. This provides yet another reason for radiologists to be more involved in patient care.

## CLINICAL RELEVANCE/APPLICATION

Radiologist's participation in pathology results review after CT-guided biopsy results in higher rate of re-biopsy for discordant cases and thus shortens average time to diagnosis.

## SSK12-06 Assessing Cancer Yield and Compliance with 6-, 12-, (18-) and 24-month Follow-Up for BI-RADS 3 Lesions at Recall from Screening for Women in the National Mammography Database (NMD)

Wednesday, Dec. 4 11:20AM - 11:30AM Room: S104A

### Participants

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## PURPOSE

Probably benign, BI-RADS 3 (BR3) assessments are reserved for specific imaging findings known to have  $\leq 2\%$  likelihood of malignancy. We assessed compliance, outcome and cancer yield after BR3 assessments at 6-, 12-, (18-) and 24-month follow-up.

## METHOD AND MATERIALS

This retrospective cohort HIPAA-compliant study included all women recalled from screening mammography followed by BR3 assessment at additional evaluation from 2009 to 2018, from 471 NMD facilities. Only the first BI-RADS 3 occurrences were analyzed for women  $\geq$  age 25 with no reported personal history of breast cancer with biopsy or  $\geq 2$ -yr imaging follow-up, or downgraded to BI-RADS 1 or 2 with  $\geq 1$ -yr follow-up. Outcomes were analyzed: "6-mo" visit is defined as 91-270 days after BR3 assessment; 12-mo, 271-460 days; 18-mo, 461-640 days; 24-mo, 641-820 days. Cancer yield (CY) is calculated as number of breast cancers per number of women. PPV3 is probability of breast cancer per number of biopsies performed.

## RESULTS

In 65,908 women (median age 55 years; range 25-90), results from 204,439 mammograms were included. Overall biopsy rate of BR3 lesions was 10.06% (6633/65,908) with CY of 1.34% (885/65,908, 95%CI 1.25 to 1.43%), PPV3 13.3%. 612 (0.9%) women had biopsy at the initial recall/BR3 visit yielding 37 cancers. 2622 women (4.0%) had follow-up at  $\leq 90$  days: 503 (19.2%) biopsied, CY 1.41% (37/2622). 44,326 (67.3%) women had follow-up at 6-mo: 4301 (9.7%) biopsied, 653 (15.2%) cancers, CY 1.47%. 29,688 (45.0%) women had follow-up at 12-mo: 1620 (5.5%) biopsied, 301 (18.6%) cancers, CY 1.01%. 7584 (11.5%) women had follow-up at 18-mo: 417 (5.5%) biopsied, 85 (20.4%) cancers, CY 1.12%. 6948 (10.5%) women had follow-up at 24-mo: 273 (3.9%) biopsied, 46 (16.8%) cancers, CY 0.66%. CY for 21,729 cases downgraded by 6-mo and seen again by 12-mo = 0.24%. CY for 22,629 cases downgraded by 1 yr and seen again by 24-mo = 0.26% ( $p < 0.0001$  for all BR3 CY comparisons).

## CONCLUSION

Compliance with 6-month follow-up was high at 67.2%. Overall CY for probably benign findings was 1.34%, with CY at each follow-up below accepted limit of 2%.

## CLINICAL RELEVANCE/APPLICATION

In the NMD, use of BR3 assessments is appropriate, with  $< 2\%$  overall cancer yield. 653/885 (73.8%) cancers were diagnosed at or before 6-mo visit. Continued imaging surveillance of BR3 is supported by malignancy rates  $>$  those of BR1 or -2 at each follow-up.

## SSK12-07 Cost-Effectiveness of MRI-Guided Thrombolysis for Stroke with Unknown Time of Onset

Wednesday, Dec. 4 11:30AM - 11:40AM Room: S104A

### Awards

#### Trainee Research Prize - Resident

#### Participants

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Matthias P. Fabritius, MD, Munich, Germany (*Abstract Co-Author*) Nothing to Disclose  
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### PURPOSE

In acute ischemic stroke, about 25% of patients present with unknown time of onset, which is a contraindication for intravenous thrombolysis (IVT) treatment. Among this patient group, MRI has been shown to identify patients with salvageable brain tissue. The recent WAKE-UP trial demonstrated a clinical benefit of such MRI-guided IVT administration over best supportive care (BSC). We aimed to determine the cost-effectiveness of this management strategy.

### METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with MRI-guided IVT or BSC (Figure 1). The analysis was performed in a United States setting from a societal perspective. Input parameters for the model were based on most recent and best available evidence (Table 1), including outcome data from the WAKE-UP trial (Figure 2). Starting age was set to 65 years according to the median age in the trial. Probabilistic sensitivity analyses (PSA) were performed using 10,000 Monte Carlo simulations to estimate uncertainty. Incremental costs (IC), incremental effectiveness (IE), and incremental cost-effectiveness ratios (ICER) were derived. Cost-effectiveness acceptability rates were determined for varying willingness-to-pay (WTP) thresholds.

### RESULTS

Based on outcome data of 503 randomized patients, the base-case analysis identified MRI-guided IVT as the strategy that resulted in incremental QALYs and cost-savings over the projected lifetime compared to BSC (IC: -\$21,481; IE: +0.62 QALYs; ICER: IVT dominant). Adjusting for all input parameter uncertainty in PSA, MRI-guided IVT was the preferred strategy with acceptability rates of >99% at all WTP thresholds ranging from \$0 to \$150,000 per QALY (Figure 3). Simulations led to 99.47% dominant/cost-saving iterations (Figure 4).

### CONCLUSION

MRI-guided IVT is projected to provide long-term clinical benefit whilst also leading to long-term cost-savings in the management of stroke patients with unknown time of onset.

### CLINICAL RELEVANCE/APPLICATION

Providing MRI-guided IVT in stroke with unknown onset requires dedicated infrastructure. Based on the projected health and cost benefits, investments to support such an infrastructure are justified.

## SSK12-08 Cost-Effectiveness Analysis of Local Ablation and Surgery for Liver Metastases of Oligometastatic Colorectal Cancer

Wednesday, Dec. 4 11:40AM - 11:50AM Room: S104A

#### Participants

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Wolfgang G. Kunz, MD, Munich, Germany (*Abstract Co-Author*) Grant, Medtronic plc

### PURPOSE

To evaluate the cost-effectiveness of local ablative and surgical approaches in the treatment of liver metastases of oligometastatic colorectal cancer (omCRC).

### METHOD AND MATERIALS

A decision model based on Markov simulations estimated lifetime costs and quality-adjusted life years (QALY) associated with the treatment strategies radiofrequency ablation (RFA), microwave ablation (MWA), and surgical resection. A United States healthcare perspective was applied. Model input parameters were based on best available and most recent evidence (Table 1). The starting age was set to 73 years. Probabilistic sensitivity analyses (PSA) were performed using 10,000 Monte Carlo simulations to estimate model uncertainty. The percentage of cost-effective iterations was determined for different willingness-to-pay (WTP) thresholds.

### RESULTS

The base-case analysis showed that surgery lead to higher costs (\$49,447.86 vs. \$42,467.97 vs. \$42,245.78) while providing best outcomes compared to RFA and MWA (8.12 vs. 6.97 vs. 8.03 QALYs). In PSA, MWA was the most cost-effective strategy for all WTP thresholds below \$80,000 per QALY. For increasing WTP thresholds, surgery showed comparable yet increasingly higher percentages of cost-effective iterations compared to MWA. Local ablation with RFA was dominated by either MWA or surgery at all

WTP thresholds.

## CONCLUSION

In omCRC patients with liver metastases, treatment with MWA and surgery are estimated to provide comparable efficacy. MWA was identified as the most cost-effective strategy in intermediate resource settings and should be considered as an alternative to surgery in high resource settings.

## CLINICAL RELEVANCE/APPLICATION

In case patients are eligible for local treatment as well as surgery, MWA and surgery can be offered as comparable treatment options to omCRC patients with liver metastases.

## SSK12-09 Early Admission and Mortality Rates for Common Outpatient Interventional Radiology Procedures

Wednesday, Dec. 4 11:50AM - 12:00PM Room: S104A

### Participants

Ammar Sarwar, MD, Boston, MA (*Presenter*) Stockholder, Agile Devices, Inc; Scientific Advisory Board, Agile Devices, Inc; Grant Support, Sirtex Medical Inc  
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## PURPOSE

Patient outcomes for outpatient interventional radiology (IR) procedures have been reported for single institutions, but not more broadly. In this study, we use national Medicare data to evaluate early admission and mortality rates after common outpatient IR procedures.

## METHOD AND MATERIALS

Working with the Center for Medicare and Medicaid (CMS) Chronic Conditions Data Warehouse (CCW) and Research Data Assistance Center, we identified and obtained all outpatient claims for interventional radiology (IR) procedures and determined 7- and 30-day readmission and crude mortality rates, for the most common IR procedures performed in 2012. One hundred percent of the national outpatient Medicare claims files were obtained from CMS. The frequency of procedures, 7 and 30-day admission rates; and 7 and 30-day crude mortality rates were determined.

## RESULTS

In 2012, dialysis fistulogram and port placement (N=114,208 and 92,313) were the most commonly performed outpatient interventional radiology procedures amongst the Medicare population; they were performed nearly three times as frequently as the third most common procedure, liver biopsy (N=38,332). TIPS had the highest 7- and 30-day admission rates (14% and 42%), followed by percutaneous biliary drainage (13% and 40%). Percutaneous gastrostomy and transhepatic cholangiogram had the highest 7-day mortality rate (2% each). Three procedures had at least 10% 30-day mortality (TIPS 10%, percutaneous cholangiogram 11%, percutaneous biliary drainage 12%).

## CONCLUSION

Early mortality and admission are moderately common following outpatient IR procedures. Predictive models that account for patient risk could be useful both 1) to account for differences among labs in the difficulty of their patients, and 2) to flag higher risk patients undergoing higher risk IR procedures as potential candidates for in-hospital care.

## CLINICAL RELEVANCE/APPLICATION

With increasing interest in Office-Based Labs in IR practice, early admission and mortality rates should be explored as potential quality indicators for outpatient IR procedures.

Printed on: 10/29/20



SSK18

## Physics (CT Protocols/Risk Reduction)

Wednesday, Dec. 4 10:30AM - 12:00PM Room: E353C



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Frank N. Ranallo, PhD, Madison, WI (*Moderator*) Grant, General Electric Company  
Tinsu Pan, PhD, Waukesha, WI (*Moderator*) Consultant, Bracco Group

### Sub-Events

#### SSK18-01 Total Risk Index: A Mathematical Model for Decision Making Based on Clinical and Radiation Risk Assessment in CT

Wednesday, Dec. 4 10:30AM - 10:40AM Room: E353C

### Participants

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### PURPOSE

Radiological risk is a combination of radiation and clinical risk (likelihood of not delivering a proper diagnosis), which together may be characterized as a total risk index (TRI). While many strategies have been developed to ascertain radiation risk, there has been a paucity of studies assessing the clinical risk. This knowledge gap makes impossible to determine the total radiological procedure risk and, thus, to perform a comprehensive optimization. The purpose of this study was to develop a mathematical model to ascertain TRI and to identify the minimum TRI (mTRI) in a clinical CT population.

### METHOD AND MATERIALS

This IRB approved study included 21 adults abdomen exams performed on a dual-source single energy CT at two different dose levels (84 CT series). Virtual liver lesions were inserted into projection data to simulate localized stage liver cancer (LSLC). The detectability index ( $d'$ ) was calculated in each series and converted to percentage of correct observer answers (AUC) in a two-alternative forced-choice model. The AUC was converted into the loss of 5-year relative survival rate (SEER, NCI), considering an upper bound on patient's risk for a misdiagnosis of LSLC (false positive+false negative). Concerning radiation risk, organ doses were estimated using a Monte Carlo method and the Risk Index was calculated and converted in 5-year relative survival rate for cancer. Finally, the two risks were weighted equally into a combined TRI curve per each patient as a function of CTDIvol. The analytical minimum of each TRI curve provided the patient mTRI.

### RESULTS

The mTRI for LSLC patients that underwent an abdominal CT exhibited a rapid rise at low radiation dose due to enhanced clinical risk of under-dosed examinations. Increasing dose offered less risk with mortality per 100 patients between 2.1 and 6.5 (mean 4.5) at CTDIvol=5mGy; between 1.1 and 5.9 (mean 3.5) at CTDIvol=10mGy; and between 0.5 and 5.4 (mean 3.0) at CTDIvol=20 mGy.

### CONCLUSION

The clinical risk seems to play a more dominant factor in designing optimum CT protocols. The TRI may provide an objective and quantifiable metric of the interplay of radiation and clinical risks during the optimization of the CT technique for individual patients.

### CLINICAL RELEVANCE/APPLICATION

CT risk-based Optimization can be made possible by first quantifying both radiation and clinical risk using comparable units, then calculating an overall risk, and finally minimizing the total risk.

#### SSK18-02 Repeated/Rejected Events in CT: A Study Quantifying their Frequency and Impact on Patient Dose

Wednesday, Dec. 4 10:40AM - 10:50AM Room: E353C

### Participants

Sean Rose, PhD, Madison, WI (*Presenter*) Nothing to Disclose  
Ben Viggiano, Madison, WI (*Abstract Co-Author*) Nothing to Disclose  
Timothy P. Szczykutowicz, PhD, Madison, WI (*Abstract Co-Author*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC; Medical Advisory Board, medInt Holdings, LLC; Consultant, General Electric Company; Consultant, Takeda Pharmaceutical Company Limited

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**PURPOSE**

We have developed and validated an algorithm for automated detection of repeat/reject CT scans. Here we use the method to identify high repeat rate protocols at two sites and estimate their associated excess dose. We additionally determine reference standard repeat rates for each protocol.

**METHOD AND MATERIALS**

The algorithm estimated repeat/reject rates from high-volume protocols at CT scanners from two sites using dose monitoring data collected over 3 years. The sites included a rural and an academic hospital, sites A and B, respectively. We only considered repeats consisting of additional overlapping helical/axial scans in this study. Effective doses were calculated from all exams performed with the ten highest repeat-rate protocols at each site. Site-wide reference repeat rates were identified for each protocol by pooling exams performed with similar protocols (e.g. abdomen/pelvis protocols for all patient sizes) at each site and taking the minimum aggregate repeat rate between the two sites. Reference repeat rates were used to identify protocols for which targeted training has the largest potential to reduce repeat rates.

**RESULTS**

Overall repeat rates were the same for both sites, 1.4% [1.2,1.6] and 1.4% [1.3,1.5] (95% confidence intervals shown in brackets). Among the ten highest repeat rate protocols, the median percent increase in mean effective dose between normal and repeat-containing exams was 107.5% (interquartile range [89.9,130.2]) for site A and 64.6% (interquartile range [44.4,88.8]) for site B. More multiphasic protocols were used at Site B relative to Site A, making the relative dose increase smaller. Using the site-wide reference repeat rate (i.e. best institution practice), we calculated Site A and B could have reduced their number of repeat exams by 55 and 42 respectively over a three year period.

**CONCLUSION**

Overall repeat rates at the two sites were similar, but the ten highest repeat rate protocols differed. Comparison to site-wide reference repeat rates suggests that protocol-specific intervention may be effective in reducing repeat rates at both sites.

**CLINICAL RELEVANCE/APPLICATION**

Our informatics based repeat/reject methodology for CT can be used to quantify excess dose delivered due to operator error and identify best practice scanning within an institution.

**SSK18-03 One Size Does Not Fit All: Factors Associated With Increased Frequency Of Radiation Overexposure Alerts Based On Fixed Alert Thresholds**

Wednesday, Dec. 4 10:50AM - 11:00AM Room: E353C

**Participants**

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**PURPOSE**

To quantify the expected rate of CT radiation dose alerts for three body regions using accepted radiation benchmarks, and to assess key determinants of alert frequency.

**METHOD AND MATERIALS**

This IRB-approved retrospective cohort study evaluated 6 months of consecutive CT examinations performed within an academic medical system. CTDIvol x-ray tube output metrics were compared to the body-region-specific benchmark levels Achievable Doses (AD), Diagnostic Reference Levels (DRL), and Dose Notification Values (DNV), and simulated alerts were generated when benchmarks were exceeded. Frequency and proportion of events triggering alerts were calculated. A logistic regression model was fit for the outcome of simulated alert as a function of the independent predictors: scanner, body region, gender, weight, and age.

**RESULTS**

For 17,000 head, chest and abdomen exams, the proportion of events triggering alerts increased with weight for all scanners and body regions. Significant covariates were scanner, body region, patient weight, and age (all  $p < 0.0001$ ). Odds of alert generation for the AD, DRL, and DNV benchmarks increased by 3.3%, 3.0%, and 1.3% per pound, respectively, and by 0.8%, 1.1% and -2.7% per year of age (all  $p < 0.0001$ ). Compared to the most highly optimized scanner, odds of alert generation varied by a factor of 595 for AD, 1126 for DRL, 13 for DNV.

**CONCLUSION**

Alert frequency was significantly correlated with weight, age, body region and scanner. Controllable factors include scanner functionality and associated protocol optimization. The patient factors driving alert frequency are predominantly weight, and to a lesser degree, age. Fixed dose threshold values can thus frequently produce false alerts in appropriately performed exams of large patients, while not triggering alerts in outlier scans of higher than expected dose in small patients.

**CLINICAL RELEVANCE/APPLICATION**

Factors influencing dose alert frequency were explored for a large cohort of CT scans in a multi-scanner environment. These have

implications to the utility of fixed dose threshold alert values.

#### **SSK18-04 How to Use Lead Apron to Reduce Excess Radiation Dose Caused by Over-Scan in Computed Tomography Using 40mm Collimation: An Anthropomorphic Phantom Study**

Wednesday, Dec. 4 11:00AM - 11:10AM Room: E353C

##### **Participants**

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##### **PURPOSE**

The typical over-scan range with 40mm collimation in helical scans was about 25x2mm resulting in dose penalty, but the use of lead apron may be used to reduce the dose penalty. The purpose of this study was to explore the optimal way of placing the lead apron to maximize dose reduction for the over-scans without negatively impact image quality with 40mm collimation.

##### **METHOD AND MATERIALS**

We used an anthropomorphic phantom containing a pig liver, kidney, meat and a femur head in a water box to evaluate image quality with the apron placed at different distances to the imaging boundary. A scout was taken first without lead apron to determine the desired imaging range and set up the automatic tube current modulation before putting on the lead apron. The helical scan groups were designed as follows: group 1, without apron as a reference and groups 2-22 with the apron first placed at the imaging boundary and in 0.5mm increment away from the it. The scan techniques were kept the same for all scans at 40mm collimation, 120kVp, 10-740mA for a noise index of 7HU. Images were reconstructed at 5mm slice thickness and the image nearest the imaging boundary was used for analysis and comparison. 10 regions of interest (ROI, 5mm\*5mm in size) of different tissues in the images were selected to measure CT value. Measurements in group 1 (without apron) were as reference standards. The CT values of the 10 ROIs in each group from groups 2-22 were compared with group 1 using Paired t-test and the CT value difference ( $dCT(i)=CT(i)-CT(1)$ ) for each ROI in matched location was calculated to evaluate objective imaging quality by a boxplot. Subjective image quality was also evaluated in terms of image noise and shading artifacts.

##### **RESULTS**

In the Paired t-test, the p values were continuously greater than 0.05 for groups 13-22 (apron 5.5-10mm from the boundary) with the average dCT values smaller than 3HU. There was no difference in subjective image quality between groups 13-22 and group 1.

##### **CONCLUSION**

Placing lead apron at least 5.5mm from the imaging boundary when using 40mm collimation is recommended, reducing the over-scan dose penalty by 78%.

##### **CLINICAL RELEVANCE/APPLICATION**

Lead apron may reduce the dose penalty for the over-scans without negatively impact image quality and placing lead apron at least 5.5mm from the imaging boundary in 40mm collimation is recommended.

#### **SSK18-05 Effect of Gonad Shields on the Automatic Exposure Control in Computed Tomography: Influence on the Development of Standard Operating Procedures**

Wednesday, Dec. 4 11:10AM - 11:20AM Room: E353C

##### **Participants**

Andrea Steuwe, Dusseldorf, Germany (*Presenter*) Nothing to Disclose  
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##### **PURPOSE**

To analyze the influence of a lead gonad shield on the automatic exposure control (AEC) of three different computed tomography (CT) scanner models to develop in-house standard operating procedures (SOPs).

##### **METHOD AND MATERIALS**

An anthropomorphic male Alderson phantom was scanned thrice with the standard abdomen/pelvis protocol on three different CT scanners (Somatom Definition Edge (1), Somatom Definition Flash (2), Somatom Definition AS (3), all Siemens Healthineers, Germany) in cranio-caudal direction. Per scanner, the phantom was scanned (a) without shield, (b) with added shield after the scout (Mavig gonad shield, 1mm Pb) and (c) scout and scan with shield, covering the entire abdomen/pelvis. Subsequently, the scan range was shortened at the cranial side with the following distances to the shield: (d) 0cm (scan range adjacent to shield), (e) 1cm, (f) 2cm and (g) 3cm. Exposure [mAs] per reconstructed slice was determined and averaged over the three repetitions.

## RESULTS

Compared to scans without shield (acquisition a), inclusion of the gonad shield on the scout resulted in increased x-ray exposure: For all scanners, exposure increased adjacent to the shield for approximately one detector width (up to 15%). Along the caudal part of the shield exposure increased by up to 85%. Modulation along the cranial part of the shield varied per scanner: Exposure increased for scanner 1 (+10%), stayed similar for scanner 2 and decreased for scanner 3 (-20%). For scans without gonad shield in the scan range (acquisitions d-g), exposure still increased adjacent to the shield (up to 15%). Placement of the shield after the scout (acquisition b) did not change exposure considerably for all evaluated scanners.

## CONCLUSION

Our results indicate that the FOV range needs to be adapted to the scanner's detector width when using gonad shields with AEC, or ideally, placement of the shield needs to be performed after acquisition of the scout scan.

## CLINICAL RELEVANCE/APPLICATION

Even for the same vendor, the influence of gonad shields on the AEC varies per scanner model and needs to be assessed prior to the development of scanner- and protocol-dependent SOPs.

### SSK18-06 An Organ Dose Calculation Tool for Fetus at Various Ages Undergoing Computed Tomography

Wednesday, Dec. 4 11:20AM - 11:30AM Room: E353C

#### Participants

Choonsik Lee, PhD, Rockville, MD (*Presenter*) Nothing to Disclose

Les R. Folio, MPH, DO, Bethesda, MD (*Abstract Co-Author*) Institutional research agreement, Carestream Health, Inc

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## PURPOSE

Pregnant patients may undergo CT in emergencies unrelated with pregnancy and potential risk to the developing fetus is of concern. It is critical to accurately estimate fetal organ doses in CT scans. We developed a fetal organ dose calculation tool using pregnancy-specific computational phantoms combined with Monte Carlo radiation transport techniques.

## METHOD AND MATERIALS

We adopted a series of pregnancy computational phantoms developed at the University of Florida at the gestational ages of 8, 10, 15, 20, 25, 30, 35, and 38 weeks (Maynard et al. 2011). More than 30 organs and tissues and 20 skeletal sites are defined in each fetus model. We calculated fetal organ dose normalized by CTDI<sub>vol</sub> to derive organ dose conversion coefficients (mGy/mGy) for the eight fetuses for consequential slice locations ranging from the top to the bottom of the pregnancy phantoms with 1 cm slice thickness. Organ dose from helical scans were approximated by the summation of doses from multiple axial slices included in the given scan range of interest. We then compared dose conversion coefficients for major fetal organs in the abdominal-pelvis CT scan of pregnancy phantoms with the uterine dose of a non-pregnant adult female computational phantom.

## RESULTS

A comprehensive library of organ conversion coefficients was established for the eight developing fetuses undergoing CT. They were implemented into an in-house graphical user interface-based computer program for convenient estimation of fetal organ doses by inputting CT technical parameters as well as the age of fetus. We found that the esophagus received the least dose whereas the kidneys received the greatest dose in all fetuses in AP scans of the pregnancy phantoms. We also found that when the uterine dose of a non-pregnant adult female phantom is used as a surrogate for fetal organ doses, root-mean-square-error ranged from 0.08 mGy (8 weeks) to 0.38 mGy (38 weeks). The uterine dose was up to 1.7-fold greater than the esophagus dose of the 38-week fetus model.

## CONCLUSION

The calculation tool should be useful in cases requiring fetal organ dose in emergency CT scans as well as patient dose monitoring.

## CLINICAL RELEVANCE/APPLICATION

The methods and tool we developed in this study should provide more accurate fetal organ dose estimations at various gestational ages, which should help radiologists and mothers to better understand the health impact of fetus undergoing CT.

### SSK18-07 AEC- and Scan Time-Optimized Pediatric Body CT Protocols based on Size-Specific Dose Needs

Wednesday, Dec. 4 11:30AM - 11:40AM Room: E353C

#### Participants

Megan Lipford, PHD, Madison, WI (*Presenter*) Nothing to Disclose

Timothy P. Szczykutowicz, PhD, Madison, WI (*Abstract Co-Author*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC; Medical Advisory Board, medInt Holdings, LLC; Consultant, General Electric Company; Consultant, Takeda Pharmaceutical Company Limited

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## PURPOSE

We have developed a method for creating pediatric CT protocols. Currently, no methods exist for building a protocol that meets specific dose and scan time requirements for as a function of size/age.

## METHOD AND MATERIALS

In our method, CT manuals and/or measurements define the maximum CTDI<sub>vol</sub> based on the tube limits and the range of available

collimations, pitches, rotation times, etc. Then, using aggregated clinical data from 210 pediatric CT body exams, we characterized the dose and scan length required as a function of patient size (AP+Lat). With these data, we created a spreadsheet having an input of acquisition parameters and scanner specific speed and dosimetry values. Combining the clinical data with the scanner input data, the spreadsheet output a maximum patient size and scan time. We demonstrate the method by building protocols for the GE Revolution and Siemens Force. For each, we build two sets of protocols: one optimized for scan speed but with limited patient size dynamic range (i.e. size bins spanning a couple years), and one clinically robust protocol that can span large size ranges with a single protocol (i.e. size bins spanning 5-10 years).

## RESULTS

The speed optimized sets of protocols resulted in 5 protocols for the Force and 4 for the Revolution in order to span newborn to teenager. The clinically robust set only used 2 protocols to span newborn to teenager. Scan times for the speed optimized sets had a minimum of 0.26 s, but at that scan speed could only image to a patient size of 310 mm AP+Lat (i.e. 2 years). The clinically robust set of protocols allowed a minimum scan time of 0.48 seconds for newborns but with a dose dynamic range up to 430 mm AP+Lat (i.e. 12 years). Our results also show the scan times between these premium models were similar, with no scanner taking longer than 2 seconds to scan a pediatric abdomen.

## CONCLUSION

With this method of creating protocols, it is easy to predict how parameter adjustments affect the scan time (i.e. breath hold) and range of appropriate patient sizes (i.e. ages). In our demonstration, running a scanner as fast as possible required more changes in rotation time and pitch as a function of patient size.

## CLINICAL RELEVANCE/APPLICATION

Before our work, no method existed for predicting if a protocol will actually allow for enough dose or a short enough scan time on a patient size and indication basis.

### SSK18-08 Diagnostic Reference Levels and Achievable Doses for Computed Tomography for EUCLID (European Study on Clinical DRLs) Defined Clinical Indications: Data from a Multinational Dose Registry

Wednesday, Dec. 4 11:40AM - 11:50AM Room: E353C

#### Participants

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## PURPOSE

Radiation doses for Computed Tomography (CT) examinations between patients, institutions, and countries are highly variable. Diagnostic reference levels (DRLs), and achievable doses (ADs) are often created to help reduce unnecessary variation. The European Society of Radiology has identified common indications for CT named EUCLID (European Study on Clinical DRLs) in order to create benchmarks for these examination types. We generated DRLs and ADs for these examinations.

## METHOD AND MATERIALS

Standardized data from > 2.3 million CT examinations in adults 18 years of age and older were collected between January 2016 and December 2018 from 155 institutions across 7 countries in a large, multinational CT Dose Registry. Two dose metrics were evaluated: CT-dose index (CTDI<sub>vol</sub>), and dose-length product (DLP).

## RESULTS

AD (50% in dose distribution) and DRL (75% in dose distribution) are summarized as follows (CTDI<sub>vol</sub> (mGy)/ DLP (mGy-cm), sample size n): chronic sinusitis (15 and 21 / 250 and 373, n= 57070), stroke to detect and exclude hemorrhage (47 and 53/ 872 and 1076, n= 14040), cervical spine trauma (19 and 30/ 450 and 962, n= 111397), pulmonary embolism (10 and 15/ 372 and 558, n= 112784), coronary calcium scoring (4 and 7/ 66 and 102, n= 22579), coronary angiography (21 and 31/ 497 and 915, n= 3176), lung cancer first and follow-up (11 and 15/ 556 and 858, n= 7064), hepatocellular carcinoma (9 and 14/ 1304 and 2016, n= 4289), colic/abdominal pain (10 and 14/ 519 and 773, n= 64724), and appendicitis/routine abdomen (11 and 16/661 and 1059, n= 721263). Most CT scans for clinical indications showed large differences in radiation dose compared to routine CT scans, e.g. sinusitis scans were >60% lower in both CTDI<sub>vol</sub> and DLP compared to routine head CT scans. Further, there were large differences in the DRLs and ADs across facilities.

## CONCLUSION

DRLs and ADs for the clinical indications of EUCLID were presented and showed differences to routine CT scans. Dose metrics from large multi-center studies can help create representative DRLs and ADs that can be used for dose optimization, institutional evaluation, and indication-specific dose-optimized protocols.

## CLINICAL RELEVANCE/APPLICATION

DRLs and ADs for clinical indications are essential due to high variation of CT radiation doses and for dose optimization, institutional evaluation, and indication-specific dose-optimized protocols.

### SSK18-09 Reference Dataset for Benchmarking Organ Doses Derived from Monte Carlo Simulations of CT Exams

Wednesday, Dec. 4 11:50AM - 12:00PM Room: E353C

#### Participants

Anthony Hardy, MS, Los Angeles, CA (*Presenter*) Nothing to Disclose  
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Erin Angel, PhD, Tustin, CA (*Abstract Co-Author*) Employee, Canon Medical Systems Corporation

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Michael F. McNitt-Gray, PhD, Los Angeles, CA (*Abstract Co-Author*) Institutional research agreement, Siemens AG

## **PURPOSE**

AAPM Report 195 contains reference datasets for the direct comparison of results between different Monte Carlo (MC) simulation tools but stops short of providing the necessary information for comparing organ doses. The purpose of this work was therefore to extend the efforts of AAPM Report 195 by providing a reference dataset for benchmarking absolute and normalized organ doses from MC simulations of CT exams.

## **METHOD AND MATERIALS**

The reference dataset contains (1) scanner characteristics, (2) patient information, (3) exam specifications, and (4) organ dose results in tabular form. The scanner characteristics include descriptions of equivalent source spectrum, bowtie filtration profile, and scanner geometry information. Additionally, for MCNPX MC engines, normalization factors are provided to convert simulation results to units of absolute dose. The patient information was based on publicly available fetal dose models and includes de-identified image data; voxelized MC input files with fetus, uterus, and gestational sac identified; and patient size metrics in the form water equivalent diameter (D<sub>w</sub>) distributions from the image data and from a simulated topogram. Exam characteristics include the scan length and imaging protocol specifications. For tube current modulation (TCM) simulations, an estimate of TCM is provided based on a validated method that accounts for patient attenuation and scanner tube current limitations. In this case, CTDI<sub>vol</sub> estimates were based on average tube current across the scan volume. Organ dose simulation results are given for each patient model and for TCM and fixed tube current (FTC) CT exam scenarios both in terms of absolute and CTDI<sub>vol</sub>-normalized fetal dose.

## **RESULTS**

Results TCM and FTC simulations for absolute and normalized fetal dose are presented in tabular form with associated MC error estimates for benchmarking.

## **CONCLUSION**

The reference dataset for MC benchmarking is now available. This will enable researchers to compare their simulations to a set of reference data.

## **CLINICAL RELEVANCE/APPLICATION**

This dataset will be used for benchmarking dose management software results against MC simulations.

Printed on: 10/29/20



QIE-WEA

## Quality Improvement Reports Wednesday Poster Discussions

Wednesday, Dec. 4 12:15PM - 12:45PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI123-ED- WEA1 Improving MRI Outpatient Wait Times

Station #1

#### Participants

Justin M. Honce, MD, Aurora, CO (*Presenter*) Nothing to Disclose  
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Julia Drose, BA, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose  
Nancy Cheung, MPH, Aurora, CO (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

When comparing our outpatient MRI mean wait times from time of check-in to time when exam begins, to the American College of Radiology (ACR) GRID data, we found ours (53.2 minutes) to be 10% longer than other academic radiology centers in the United States (48 minutes), 31% longer than institutions in the west (36.7 minutes) and 51% longer than the aggregate of all sites who submitted data (26 minutes). MRI Outpatients are routinely asked to arrive 30 minutes prior to their scheduled appointment time, in order to ensure they are screened for potential contraindications and given an IV when contrast is necessary. Therefore, our ultimate goal was to decrease the 53.2 minute wait time to 30 minutes.

#### METHODS

Several different quality improvement tools were utilized throughout this process. We began by performing a time study observing outpatients scheduled to receive either contrasted or non-contrasted MRI studies. A variety of parameters were recorded, including patient arrival in the Department, patient check-in, length of time to fill out an MRI screening form, IV insertion time and time the exam began. We also recorded the amount of time the patient spent in the central waiting room and the time they spent after changing and having an IV inserted, in the MRI waiting room. Interviews with MRI Technologists and Radiology RNs were conducted during the time study to glean their thoughts on factors contributing to increased outpatient wait times. A guiding coalition was then convened, with representation from every area in Radiology that interacted with MRI outpatients. This included schedulers, receptionists, RNs, Technologists, tech assistants and Radiologists. A value stream analysis of the baseline time study data was presented showing value-added versus non-value-added wait times. A process map outlining current state was then constructed and reviewed. Several exercises were conducted with the group to identify issues perceived as contributing to unnecessary patient waits, and then selecting those that occurred most frequently. From this, a measurement and improvement plan was constructed which included implementation of several different interventions. PDSA cycles were utilized to review collected data and determine if a specific change was statistically significant in reducing wait times. Bimonthly meetings were held with the guiding coalition to review findings and identify subsequent interventions to be studied. A run chart of average turn-around-time from patient arrival to exam begin was constructed to show which interventions contributed to a decrease in patients waiting. From this data several process improvements were implemented in the MRI outpatient area.

#### RESULTS

A time-and-motion study was conducted to evaluate current state. The value stream maps constructed from this data indicated an average of 27 minutes spent on tasks for contrasted exams and 15 minutes spent on tasks for non-contrasted exams. Patients spent an average of 28 minutes waiting in between steps for both contrast and non-contrast exams. Five PDSA cycles were implemented based on process changes suggested by the guiding coalition. PDSA 1 involved giving MRI outpatients bags to remove and place jewelry in at check-in, negating the need to do this prior to entering the MRI. This intervention did not impact mean wait times, but was adopted due to patient satisfaction. PDSA 2 involved limiting the times MRI Technologists would attempt to scan patients unable to hold still, to two attempts. This change resulted in a mean wait time of 48 minutes, and was adopted. PDSA 3 asked RNs to alert MRI Technologists when patients had an IV placed and were ready to be scanned, either by calling or waking into the MRI control room. Mean wait time following this change was 41 minutes. PDSA 4 assigned a dedicated MRI Technologist to the reception desk to bring patients back to the changing area immediately following check-in. The Technologist would then place the IV if an RN was not immediately available and complete the MRI screening form with the patient. The mean wait time following this change was 40 minutes. A 5th PDSA involved changing time slots in the EPIC Radiant scheduling module to 15 minute increments to eliminate gaps and adjusting exam time lengths to more accurately represent specific protocols. An average wait time of 42 minutes was realized following these changes, but data collection for this PDSA is on-going. An Xbar-R chart of average turn-around-time from checkin to exam begin by PDSA showed a sustained improvement of 10.6 minutes after testing and implementation of PDSAs 3-5. This was a 20% improvement from the baseline period.

#### CONCLUSION

MRI outpatient wait times will continue to be monitored for sustainability and improvement. Ongoing interventions include revising scheduled exam times as necessary, opening an additional IV start area and implementation of physical and technological modifications to improve efficiency.

#### QI124-ED- WEA2 AI Driven Quantitative System for Assessing the Quality of Diagnostic Ultrasound

Station #2

#### Participants

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**PURPOSE**

To present a quantitative system, driven by AI, for assessing the quality of ultrasound examinations, and to determine its reproducibility, taking into consideration if the images obtained in the abdominal ultrasound exam fulfill the established requisites from the protocol.

**METHODS**

One of the basic criteria of quality is the presence of key images defined in the abdominal ultrasound protocol by AIUM. Our AI-driven system is an important tool to help us check if the set of images of an abdominal ultrasound exam matches the AIUM requisites or not. A dataset composed of the main classes of images required in the abdominal protocol is used to train the AI algorithm. Each class of images is composed of at least 400 images obtained from different patients, about 3 images per patient for each class, properly anonymized. A mobile NASNet was trained from scratch to classify the images in 15 classes. After that step, the algorithm is able to recognize the pattern present in each class: (1) longitudinal image of the left hepatic lobe, (2) longitudinal image of the right hepatic lobe, (3) hepatic veins and IVC, (4) portal vein, (5) longitudinal gallbladder, (6) transversal gallbladder, (7) pancreas, (8) aorta, (9) longitudinal right kidney, (10) transversal right kidney, (11) spleen, (12) longitudinal left kidney, (13) transversal left kidney, (14) urinary bladder. There is also a (15) NO category, composed of non-identifiable abdominal images.

**RESULTS**

Once the inference is performed in an abdominal ultrasound with its given set of images, it is possible to analyze how many images matches with the established standard. The accuracy in the training/validation/test sets was, respectively, 99.8/98.2/97.5%. With the ongoing growth in the number of images in our dataset, we are aiming better results. It's interesting to state that the most common wrong predictions were confusing right and left kidney.

**CONCLUSION**

It will also be possible to ensure quality improvement in ultrasound department, with this low cost and wide range quality assessment tool. We can open new possibilities in the near future, for instance classifying not only the presence of the key images, but also other quality criteria as focus, depth and gain adjust on each image. Protocol driven quality improvement aided by AI, will benefit patients, doctors and sonographers as well, once we ensure to follow all cybersecurity recommendations and conventions, technology will perform as a tool for intelligence augmentation and business scale, and not as a threat.

**Q1012-EB-WEA Radiology Information System (RIS) Integrated Faculty Scoring and Feedback System for After Office Hours (AOH) On-Call Resident Provisional Radiology Reports**

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Participants

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**PURPOSE**

While the radiology residents in our general acute care hospital are rostered on subspecialty-based rotations during office hours as per ACGME model, they are required to provisionally report any acute diagnostic imaging scans across different subspecialty in first line after office hours (AOH) on-call duties. These provisional reports are subsequently re-read and approved by various attending faculty radiologists independently the next working day, allocated according to subspecialty. As our resident appraisal model is subspecialty based, there is currently no objective method to assess their reporting accuracy during AOH on-call duties. Furthermore, it is logistically challenging for the various attending faculty radiologist to provide feedback on the provisional reports given the different physical locations of subspecialty teams within campus and residency working hour limits.

**METHODS**

We designed a faculty report scoring and feedback module integrated into our electronic Radiology Information System (RIS) software, Carestream Vue RIS version 11 (Carestream Health, Rochester, New York, USA). All attending faculty radiologist are encouraged to voluntarily grade all provisional AOH CT and MRI scan reports transcribed by the on-call resident before verifying the reports. There are 4 options on the scoring scale: A, B, C and D. Grade A, matched to numerical value of 4 for analytic purposes, represents an excellent report without need for report amendments. Grade B, matched to value of 3, represents a typical report with only minor non-significant report amendments such as missing a simple renal cyst. Grade C, matched to value of 2, represents reports with minor discrepancies defined as clinically significant but not life threatening misdiagnosis such as missing a pulmonary nodule. Grade D, matched to value of 1, represents reports with major discrepancies defined as life threatening misdiagnosis such as missing an intracranial hemorrhage. The module also includes a free text box for the scorer to provide written feedback. At the end of each month, a residency program administrator processes the application generated log of all the reports graded. Individualized report card are sent via email to each resident comprising of: mean score for the month, number of discrepancies graded (grade C and D), list of scored reports from the resident including free text comments. Analysed cohort results and

commonly misdiagnosed conditions are also discussed in monthly residency faculty meetings and reviewed during performance appraisal.

## RESULTS

Our pilot project ran for 9 months from July 2018 to March 2019. A total of 2972 CT and MRI scans were scored - mean of 330.2 scans per month, range from 232 to 393. Most of the scans scored were from neuroradiology subspecialty (2491, 83.8%), followed by body (thorax and abdominal) subspecialty (331, 11.1%) and musculoskeletal subspecialty (150, 5%). There were total of 146 reports scored as minor discrepancy (mean 16.2 per month) and 1 report scored as major discrepancy (mean 0.1 per month). Total of 361 reports were given free text comments (mean 40.1 per month). Mean of 19.7 residents were graded per month (range 14 to 23) and the individual mean scores per month range from 2.9 to 4.

## CONCLUSION

Our scoring and feedback system for AOH on-call resident provisional radiology reports has gained acceptance in the department as an integral part of summative workplace assessment and identified significant number of AOH provisional report discrepancies. It enables residents to objectively review their on-call reporting accuracy, temporal development and obtain individualized feedback from faculty. Concurrently our teaching faculty utilized the data obtained to identify common reporting discrepancies, thereby modify training curriculum to address knowledge gaps and indirectly improving patient care. Moving forward, we plan to survey the residents and faculty to assess subjective results of this project at the end of 1 year. The program will subsequently be improved upon based on collated feedback. We expect to introduce mandatory grading of all AOH on-call reports eventually, which will allow us to track longitudinal and objective improvement in resident performance.

## Q1013-EB- WEA **Impact of a Lecture Evaluation System on Lecture Type and Quality: A 24-Month Analysis and Insights on Resident Learning Styles**

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### Participants

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## PURPOSE

With the recent change in ABR exam structure and the gradual change in resident learning style, classroom-based resident education has required adaptation. We implemented a live lecture evaluation system to provide instant feedback from the residents to individual lecturers/division directors and to observe long-term trends in the ratings of different education methods.

## METHODS

A lecture evaluation system was created in February 2016, which allowed anonymous feedback after completion of the lecture. The evaluations included lecture content ratings and type of interactive component, including traditional hot seat case conference, lectures with live audience response through a web-based app (RSNA Diagnosis Live), or a non-interactive didactic lecture. Additionally, residents reported if the lecture would be improved with interactivity to account for lectures best presented in didactic-only format. Responses over 24 months were analyzed. Unpaired t-test analysis was performed on the different groups (interactive versus non-interactive conferences, and live audience response versus traditional case conference). Impact of the lecture evaluation system on the number of lectures with interactivity was analyzed from year 1 to year 2.

## RESULTS

Over the 24-month timeframe, 524 lectures were performed and 1580 evaluations were received. There were 275 lectures in year 1 and 249 lectures in year 2 that received evaluations. In year 1, 134 lectures (49%) were non-interactive and 141 lectures (51%) were interactive. Within the interactive year 1 subset, there were 26 lectures (18%) that utilized a web-based lecture format and 115 lectures (82%) that were traditional case-based conference. In year 2, there was a significant increase in the proportion of interactive lectures (61% vs 51%,  $p=.03$ ) and a significant increase in the overall lecture rating for the interactive lectures (4.48 to 4.59,  $p=.04$ ). There was a significant decrease in the number of didactic lectures that would benefit from interactivity (52% to 38%,  $p=.04$ ). There was no significant difference in the percentage of web-based lectures in each year. Combining both years, the mean lecture rating for the interactive subset was 4.57, which is significantly higher than the mean lecture rating of 4.18 for the non-interactive subset ( $p<0.0001$ ). Within the interactive group, the web-based lectures were rated significantly higher than the oral case-based lectures (4.7 and 4.53, respectively;  $p=0.02$ ).

## CONCLUSION

The implementation of the lecture evaluation system had a significant impact on lecture type and lecture quality after just one year, presumably due to direct feedback to the individual lecturers and program directors. By the second year, more lectures included interactivity and a majority of the non-interactive lectures were perceived to be best delivered in a didactic format. Based on resident feedback over 24 months, interactive lectures are better received than non-interactive lectures, with the web-based format as the preferred method. Adapting the curriculum based on lecture evaluations and resident learning style is crucial for promoting better resident education.

## Q1022-EB- WEA **Lung Biopsy On-Time Starts and Day of Procedure Patient Wait Times**

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### Participants

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**PURPOSE**

Improve on time starts and decrease day of procedure patient wait time for lung biopsies. In the first half of 2017, 13% of the lung biopsies started within 60 minutes of their scheduled start time (on-time start) and 27% of patients waited in the department more than 120 minutes before their procedure started. We sought to increase on-time procedure starts from 13% to 50%, and increase patients waiting fewer than 120 minutes from 27% to 60% by December 31, 2018.

**METHODS**

A3 problem solving methodology was employed to improve the day of procedure workflow for outpatient lung biopsies at our institution. A problem-solving team consisting of radiologists, nursing, schedulers, and IT was formed. Two metrics to track performance were selected: on time start rate, as defined as first image time within sixty minutes of procedure scheduled time, and day of procedure patient wait time, as measured by time between patient arrive in department and first image time. Baseline performance was measured, and SMART goals were set. Team members traveled to the Gemba and observed the current workflow. A process map was compiled. The factors contributing to delays were mapped on a fishbone diagram, and a value stream map was created. The baseline data was stratified by patient arrival time to further study the impact of patient timeliness on workflow. These analyses demonstrated that our main problems were with patient flow through pre-op, procedure room availability, and communication amongst team members. We devised five interventions, which were sequentially performed in small PDSA cycles: institution of an electronic list of patients ordered for lung biopsy, moving informed consent of patients to a time prior to the day of biopsy, pre-signing orders, instructing patients to arrive an extra thirty minutes early, and weekly e-mails amongst team members to prepare for the coming week's biopsies.

**RESULTS**

Our process map demonstrated there is a lot of redundant communication amongst team members, and that there are multiple roadblocks in the process. Therefore, we designed interventions to facilitate communication: we developed an online biopsy list accessible to all team members, and started weekly planning e-mails amongst team members. To reduce roadblocks, we started meeting patients in clinic on a day prior to the biopsy to perform informed consent and sign day of procedure orders. The value stream map showed that the greatest variability within the process (as measured by the standard deviation divided by the mean) is for patients waiting for the procedure room to open up. Stratification of our data by patient arrival time demonstrated that procedures for patients who arrive extra early started more often on time and patient wait time was not affected. Therefore, all patients were subsequently instructed to arrive 60 minutes before their procedure start time, instead of 30 minutes, as was the standard before. Following these interventions, on time starts doubled from 13% to 27% and patients waiting fewer than 120 minutes doubled from 24% to 54% by December 31, 2018. This is less than our goal of 50% on time starts and 60% of patients waiting fewer than 120 minutes.

**CONCLUSION**

Structured quality improvement methodology assisted in improving on time lung biopsy starts and decreasing patient wait times. Our performance remains below our target, and additional countermeasures to improve procedure room availability will be tested.

**QI027-EB- WEA Increasing Time Between Interruptions In A Busy Reading Room**

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**Awards**

**Quality Improvement Reports Award Identified for RadioGraphics**

**Participants**

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Alex Towbin, MD, Cincinnati, OH (*Abstract Co-Author*) Author, Reed Elsevier; Grant, Guerbet SA; Grant, Cystic Fibrosis Foundation; Consultant, Reed Elsevier; Advisory Board, IBM Corporation; Advisory Board, KLAS Enterprises LLC;  
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**PURPOSE**

Radiologists are required to perform complex cognitive tasks during the course of their daily work, often interpreting studies with thousands of images. Prior research has shown that repeated interruptions can have a negative effect on humans performing complex tasks, resulting in errors, decreased efficiency and increased stress levels. Frequent interruptions are common in radiology department reading rooms and occur by phone, in person, or by pager. The purpose of this quality improvement project was to use quality improvement methodology to increase the median time between interruptions that occur daily in our busiest reading room by 50% between July 2018 and January 2019.

**METHODS**

An improvement team was established, consisting of 2 radiologists, 2 technologists, a reading room assistant and a quality improvement specialist. Data was collected manually by a trained observer counting the number of interruptions that occurred, the type of interruption (telephone, pager, in-person), and the time (in minutes and seconds) between each interruption for 1 hour per day, 5 days per week between the hours of 10 am - 3 pm. The median time between interruptions was calculated. Data was displayed in a time between run chart. To drive improvement, a process map was developed outlining how typical interruptions occur, and a simplified failure modes effect analysis was performed. After several rounds of data collection, a Pareto chart was made demonstrating the most common types of interruptions, and a key driver diagram was developed. Multiple interventions were

tested attempting to reduce the most common unnecessary interruptions. Successful interventions were adopted on a larger scale.

## **RESULTS**

At baseline, the median time between interruptions was 187 seconds. The most common causes of interruptions were technologists calling to check images per departmental protocol, telephones ringing in multiple locations at the same time, and in-person visits to the reading room, mostly by clinical colleagues. The improvement team worked to evaluate departmental protocols requiring technologists to check images, create clear expectations for clinicians and others visiting the reading room, and design an upgraded phone system to reduce redundant phone calls. The interventions tested included allowing technologists to perform the initial quality control checks on their own images for most examinations (involving the radiologist only if needed), adding signage to the reading room directing visitors to the reading room assistants for appropriate triage, and designing a phone system that would eliminate the problem of multiple phones ringing at once. At the end of the project period, the median time between interruptions was increased to 336 seconds, a 77% increase.

## **CONCLUSION**

Using quality improvement methodology and a team approach, we were able to increase the time between interruptions in our busiest reading room by 77%. Although we exceeded our initial project goal, we plan to continue our work to further increase the time between interruptions. We believe that this work will help to decrease radiologist stress levels and increase work efficiency.

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QIE-WEB

## Quality Improvement Reports Wednesday Poster Discussions

Wednesday, Dec. 4 12:45PM - 1:15PM Room: QR Community, Learning Center

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### Sub-Events

#### QI125-ED- WEB1 **Beyond Error Detection and Efficiency Enhancement: Point-of-Care Photography as a QI Tool in Radiography**

Station #1

#### Participants

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#### PURPOSE

Radiologists are rarely in the physical presence of their patients. This creates potential image quality and interpretation challenges, from images saved under incorrect patient identifiers, uncertainty about what procedures have taken place, to a lack of appreciation of the technical factors impacting the quality of images obtained. This project describes a process to address such challenges by acquiring point-of-care patient photos with radiographs.

#### METHODS

A system to automatically acquire patient photos with portable radiography was deployed at a large academic hospital. The system consists of: 1) WiFi-enabled smart cameras installed on portable radiography units (Fig. 1), and 2) an integration server responsible for retrieving acquired photos, matching photos to radiographs, then processing and sending photos to the hospital's picture archiving and communication system (PACS). Photo acquisition is automatically triggered without disrupting technologists' workflow. Photos are added to radiographs as a new series in PACS (Fig. 2). They are thus stored in a HIPAA-compliant environment and available only to individuals with appropriate access, i.e., radiologists, technologists, physicians, and nurses. Interruption of interpretation workflow is minimized by displaying the photo(s) after the series of radiographs. In addition, technologists have access to these photos prior to marking studies as complete.

#### RESULTS

Within the first year of deployment this quality improvement (QI) project resulted in the detection and reconciliation of misidentified radiographs, led to a perception of improved technologist and hospital workflow, and generated preliminary evidence of increase in radiologist accuracy and confidence. Misidentifications: Multiple misidentified studies were detected and reconciled with the assistance of patient photos. For those detected by the technologists, reconciliation could be carried out by the technologists themselves, saving radiologists time and effort. In all cases, reconciliation was made easier by the photos. In at least one instance, the patient photo allowed the technologists to not only detect the error but to further identify the correct patient to whom the initially erroneously assigned radiograph belonged. Workflow improvements: Due to the sensitive nature of patient photos, several opportunities for improvements to the patient experience were identified and carried out. Because the photos are sometimes obtained when patients are vulnerable, such as intubated in the ICU, staff training regarding maintaining patient dignity by appropriately draping patients during radiography, decreasing automatic logout time for hospital workstations, and implementing privacy screens for hospital workstations were implemented. Radiologists' confidence: To understand the effect of patient photos on radiologist interpretation, a preliminary study was conducted to assess radiologist accuracy and confidence in assessing lines and tubes on radiographs. This study suggested that patient photos increase both accuracy and confidence in radiologists' interpretation for these studies.

#### CONCLUSION

Several follow-up actions are being implemented in this ongoing QI project. For instances when it may not be possible to adequately cover the patient, e.g., during emergency imaging, a physical 'stop' button is being developed for the camera that technologists can use to prevent automatic photo acquisition for a predetermined time period. In sensitive instances, this will allow radiographs to be acquired without photos. In addition, a blank leader image will be added to each photo series with embedded text indicating that patient photos follow. This will prevent photos from being displayed unintentionally on hospital workstations and alert the viewer to these photos. Lastly, radiologist reading logs will be analyzed to assess the effect on reading time and confidence. An intriguing emergent benefit of this project is the availability of accurate timestamps corresponding to radiograph acquisition. Accurate timing information is crucial for numerous patient care QI metrics. The clocks of the portable radiography units were found to drift at a machine-specific rate of +/- 1-2 seconds per day, resulting in variations of multiple minutes between machines.

Conversely, each camera clock is synchronized with the integration server clock, which in turn is synchronized using multiple network time protocol servers. Therefore, when photo acquisition is triggered automatically upon radiograph acquisition, a globally correct timestamp is generated and used as the acquisition time for each photo. By implementing this QI project, patient care improved by increasing the detection and reconciliation of misidentified studies, identifying improvements to patient care and privacy, and potentially increasing radiologist confidence and accuracy in interpreting portable radiographs. The further quantification of these improvements is an ongoing topic of research.

#### **Q1126-ED- WEB2 Improving MRI Safety in Pediatric Patients Undergoing Sedation: Impact of In-situ Bi-monthly Multidisciplinary Simulation Training**

Station #2

##### **Participants**

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##### **PURPOSE**

Primary objective was to identify gaps in practice management and increase personnel comfort in proper management of an unstable sedated patient while undergoing magnetic resonance imaging (MRI).

##### **METHODS**

In 2018, an in-situ bi-monthly MRI simulation program was implemented on appropriate management of an unstable pediatric patient receiving sedation during an MRI (a high-acuity, low-frequency event). Multidisciplinary team members included pediatric sedation physicians (intensivists), nursing from both sedation team and diagnostic imaging, child-life specialists, MRI technologists and technologist aide, Radiology Quality and Safety leaders, and Simulation Lab instructors. Scenarios simulated moving unstable patient out of Zone 4, role clarification, identification of emergency equipment location, and code activation. Identification of potential safety threats and team debriefing occurred in real time. A 10-question survey assessed the impact of simulation training after one year. Quality improvement tools in this project included flow charts, failure mode and effects analysis during post-simulation debriefing to aid in recognizing potential failures, latent safety threats and barriers to following prescribed workflow.

##### **RESULTS**

Nineteen, at least partially completed, survey responses were received (9 PICU physicians, 3 radiology quality and safety team members, 2 MRI technologists, 1 MRI technologist aide, and 4 sedation team nurses). Sixty-three percent (10/16) of participants reported that the simulations identified a gap in practice that could have potentially harmed patients. Ninety-four percent (16/17) of participants agreed that the simulation addressed potential barriers to safely moving a sedated patient out of MRI Zone 4. Eighty-eight percent (14/16) of participants agreed or strongly agreed that the simulations helped clearly define roles in an emergency and improved awareness of resuscitation equipment location in MRI. An improvement in comfort on the proper workflow in managing an unstable sedated patient in MRI was seen in 70% (12/17) of respondents, with most (53%, 9/17) changing from comfortable to very comfortable after simulation training.

##### **CONCLUSION**

A high percentage of participants acknowledged that the simulation program helped identify a practice gap that could have harmed a patient and address potential barriers to safe evacuation of a patient from MRI Zone 4. Successful in-situ simulation programs require a multidisciplinary team approach to meet the needs of each team member. Simulations help practice high acuity, low frequency events that carry high risk of potential patient harm. Collaboration between team members has allowed for clearer role definitions, workflow familiarity, and identification of latent safety threats. Practice gaps and patient safety threats identified and corrected included malfunctioning intercom system preventing communication between MRI and nursing prep hold, deficiencies in oxygen supply during patient transfer, and confusion on who should call a code and location of resuscitation equipment in MRI.

#### **Q1127-ED- WEB3 Standardized Progress Note Template in the Electronic Medical Record Improves Documentation of Contrast Extravasation Events**

Station #3

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##### **PURPOSE**

CT contrast extravasation events are common, occurring in 1/100 to 1/1000 patients. Although most CT extravasations are self-limited, both initial physician evaluation and clinical follow-up are recommended to assess for signs and symptoms or more serious complications, such as compartment syndrome or skin ulceration. The ACR further recommends that all CT contrast extravasations

and any related treatment should be documented in the medical record, particularly the radiology report, and the ordering physician should be notified. Conversely, MRI contrast extravasations are less common and rarely require physician evaluation or clinical follow-up; gadolinium based contrast media is less toxic to the skin and subcutaneous soft tissues than iodinated contrast. The purpose of this quality improvement project was to measure how the creation of a standardized progress note template in the electronic medical record (EMR) impacted the presence and consistency of radiologist documentation of initial physical evaluation and of patient as well as provider communication.

## METHODS

All extravasation events at our 738-bed tertiary care urban teaching hospital are filed through an online safety event management reporting and tracking system. All 81 extravasations over a 6-month baseline period (March to September 2017) were reviewed to determine the presence of any EMR documentation on initial radiologist evaluation and treatment. Our intervention was the creation of two standardized 'SmartText' contrast extravasation progress note templates in our EMR with embedded pick lists for most mandatory fields; separate templates were designed for inpatients and outpatients. Mandatory fields included the volume and site of extravasated contrast, pertinent physical exam findings, treatment; additional fields included discharge instruction review for outpatients and direct communication of extravasation to clinical housestaff for inpatients. Trainees, staff and technologists were all educated regarding the new templates and documentation workflow. All 34 extravasations during the first two months of the standardized template roll-out (February and March 2019) were reviewed in the EMR for documentation of radiologist evaluation and treatment.

## RESULTS

Radiologist documentation of contrast extravasation in the EMR increased from 76% (45/59) in CT during baseline to 88% (23/26) following the intervention and from 0% (0/22) in MRI to 25% (2/8). Documented CT extravasations during baseline mainly included a hand-filled form scanned into the patient's EMR (43/45; 96%), with a few free-text progress notes (2/45; 4%). Following the intervention, all CT extravasations were documented using the standardized progress note template (23/23) with consistent reporting of physical exam findings, discharge instructions for outpatients, and communication with clinical house staff for inpatients. A single emergent hand surgery consult was required during baseline.

## CONCLUSION

Creation of standardized contrast extravasation progress note templates in the EMR with embedded pick lists improved consistent documentation of physical examination findings as well as patient and provider communication in the EMR.

## Q1026-EB- WEB Automation of the ACR MRI Low-Contrast Resolution Test Using Machine Learning

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### Participants

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## PURPOSE

Magnetic Resonance Imaging (MRI) is a powerful, widespread and indispensable medical imaging modality. The American College of Radiology (ACR) recommends weekly acquisition of phantom images to assess the quality of scanner. Usually, these images must be analyzed by experienced technicians. Automatic analysis of these images would reduce costs and improve repeatability. Some automated methods have been proposed, but the automation of two of the ACR image quality tests remains an open problem. Reports on the high- and low-contrast resolution tests are scarce and so far none of the proposed methods produce results robust enough to allow replacing human work.

## METHODS

We use Machine Learning to emulate, with high accuracy, the detection of 120 low-contrast structures of ACR phantom by an experienced professional. We used a database with 620 sets of ACR phantom images that were acquired on scanners of different vendors, fields and coils, totaling 74,400 low-contrast structures. Technicians with more than 10 years of experience labeled each structure as 'detectable' or 'undetectable'. Machine learning algorithms were fed with image features extracted from the structures and their surroundings. Among the five methods we tested, Logistic Regression yielded the largest area under the ROC curve (0.878) and the highest Krippendorff's alpha (0.995). They are also better than the classifications made by junior technicians (with less than 5 years of experience). This indicate that the ACR MRI low-contrast resolution test may be automated using Machine Learning. We have in our database 620 ACR phantom acquisitions in the last 12 months, obtained in 13 scanners of different vendors (Siemens, GE and Philips), magnetic fields (1.5T and 3.0T) and head coils (8, 12 and 32 channels). That means, we have 74,400 low-contrast structures imaged in a great range of conditions to train our classification algorithms. All image processing was carried out using in-house algorithms programmed in Matlab and R language.

## RESULTS

The method with the largest AUC was LR (logistic regression) with area of  $0.878 \pm 0.056$ , where 0.878 is the mean of the areas obtained by 10-fold cross-validation and 0.056 is the standard deviation. LR also yielded the the highest Krippendorff's alpha (0.995). It is noteworthy that there is no guarantee that AUC and Krippendorff's alpha will agree that a specific algorithm is the best. We tried to solve this problem without using machine learning and did not get good results. Thresholding the signal-to-noise ratio did not work well. We also tried to include the area of the hole into the formula without success. To assess the quality of our method, we compared the answers of junior technicians (with less than 5 years of experience) with our algorithm, considering the answers of senior technicians (with more than 10 years of experience) as "gold standard". The results indicate that junior technicians classified correctly 82% of all holes; and classified correctly only 34% of undetectable holes and 84% of detectable holes. To measure the performance of our algorithm, we thresholded the output of LR model (that yielded the best results) using criterium "ROC01", that minimizes the distance between ROC plot and point (0,1). The results indicates that LR model classified correctly 84% of all holes, 68% of undetectable holes and 87% of detectable holes. In conclusion, our algorithm is better than junior technicians in classifying the holes as detectable/undetectable.

## CONCLUSION

We fed five learning algorithms with features extracted from the ACR phantom images, and with labels (detectable/undetectable) assigned by senior technicians with more than 10 years of experience. Among the five methods we tested, Logistic Regression yielded the largest area under the ROC curve (0.878) and the highest Krippendorff's alpha (0.995). The results achieved in this study are substantially better than those previously reported in the literature. Also, the results are better than those obtained when junior technicians (with less than five years of experience) labels the image structures manually. This indicates that it may be possible to replace human operator in ACR low-resolution test.

**Q1021-EB- WEB Improving 'Door to CT' Time in Acute Stroke Patients and 'Door in-Door out' Time in those appropriate for Endovascular Thrombectomy (performed in external tertiary Neuroradiology centre) as part of an Irish National QI Stroke Programme**

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**PURPOSE**

A National Endovascular Thrombectomy (EVT) referral service was commenced in Ireland in 2018. We noted avoidable delays in the clinical and imaging pathway of patients presenting to our institution with signs and symptoms of acute stroke. This resulted in delayed administration of IV thrombolysis and delayed or missed opportunities for referral for EVT. We noted delays in referral to radiology for CT, delays in patient transfer to CT, scan delays within the CT department and delays in transfer of patients out of our hospital for EVT.

**METHODS**

We formed a FAST committee with members including the Attending Stroke physician departmental lead, Stroke specialist nurse, Radiology resident and Emergency Department nursing manager to address the problem. We adopted the 'Plan, Do, Study, Act' methodology and created a process map of the existing process. A multidisciplinary meeting was arranged with representatives of all medical and allied health professionals a patient encounters from the onset of acute stroke, including paramedics, emergency department staff, clerical staff, medical physicians, radiographers, radiologists and portering staff. 'Red flags' or areas of possible improvement were identified in every step of the process and we created driver diagrams to redesign our acute clinical and imaging stroke protocol. Sub-specialty education sessions were performed at the time of protocol implementation. To improve our specific 'Door to CT' and 'Door in Door out' times we implemented a new 'Pre-alert' referral to radiology from ED department staff for incoming stroke patients. A new CT ordering proforma was developed to include relevant clinical information to aid in faster imaging interpretation and to identify patients who met referral criteria for EVT. Provision of a timely verbal report on the non-contrast CT brain to the stroke physicians in the CT department prior to CTA was commenced to allow administration of bolus dose thrombolysis in appropriate patients. Clear criteria for EVT referral and appropriate direct line neuroradiology contact numbers were provided for referring physicians. A new CT/CTA reporting proforma was implemented to facilitate audit.

**RESULTS**

A retrospective review of stroke patient presentation times from clinical records and corresponding CT times from PACS before implementing protocol were analysed. These were compared with new clinical stroke patient documentation and new stroke proforma CT reports. Data and times collected were collected monthly and presented on graphs. A 43% reduction in 'Door to CT' time was observed following protocol implementation. Number of EVT referrals tripled following protocol implementation.

**CONCLUSION**

Marked improvement in 'Door to CT' and 'Door in-Door out' times. Increase in appropriate referrals for EVT at Neuroradiology centre. Improved patient morbidity and outcomes. Continuous FAST committee meetings, audit and individual case analysis. Appropriate changes to protocol and process map based on case analysis in order to sustain ongoing improvement. Continued education to rotating medical staff.

**Q1002-EB- WEB Common Data Element (CDE) Implementation for CT Paranasal Sinusitis: Improved Disease-Specific Evidence-Based Clinical Reporting, Moving Towards a Community Standard, and Building a Foundation for Research in Artificial Intelligence/Machine Learning**

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**PURPOSE**

The ASNR-ACR-RSNA has created dictation macros which include Common Data Elements (CDE) for evidence-based disease-specific reporting, including CT paranasal sinus inflammatory evaluation. We planned to use these macros to improve our reporting towards a community standard for paranasal sinusitis CT exams as a project for quality improvement, study pre-existing current state of reporting, implement the CDE macro, study the macro post-implementation utilization and reporting, and then re-evaluate our current practice to understand how we can further optimize our reporting to be both clinically relevant and useful for artificial intelligence/machine learning research.

## **METHODS**

All CT sinus exam reports from 3/1/2018-5/1/2018 (before promotion of CDE macros) as well as 12-7-2018-1/31/2019 (after institutional implementation of CDE macros) were reviewed. Exams were excluded if not specifically for paranasal sinus inflammatory disease. Following CDE macro implementation on 12/7/2018, each of the 19 Common Data Elements for the CT paranasal sinus inflammatory macro were marked as either present or absent from each report, as well as the percentage of all 19 CDE's in each report. We also analyzed the adoption rate of the CDE macro.

## **RESULTS**

Before CDE macro implementation, 66 reports met inclusion criteria, and 35 met exclusion criteria. Pre-intervention most commonly reported CDE include: maxillary sinus (97%), frontal sinus (91%), and ethmoid sinus (91%) (FIGURE 1). Pre-intervention least commonly reported CDE include: uncinata process lateralization (2%), nasopharynx (11%), and temporomandibular joint (11%). Completeness of reports for inclusion of all 19 CDE fields was 11-79%. After CDE macro implementation, 59 reports met inclusion criteria, and 30 met exclusion criteria. The CDE macro was adopted for 56% of reports. For those adopting the CDE macro, reporting improved for uncinata process lateralization (79%), nasopharynx (79%), and for temporomandibular joint (73%). Those not adopting the CDE macro, reporting remained similar to pre-intervention frequency for uncinata process lateralization (4%), nasopharynx (0%), and temporomandibular joint (8%). Completeness of reports for inclusion of all 19 CDE fields was 84% for those adopting the CDE macro, and 44% for those not adopting the CDE macro.

## **CONCLUSION**

Implementation of the ASNR-ACR-RSNA CDE macro for CT paranasal sinus inflammatory consistently improved disease-specific reporting when adopted by the radiologist. We hope incorporation of the CDE macros will bring our group towards a community standard of evidence-based clinically useful reporting. These CDE macros will hopefully facilitate research into natural language processing, machine learning, and deep learning as the field of artificial intelligence advances imaging. As part of this Plan-Do-Study-Act project for quality improvement, further improvement of CDE adoption is planned via education as to the clinical importance of disease-specific reporting, demonstrating shortcuts in dictation software to improve turnaround times, and incorporating these macros into trainee education.

Printed on: 10/29/20



SSM15

## Informatics (Image Sharing, Data, Security, Quality)

Wednesday, Dec. 4 3:00PM - 4:00PM Room: E353B



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

**FDA** Discussions may include off-label uses.

### Participants

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### Sub-Events

#### SSM15-01 Development of Good Practice Compliant Clinical Trial Imaging Management System for Multi-Center Clinical Trials

Wednesday, Dec. 4 3:00PM - 3:10PM Room: E353B

### Participants

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### PURPOSE

As utilization of imaging in multi-center clinical trials has rapidly increased, the amount of data and work flow complexity also increased, requiring a dedicated computerized system, a clinical trial imaging management system (CTIMS). Recently, the US FDA emphasizes the Good Clinical Practice compliance of the CTIMS. Thus, we aimed to develop a comprehensive CTIMS with intention to thoroughly meet the current regulatory guidelines and various functional requirements.

### METHOD AND MATERIALS

Key regulatory and functional requirements of CTIMS were extracted thorough review of many related regulations/guidelines including ICH-GCP E6, FDA 21 CFR Part 11 and 820, Good Automated Manufacturing Practice (GAMP®), Clinical Data Interchange Standards Consortium (CDISC). Based on these requirements, the system architecture was designed by multidisciplinary team including radiologists, engineers, clinical trial specialists, regulatory medicine professionals. Computerized system validation of the developed CTIMS was performed internally and externally.

### RESULTS

Our CTIMS was developed based on two-layer design composed of the server system and the client system, which is efficient to meet the regulatory/functional requirements. The server system manages system security, data archive, backup, audit trail, etc. The client system provides various functions including de-identification, image transfer, image viewer, image quality control, electronic record, etc. Computerized system validation internally using V-model and externally by global quality assurance company demonstrated that CTIMS meet all regulatory/functional requirements. Currently, our CTIMS system has been successfully implemented into more than 20 pharmaceutical multi-center clinical trials since 2017.

### CONCLUSION

In the era of bigdata, the use of CTIMS is crucial in multi-center clinical trials to deal with the large amount of image data and complexity of imaging management process. CTIMS must meet the both regulatory and functional requirements of the clinical trial, enhancing work flow efficiency and more reliable data/outcomes.

### CLINICAL RELEVANCE/APPLICATION

The Good Practice compliant CTIMS with comprehensive functions is an essential part of multi-center clinical trials to generate high quality data and minimize protocol violation.

#### SSM15-02 Tofu: For Stir-Fry and Ultrasound Procedural Training

Wednesday, Dec. 4 3:10PM - 3:20PM Room: E353B

### Participants

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## CONCLUSION

Firm tofu is a cheap US training medium that trainees at all reported improved their skills and confidence at minimal cost. Use of these blocks in a standard curriculum may be of benefit early on in resident education.

## Background

Despite the availability of commercial simulations, training new residents in procedures has traditionally been on patients who present with a need for treatment. This "trial-by-fire" experience, can be stressful for supervising physicians and trainees, and often deleterious to patients. Commercial ultrasound (US) phantoms are extremely costly for limited utility. We postulated that a cheap non-anatomic simulation could still greatly improve procedural skills and trainee confidence at a low cost in time and money. Based on prior publications, the use of tofu was suggested as a tissue simulation due to similar propagation speed to soft tissue. Internal echogenicity was noted to be similar to some soft tissues.

## Evaluation

Blocks of tofu were initially evaluated by both an attending interventional radiologist and a diagnostic radiologist to establish parameters. 11 trainees of varying levels of experience were asked to fill out a survey documenting their perceived experience, level of training and comfort with ultrasound guided procedures on a 10-point scale before completing testing. Trainees were randomized to initial testing on a tofu model or a commercially available phantom, and then completed a survey asking to evaluate change in the previously evaluated findings on a -5 to 5 point scale. Testing consisted of basic ultrasound guidance tasks including identification of target in multiple projections along with real-time needle guidance. Participants then underwent testing on the other model followed by a second survey.

## Discussion

Although no statistically significant trend could be identified on pre-testing surveys, trainee confidence demonstrated an overall positive improvement after use of the tofu-based model by 3.4 points. Use of the commercial phantom resulted in an improvement of 2.2 points, with most of the trainee concerns raised by more experienced residents, including excessive stiffness and residual tracts from prior training.

## SSM15-03 Protecting Patients from Cyber-Attacks on CT's Using Machine Learning Methods

Wednesday, Dec. 4 3:20PM - 3:30PM Room: E353B

### Participants

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## PURPOSE

Today, security methods for protecting medical imaging devices (MIDs) from cyber-attacks mainly focus on hospitals' network and endpoint security level; such methods are limited and are often breached (e.g., the WannaCry attack) as they rely on constantly installing regular security updates, a challenging task in a clinical setting with numerous devices. Moreover, cyber attacks that target internal components of MIDs ecosystem are harder to detect and protect; such attacks are potentially more dangerous and can potentially affect patients' health. For example, once the internal control unit of the MID is compromised, it is possible to manipulate its behavior and potentially jeopardize scans, device mechanics, and even patients safety.

## METHOD AND MATERIALS

We recorded over 10,000 scan commands sent from a computed tomography (CT) scanner host control unit to the gantry. Each record contains various technical parameters of the scan, including labels such as the body part being scanned, the scan protocol, etc. Furthermore, we recorded, with the assistance of radiologists and technicians, potentially malicious commands on real CT device (while no patient was present). We then applied different machine learning methods (e.g., Random Forest) to create an anomaly detection model that can distinguish between normal and malicious scans, with respect to the scan labels.

## RESULTS

We were able to classify scan commands to the appropriate scan labels (i.e., body part, scan protocol, and study description) with 90-98% accuracy (depending on the specific scan label) and detect all synthesized malicious commands. Furthermore, our anomaly detection model can also help notify and protect anomalies resulting from human error.

## CONCLUSION

Scan commands, often ignored or only used for maintenance purposes, contain important information about the scan process. By utilizing this information, we were able to study and define normal commands structure, and consequently detect scenarios in which anomalous commands were sent maliciously or by mistake.

## CLINICAL RELEVANCE/APPLICATION

Using machine learning methods can help detect cyber-attacks, as well as other anomalies such as human error, and by that protect patients from potential harm and improves safety.

## SSM15-04 Deploying Deep Learning for Quality Control: An AI-assisted Review of Chest X-Rays Reported as 'Normal' in Routine Clinical Practice

#### Participants

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#### PURPOSE

Quality control in radiology has thus far been restricted to performing random double reads or collating information about clinical correlation - both tedious and expensive activities. We present a novel use-case for AI to double read Chest X-Rays (CXRs) and indicate a list of cases where the radiologist may have erred.

#### METHOD AND MATERIALS

This study on the feasibility of deploying deep learning algorithms for quality control was conducted on pooled data from four out-patient imaging departments. The radiology workflow included a 'report approval' station where a simple, high level, binary label - 'normal' or 'abnormal' - was applied by radiologists. All adult CXRs marked 'normal' were prospectively analyzed through a deep learning algorithm (LUNIT Insight, S. Korea) tuned for automated normal vs abnormal classification. Note that the algorithm used was not trained on data from the institutes and country of testing. It provided an 'abnormality score' (range 0.00 - 1.00) and all images marked as 'abnormal' in high sensitivity setting (threshold = 0.16) were reviewed by a sub-specialist chest radiologist with 8 years' experience.

#### RESULTS

A total of 708 CXRs were marked 'normal' by radiologists during the one-month period of the study. 46 / 708 (6.49%) of CXRs were labelled 'abnormal' by the algorithm. Upon review of these 46 CXRs, 12 showed true abnormalities upon review. These 12 cases included four with lung opacities, three with significant blunting of costophrenic angles, two with apical fibrosis, one with a cavity, one with a nodule and one case with cardiomegaly. Appropriate corrective and preventive actions were taken, and feedback was provided to radiologists who reported these cases.

#### CONCLUSION

We demonstrate AI algorithms' ability to quickly parse through large datasets and help identify errors by radiologists. This is a fast and effective method to deploy AI algorithms in clinical practice with no risk (from AI) to patients, and clear measurable positive impact.

#### CLINICAL RELEVANCE/APPLICATION

Radiologists work flow supported by a parallel, second read AI would allow for faster reporting as it can help reduce errors in radiology reports, improving patient-care in the process. Importantly, this quality assurance study on CXR reporting, demonstrates the potential for AI to both personalize and prioritize training modules for radiologists.

#### SSM15-05 Informatics Challenges and Solutions to Host an Ultra-High Resolution Computed Tomography System

Wednesday, Dec. 4 3:40PM - 3:50PM Room: E353B

#### Participants

Sarah E. McKenney, PhD, Stanford, CA (*Presenter*) Nothing to Disclose  
Thomas W. Loehfelm, MD, PhD, Atlanta, GA (*Abstract Co-Author*) Nothing to Disclose  
John R. Hancock, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
John R. Harrison, BA, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose  
Erin Angel, PhD, Tustin, CA (*Abstract Co-Author*) Employee, Canon Medical Systems Corporation  
John M. Boone, PhD, Sacramento, CA (*Abstract Co-Author*) Board of Directors and Shareholder, Izotropic Imaging Corporation; Co-author with royalties, Wolters Kluwer nv; Patent agreement, The Phantom Laboratory  
J. Anthony Seibert, PhD, Sacramento, CA (*Abstract Co-Author*) Nothing to Disclose

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#### CONCLUSION

HRCT and other high-resolution imaging systems are now on the market and may test the limits of legacy informatics infrastructure for image transfer, storage, and display. Hospital IT must anticipate these future clinical needs and account for the large data challenges as imaging systems continue to advance.

#### Background

The acquisition of a high resolution CT (HRCT) scanner presents several challenges for data transfer & retrieval, storage and rendering. Unlike a conventional CT system with a standard image slice matrix of 512x512 and a minimum slice thickness of ~0.6 mm, the HRCT system acquires 1024 and 2048 matrix sizes with a minimum slice thickness of 0.25 mm. This results in CT acquisition

series 4 to 19 times larger than a conventional CT series.

## Evaluation

Several aspects of the imaging informatics chain were evaluated in advance of installation and continued to be monitored once the system went live. 1. The timing of data transfer as a function of infrastructure lines and matrix size was examined to ensure that it met the requirements of the clinical workflow. 2. The adequacy of existing display hardware and software for image interpretation was assessed. 3. The data storage requirements were estimated and monitored.

## Discussion

(1) Data transfer has proven to have a negligible workflow impact on a 10 Gbps fiber (under 7 sec for a 13 GB 2048x2048 study). However, transfer of the same study extended to 20 min on a shared 100 Mbps network. Data transfer times were under 10 sec for the 6GB 1024x1024 studies, demonstrating performance variability, particularly on shared networks. (2) A 5MP display is recommended to display a full 2048 image set at full resolution. Otherwise, clinicians must enable zoom and pan within the image slice. Anecdotally, the exams with 0.25 mm slice thicknesses are best navigated with a cine loop and a scout localizer to avoid excessive scrolling. Jerky scrolling became obstructive when viewing 2048 images on computers where caching or RAM was limited (e.g. <8 GB). (3) Within the first 2 weeks of installation, data storage remains stable despite the accelerated use of storage space due to a strategic contract with the PACS vendor.

## SSM15-06 A Real-Time Gaze Tracking System to Analyze Spatial and Temporal Attention Characteristics of Radiologists

Wednesday, Dec. 4 3:50PM - 4:00PM Room: E353B

### Participants

Oguz Akin, MD, New York, NY (*Abstract Co-Author*) Research Consultant, Ezra AI  
Yingli Tian, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Longlong Jing, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Benjamin Reichman, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Fuat Nurili, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Cihan Duzgol, MD, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Turan A. Ilica, New York, NY (*Abstract Co-Author*) Nothing to Disclose  
Omer Aras, MD, Edgewater, NJ (*Presenter*) Nothing to Disclose

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## PURPOSE

To develop a real-time attention tracking system that can handle dynamic back-and-forth scrolling through a series of images without any hardware or software intrusion while the radiologist interpreting a study.

## METHOD AND MATERIALS

The system framework was built on the Open Health Imaging Foundation's open-source medical image viewer with integration of a Tobii 4C Eye Tracking camera. Spatial and temporal coordinates of the series of images are automatically recorded and the corresponding attention heatmaps are generated. For attention and search pattern analysis, the commonly used eye-tracking metrics are analyzed including area of interest (AOI), time to first fixation, total fixation duration, fixation duration on AOI, number of fixations on AOI, dwell time ratio, and saccade length on each image. Furthermore, 3D dynamic analysis of attention characteristics are studied including total time of the scan, slice of interest (SOI), fixation duration on SOI, number of fixations on SOI, number of scrolling (scrolling back-and-forth while focusing on different areas), number of drilling (scrolling back-and-forth while focusing on one area). The system's performance was tested using the data from 4 radiologists while interpreting 30 CT studies from the LUNA16 dataset.

## RESULTS

The system successfully captured the attention data in all interpretation sessions (n=120) without any software or hardware failure. The accuracy of the gaze tracking is 0.4° which is about 3.5-7 mm on the computer screen at a distance range of 0.5-1 m between the observer and the camera. The analysis of the attention heatmaps showed spatial and temporal variations in the 3D dynamic attention characteristics of 4 radiologists, indicating unique search patterns among different observers.

## CONCLUSION

The proposed system can be used as an objective tool to study unique search patterns among human observers. These data can be further used to develop more interactive human-computer interfaces for artificial intelligence applications.

## CLINICAL RELEVANCE/APPLICATION

As artificial intelligence applications advance, there is an increasing need to develop seamless human-computer interfaces that can capture the radiologists' attention. Such systems allowing artificial intelligence algorithms to operate more interactively with the human observers in real time could significantly expedite adoption of artificial intelligence in clinical practice.

Printed on: 10/29/20



SPSC41

## Controversy Session: Contrast Agent Controversies

Wednesday, Dec. 4 4:30PM - 6:00PM Room: N228



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Douglas S. Katz, MD, Mineola, NY (*Moderator*) Nothing to Disclose  
Andrew B. Rosenkrantz, MD, New York, NY (*Moderator*) Nothing to Disclose

### For information about this presentation, contact:

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douglasscottkatzmd@gmail.com

### LEARNING OBJECTIVES

1) To discuss the pros and cons based on the current literature and clinical experience of the use of oral contrast for abdominal and pelvic CT in the emergency setting. 2) To review the current role of gadoxetate for hepatobiliary MR imaging, including the advantages and disadvantages, current protocols, and its role compared with the use of extracellular gadolinium-based MR contrast agents. 3) To review the current role of intravenous ultrasound contrast agents for abdominal and pelvic imaging, including a brief review of the current literature, clinical experience, barriers to its use, and geographic variability of its use.

### Sub-Events

#### SPSC41A Pro and Con: Use of Oral Contrast for Emergency Abdominal and Pelvic CT

##### Participants

Perry J. Pickhardt, MD, Madison, WI (*Presenter*) Stockholder, SHINE Medical Technologies, Inc; Stockholder, Elucent Medical; Advisor, Bracco Group;  
Ania Z. Kielar, MD, Shanty Bay, ON (*Presenter*) Nothing to Disclose

#### SPSC41B Cheerleader versus Realist: Use of Gadoxetate for Liver MRI

##### Participants

Bachir Taouli, MD, New York, NY (*Presenter*) Research Grant, Bayer AG; Research Grant, Takeda Pharmaceutical Company Limited; Research Grant, Regeneron Pharmaceuticals, Inc; Consultant, Alexion Pharmaceuticals, Inc; Consultant, Bayer AG; ;  
Victoria Chernyak, MD,MS, Bronx, NY (*Presenter*) Consultant, Bayer AG

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### LEARNING OBJECTIVES

1) To understand the effect of gadoxetate use on the quality of the hepatic arterial phase. 2) To review limitations of the hepatobiliary phase in patients with and without parenchymal liver disease. 3) To review challenges that gadoxetate use presents in diagnosis of hemangioma. 4) To review challenges of gadoxetate use in diagnosis of HCC and application of LI-RADS.

#### SPSC41C Use of IV Contrast for Abdominal US: Barriers/Issues and Current Literature Summary/Experience

##### Participants

Sheila Sheth, MD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Aya Kamaya, MD, Stanford, CA (*Presenter*) Royalties, Reed Elsevier; Researcher, Koninklijke Philips NV; Researcher, Siemens AG

Printed on: 10/29/20



RC613

## Pediatric Series: Pediatric Safety and Quality

Thursday, Dec. 5 8:30AM - 12:00PM Room: S502AB

MR PD SQ

AMA PRA Category 1 Credits™: 3.25  
ARRT Category A+ Credits: 4.00

### Participants

David B. Larson, MD, MBA, Stanford, CA (*Moderator*) Grant, Siemens AG Grant, Koninklijke Philips NV  
Brian D. Coley, MD, Cincinnati, OH (*Moderator*) Royalties, Reed Elsevier; Travel support, Canon Medical Systems Corporation; Travel support, Koninklijke Philips NV; Board of Directors, NeoView Ltd; Departmental Research support, Canon Medical Systems Corporation; Departmental Research support, Koninklijke Philips NV; Departmental Research Support, Siemens AG  
Marta Hernanz-Schulman, MD, Nashville, TN (*Moderator*) Nothing to Disclose  
Lynn A. Fordham, MD, Chapel Hill, NC (*Moderator*) Nothing to Disclose

### Sub-Events

#### RC613-01 MRI Safety: Risks Unique to a Pediatric Environment

Thursday, Dec. 5 8:30AM - 8:50AM Room: S502AB

### Participants

Douglas C. Rivard, DO, Kansas City, MO (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Understand unique elements of the pediatric MRI environment. 2) Review fundamentals of MRI safety. 3) Discuss how a ferro free program works and how to implement.

### ABSTRACT

no abstract

#### RC613-02 Impacts of 3.0 Tesla Magnetic Resonance Imaging Noise on Hearing Function in Children with Hearing Protection

Thursday, Dec. 5 8:50AM - 9:00AM Room: S502AB

### Participants

Huifang Zhao, Xian, China (*Presenter*) Nothing to Disclose  
Chao Jin, Xian, China (*Abstract Co-Author*) Nothing to Disclose  
Yannan Cheng, BS,BS, Xi'an, China (*Abstract Co-Author*) Nothing to Disclose  
Peiyao Chen, Xian, China (*Abstract Co-Author*) Nothing to Disclose  
Heng Liu, PhD, Xi'an, China (*Abstract Co-Author*) Nothing to Disclose  
Jian Yang, Xian, China (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

Although 3.0T MRI has been increasingly used for children, the strong noise remains a great concern. By using Distortion product OAE (DPOAE), this study aimed to investigate the effect of MRI noise on children's cochlear function.

### METHOD AND MATERIALS

131 ears of 72 patients with no hearing impairment were enrolled and underwent a 3.0T brain MRI examination (Table 1). The subjects were divided into three groups (0-1, 2-5 and 6-12 years old) according to the development of auditory system. Two DPOAE measurements were performed before MRI and the first (test1) was recorded as baseline. The third DPOAE measurement (test3) was performed within 30 minutes after MRI. DPOAE amplitudes at frequency of 1.5~9.0 kHz were recorded. All statistical analysis were performed by SPSS 18.0 (SPSS, Chicago, IL, USA);  $P < 0.05$  was considered as statistically significant difference.

### RESULTS

As for the paired t test, there was significant increase of 1.06dB at 3kHz in DPOAE amplitude following exposure to MRI noise for 0-1 years old group ( $P < 0.05$ ; Figure 1). The standard deviations (SD) of DPOAE amplitudes change between test2 and test1, between test3 and test1 were calculated. In contrast to those before MRI, the SD of DPOAE amplitudes change at frequencies of 1.5~9.0 kHz remarkably increased after MRI (Figure 2). This effect represented the increase of DPOAE amplitude variability and with a maximum effect in 6-12 age group (Figure 3).

### CONCLUSION

Our results found a subtle reaction of cochlear function in children after exposure to 3.0T MRI noise with hearing protection. And we also observed that the younger group is likely to be more sensitive to acoustic noise.

## CLINICAL RELEVANCE/APPLICATION

The effect of the MRI noise on children with immature auditory system development has thus prompted the concern of noise-induced hearing loss after MRI. Thus efficient hearing protection and noise reduction techniques are necessary to improve the safety of MRI examinations.

### RC613-03 Finding "Just right": The Goldilocks of MRI Sequences in Pediatric PET/MRI

Thursday, Dec. 5 9:00AM - 9:10AM Room: S502AB

#### Participants

Mary Ellen I. Koran, MD, PhD, Stanford, CA (*Presenter*) Nothing to Disclose  
Helen R. Nadel, MD, Palo Alto, CA (*Abstract Co-Author*) Consultant, ICON plc

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## PURPOSE

The challenge for pediatric PET/MRI is to optimize MRI sequences and PET acquisition without prolonging sedation and examination time. As yet, there are no standard protocols utilized in pediatric PET/MRI. Utilizing the 'one-stop shop' method as has been done in PET/CT with contrast enhanced CT for attenuation correction and diagnostic evaluation would undervalue the ability of specialized MRI sequences to provide additional important information based on tumor type or disease status. The goal of this study is to correlate lesion identification on multiple MRI sequences with PET imaging, with the hopes of streamlining and optimizing pediatric PET/MRI studies.

## METHOD AND MATERIALS

Over 100 known (based off of released report) lesions were categorized as visualized or not visualized on the individual images from FDG/PET, T2-weighted coronal (T2), diffusion weighted (DWI), and T1-post contrast (T1+) MRI series independently. These included staging, response assessment, and surveillance lesions of lymph nodes, lung, bone, soft tissue, and solid organ disease.

## RESULTS

Independently, FDG/PET, T1+, DWI, and T2 MRI images were able to identify 86, 73, 68, and 67 percent of the lesions. A total of 3, 4, and 5 lesions were identified on T1+, T2, and DWI MRI, respectively, and not on PET. Conversely, 14, 21, and 20 lesions were identified on PET and not on T1+, T2, and DWI MRI, respectively. T1+, T2, and DWI provided data beyond the other two MRI sequences in 23, 16, and 23 cases respectively. T2 provided information beyond that attained by the T1+ in only 3 cases.

## CONCLUSION

After analysis of our first 100 lesions, we believe that the optimal PET/MRI screening sequence would be dependent upon the type of primary tumor, with DWI adding important information for bony disease, and T2 and T1+ adding important information for nodal disease. Interestingly, the added data from T1+ and T2 overlaps, showcasing an area for improvement in MRI protocol.

## CLINICAL RELEVANCE/APPLICATION

Optimizing MRI sequences for pediatric PET/MRI acquisition is beneficial for both the child and the imaging center, in order to obtain the best diagnostic information while coupled with minimal exam time and complexity.

### RC613-04 Whole-Body Diffusion Weighted MRI Compared to 18F-FDG PET/CT in Initial Staging and Therapy Response Assessment of Hodgkin's Lymphoma in Pediatric Patients

Thursday, Dec. 5 9:10AM - 9:20AM Room: S502AB

#### Participants

Gali Shapira Zaltsberg, MD, Ottawa, ON (*Presenter*) Nothing to Disclose  
Nagwa M. Wilson, MD, PhD, Montreal, QC (*Abstract Co-Author*) Nothing to Disclose  
Maria Esther Perez Trejo, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Lesleigh Abbott, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Stephen Dinning, MD, FRCPC, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Jorge Davila, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Cassandra Kapoor, BSC, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
Barry Smith, Ottawa, ON (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

Lymphomatous lesions have low ADC values. With treatment, there is a decrease in cellularity and subsequent increased diffusion on DWI. Whole-body diffusion weighted MRI (WB-DWI-MRI) has been shown as a sensitive and specific method for assessing treatment response in adult lymphoma patients; however, numerous small studies in pediatric patients have shown inconsistent results. The aim of our study was to compare the diagnostic performance of WB-DWI-MRI to FDG-PET/CT in the assessment of initial staging and treatment response in pediatric patients with Hodgkin's lymphoma, assessing both nodal and extra-nodal disease.

## METHOD AND MATERIALS

This prospective study comprised 11 children with Hodgkin's lymphoma. WB-DWI-MRI and FDG-PET/CT were obtained prior to initiation of treatment and after completion of two cycles of chemotherapy. Two radiologists measured the ADC values of the nodal and extra-nodal sites of involvement agreed upon in consensus and one nuclear medicine physician assessed the PET/CT. Reliability of radiologists' ratings was assessed by intra-class correlation coefficients based on a two-way random model (ICC2,1). ADC ratios (defined as ADC<sub>post</sub>/ADC<sub>pre</sub>) were assessed. The SUV<sub>max</sub> at baseline and at follow-up of the nodal and extra-nodal sites considered positive was assessed. The patients were staged (based on the Ann Arbor staging system) according to both

modalities. Therapeutic response for PET/CT was based on the Lugano classification. The same size criteria used in the Lugano classification were used for therapeutic response on MRI. Since no guidelines are available for assessment of therapeutic response based on DWI, for this study, we defined ADC ratio  $< 1 - 0.2SD$  as progressive disease,  $1 - 0.2SD < ADC \text{ ratio} \leq 1 + 0.5SD$  as stable disease,  $1 + 0.5SD < ADC \text{ ratio} \leq 1 + 1.5SD$  as partial response, and  $ADC \text{ ratio} > 1 + 1.5SD$  as complete response.

## RESULTS

There was good agreement between the two raters for both nodal and extra-nodal ADC measurements. DW-MRI determined correct tumor stage in 8/11 (72.7%) examinations, underrating three patients (27.3%). Response to treatment based on DWI and PET showed concordance in all patients (100%).

## CONCLUSION

Our experience showed that WB-DWI-MRI is inferior to PET/CT for initial staging of Hodgkin lymphoma in pediatric patients, however, it has the potential to be sensitive enough to assess response to treatment in lieu of PET/CT.

## CLINICAL RELEVANCE/APPLICATION

WB-DWI-MRI can potentially be a radiation free alternative to PET/CT in assessing response to treatment of Hodgkin lymphoma in pediatric patients.

### RC613-05 Reassessing the Risk of Acute Kidney Injury After Intravenous Contrast Media Administration for CT Imaging in Children

Thursday, Dec. 5 9:20AM - 9:30AM Room: S502AB

#### Participants

Juan Calle Toro, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Bernarda Viteri, MD, Philadelphia, PA (*Abstract Co-Author*) Spouse, Employee, Bristol-Myers Squibb Company  
Ammie M. White, MD, Flourtown, PA (*Abstract Co-Author*) Nothing to Disclose  
Madhura Pradhan, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Christian A. Barrera, MD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Hansel J. Otero, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Suraj D. Serai, PhD, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

Recently, the concept of post-contrast acute kidney injury (AKI) has been challenged in the adult literature. However, there is no similar data pertaining to children. Hence, we aim to determine whether intravenous iodinated contrast administration for computed tomography (CT) in children is independently associated with increased risk for AKI by comparing the incidence of AKI in patients receiving contrast to the incidence in those that did not.

## METHOD AND MATERIALS

This IRB approved HIPAA-compliant retrospective cohort analysis was performed at a large, urban, academic stand-alone children's hospital. From January 2008 to January 2018 all children in whom creatinine levels were available before and within 48 hours after undergoing CT with or without contrast. The primary outcome was the incidence of AKI according to the Acute Kidney Injury Network (AKIN) definition and the "Kidney Disease: Improving Global Outcomes" (KDIGO) guidelines. Patients with history of renal disease or dysfunction prior to CT were excluded. Odds ratios were calculated between groups and within group controlling for gender, age and weight.

## RESULTS

Of over 54,000 CT studies during the study period, 19,441 studies were included in the analysis; 8,872 (45.6%) studies used contrast and the remaining 10,569 (54.4%) did not. The incidence of AKI using the AKIN definition was 25% in the contrast group vs. 34% in the non-contrast group ( $p 0.09$ ). According to the KDIGO guidelines the incidence of AKI was 7% in the contrast group vs. 11% in the non-contrast group ( $p 0.17$ ). We found no significant difference in the OR when comparing groups (OR 1.3, CI 95% 0.9-1.4,  $p 0.17$ ) nor when stratified by gender, age and weight.

## CONCLUSION

In agreement with recent adult literature, we found that intravenous iodinated contrast was not associated with an increased incidence of AKI in children.

## CLINICAL RELEVANCE/APPLICATION

Recently, the concept of post-contrast acute kidney injury (AKI) has been challenged in the adult literature. However, there is no similar data pertaining to children. Here we found no association of contrast with AKI.

### RC613-06 Risk Factors of Post-Contrast Acute Kidney Injury: A Retrospective Study in Pediatric Patients

Thursday, Dec. 5 9:30AM - 9:40AM Room: S502AB

#### Participants

Liya Ma, MD, Wuhan, China (*Presenter*) Nothing to Disclose  
Zhen Li, MD, PhD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Yaqi Shen, PhD, MD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
Xuemei Hu, MD, Wuhan, China (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

To investigate risk factors of post-contrast acute kidney injury (PC-AKI) in pediatric patients and the correlation between PC-AKI and age.

## METHOD AND MATERIALS

We performed a retrospectively study of inpatients under 18 years. CT examinations, serum creatinine (SCr) values and clinical information of each subject was searched. Then 1:1 matching of PSM (propensity score matching) was performed on risk factors between enhanced and unenhanced group, and age stratification of PC-AKI was performed. Two kinds of threshold of PC-AKI was used: an increase in SCr by more than 25% or 44  $\mu\text{mol/L}$  (named CIN, contrast-induced nephropathy), or 50% or 44  $\mu\text{mol/L}$  (named AKI, acute kidney injury). The incidence of AKI/CIN before and after matching was analyzed between two groups and among different age groups.

## RESULTS

A total of 1380 cases were extracted (1081 and 299 cases in unenhanced and enhanced group respectively). 524 cases were obtained by 1:1 PSM, 262 cases in the two group respectively. After matching, the distribution of propensity score between the two groups was more similar (Figure 1). Before matching, risk factors were statistically different between two groups, including age, congenital heart disease, renal tumor, renal surgery, heart surgery, and chemotherapy, and after matching there was no significant difference in all risk factors. The total incidence of CIN and AKI before matching was 1.2% (1.1% in unenhanced group, 1.7% in enhanced group) and 6.8% (7.4% in unenhanced group, 4.7% in enhanced group) respectively, both without significant difference. After matching, the incidence of total CIN was 1.3% (1.1% in the unenhanced group, 1.4% in enhanced group) and AKI was 5.9% (7.3% in unenhanced group, 4.6% in enhanced group), also without significance. Several risk factors, such as congenital heart disease and cardiac surgery was positive correlated with CIN, and urinary calculus was negative correlated with AKI. There was no significant difference in the incidence of PC-AKI among different age groups.

## CONCLUSION

For pediatric inpatients, some risk factors (congenital heart disease, cardiac surgery, urinary calculus) may have correlation with PC-AKI. The use of iodinated contrast agent did not have correlation with PC-AKI. There was no significance in the incidence of PC-AKI among age groups.

## CLINICAL RELEVANCE/APPLICATION

The use of iodinated contrast agent is safe in CT examination of pediatric patients.

## RC613-07 Providing Expert Pediatric Teleradiology Services Around the Globe: The World Federation of Pediatric Imaging Experience

Thursday, Dec. 5 9:40AM - 9:50AM Room: S502AB

### Participants

Hansel J. Otero, MD, Philadelphia, PA (*Presenter*) Nothing to Disclose  
Daphine C. Grassi, MD, Barueri, Brazil (*Abstract Co-Author*) Nothing to Disclose  
Savvas Andronikou, MBBS, Philadelphia, PA (*Abstract Co-Author*) Nothing to Disclose  
Cicero J. Silva, MD, New Haven, CT (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To descriptively analyze the utilization, case characteristics, and referrers' opinion of a pediatric-specific teleradiology portal for low- and middle income countries.

## METHOD AND MATERIALS

This is a retrospective analysis of all cases referred to the WFPI pro-bono second-opinion teleradiology service between October 2014 and October 2018. Basic case and patient characteristics as well as feedback on usefulness and satisfaction from referrers.

## RESULTS

A total of 668 cases (352 boys, 316 girls) with a median age 1 year 4 months (range 1 day - 18 years) were reviewed over a period of 4 years by a team of 45 volunteer pediatric radiologists. The majority (n=548) of the cases came from a single referral center (Lao Friends Hospital for Children, 82%); while the remaining 120 cases came from nine additional centers, distributed among Asia (6.7%), Africa (87.5%) and The Americas (5.8%). The median delay between receiving the case and its allocation to a radiologist was 0.73 hours (IQR: 0.26-1.87 hours). The median time delay to the first radiologist response was 5.53 hours (IQR: 2.14- 13.19 hours). The most common imaging modality submitted for interpretation was radiography (n=559, 83.7%), followed by computed tomography (n=78, 11.7%), ultrasound (n=58, 8.7%) and MRI (n=5, 0.7%). Referrers provided feedback on 94 cases (14.1%), which was overwhelmingly positive

## CONCLUSION

Teleradiology offers a viable and well received option in centers with access to imaging but limited access to pediatric radiology expertise from around the world with reasonable delays in terms of time to first radiologist's response

## CLINICAL RELEVANCE/APPLICATION

The WFPI pediatric teleradiology platform provides pediatric radiology expertise, offering services among a wide range of modalities and from a variety of international referring institutions.

## RC613-08 Strategies to Reduce Pediatric MRI Scan Time and Sedation

Thursday, Dec. 5 9:50AM - 10:10AM Room: S502AB

### Participants

Michael S. Gee, MD, PhD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify strategies to reduce MRI scan time in children. 2) Develop strategies to decrease the use of sedation/anesthesia in pediatric MRI.

### ABSTRACT

None.

## RC613-09 Tools for Successful and Sustainable Quality Improvement Projects

Thursday, Dec. 5 10:20AM - 10:40AM Room: S502AB

### Participants

Lane F. Donnelly, MD, Palo Alto, CA (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) To learn key tools, processes, and key drivers to increase the likelihood of success for improvement projects.

## RC613-10 Children are Not Small Adults: Assessment of ACR TI-RADS in Pediatric Thyroid Nodules

Thursday, Dec. 5 10:40AM - 10:50AM Room: S502AB

### Participants

Danielle M. Richman, MD, MS, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Carol B. Benson, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Peter M. Doubilet, MD, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Elizabeth Asch, MD, Winchester, MA (*Abstract Co-Author*) Nothing to Disclose

Ari Wassner, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

Jessica Smith, MD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose

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### PURPOSE

To assess the reliability of the American College of Radiology (ACR) Thyroid Imaging, Reporting and Data System (TI-RADS) criteria, designed for use in adults, for guiding decisions whether or not to biopsy thyroid nodules in pediatric patients.

### METHOD AND MATERIALS

We determined the ACR TI-RADS score of each thyroid nodule in our database of patients <19 years of age who underwent ultrasound-guided fine needle aspiration (FNA) between January 2004 and July 2017. For each nodule, we determined whether the TI-RADS criteria would have led to a recommendation to biopsy, follow, or not follow the nodule.

### RESULTS

There were 404 thyroid nodules in 314 patients in our database, and 77 of the nodules (19.1%) were malignant. The majority of cancers were papillary carcinoma (68/77, 88.3%). Among the 77 cancers, 64 (83.1%) cancers had a TI-RADS score in the moderately suspicious category 4 or highly suspicious category 5. Based on TI-RADS criteria, only 60 of the 77 malignant nodules (77.9%) would have undergone FNA, while 10 of 77 (13.0%) would have been assigned follow-up without FNA, and 7 of 77 (9.1%) would have had neither follow-up or FNA. Of the 7 cancers that would have had no follow up, 2 nodules were scored as benign TI-RADS category 1, 4 as not suspicious category 2, and 1 as mildly suspicious category 3. Of the 10 cancers that would have been followed, 1 scored as mildly suspicious category 3, 4 as moderately suspicious category 4 but too small for FNA, and 5 as highly suspicious category 5 but too small for FNA.

### CONCLUSION

The use of ACR TI-RADS criteria in our pediatric thyroid nodules would have resulted in a high percentage (22.1%) of cancers not biopsied at initial visit, including a high percentage (9.1%) of cancers missed entirely (not biopsied or followed up). This suggests that ACR TI-RADS is not reliable for guiding decisions in pediatric patients.

### CLINICAL RELEVANCE/APPLICATION

To determine whether management of pediatric thyroid nodules by the ACR TI-RADS criteria would affect the timely diagnosis of cancer.

## RC613-11 Potential Cost Implications of a Clinical Decision Support System on Emergency CT Head Examinations at a Quaternary Pediatric Hospital

Thursday, Dec. 5 10:50AM - 11:00AM Room: S502AB

### Participants

Shireen Hayatghaibi, MA, MPH, Houston, TX (*Presenter*) Nothing to Disclose  
Varsha Varghese, Houston, TX (*Abstract Co-Author*) Nothing to Disclose  
Andrew Sher, MD, Houston, TX (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To determine the cost implications using time-driven activity-based costing for CT Head examinations ordered from the Emergency Center and graded as 'usually not inappropriate' by a commercially available Clinical Decision Support (CDS) tool.

### METHOD AND MATERIALS

CT head without contrast is the most commonly ordered CT examination from our pediatric Emergency Department. Following the implementation of a CDS tool (CareSelect; National Decision Support Co., Madison, WI) into the EHR, all CT examinations from September 18, 2018 through February 28, 2019 received a score based on appropriateness as per the ACR Appropriate Use Criteria. Orders were scored with the following scale: 1-3: usually not appropriate, 4-6: may be appropriate, and 7-9: usually appropriate. The CDS tool was run in silent mode (i.e. without displaying appropriateness grades to ordering providers). A micro-costing assessment was subsequently conducted on CT Head examinations receiving a grade of 1-3 using time-driven activity-based costing (TDABC). Process maps were created through shadowing 20 encounters and EHR time-stamp review of 150 patient records. Capacity cost rates for personnel, equipment, facilities, and supplies were established from institutional accounting data. The cost of each process step was determined by multiplying step-specific capacity cost rates by the mean time required to complete the step. Total pathway cost was computed by summing the costs of all steps through the process pathway.

### RESULTS

Of 1877 CT examinations ordered from the EC, 24% (445/1877) were scored 'usually not appropriate'; CT Head without contrast studies accounted for 76% (339/445) of these examinations. Utilizing TDABC, the mean total CT pathway time for a CT Head without contrast was calculated to be 42 minutes and the mean total cost of the examination was \$198 (Figure 1). Based on the 339 CT Head without contrast examinations that were graded as 'usually not appropriate', the potential cost savings extrapolated annually amounts to \$134,244.

### CONCLUSION

Implementation of a clinical decision support tool may have significant utilization effects on imaging studies ordered from pediatric emergency departments and result in substantial cost savings.

### CLINICAL RELEVANCE/APPLICATION

As reimbursement models transition to value-based health care, implementation of CDS to determine appropriate imaging utilization may assist in deriving high value health care.

## RC613-13 Dose Line Integral (DLI) for Tracking Cumulative Dose from Multiple Multi-Sequence CT Exams with Tube Current Modulation in Children

Thursday, Dec. 5 11:10AM - 11:20AM Room: S502AB

### Participants

Azadeh Tabari, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Xinhua Li, PhD, Boston, MA (*Abstract Co-Author*) Spouse, Employee, Juniper Pharmaceuticals; Employee, Constellation Pharmaceuticals  
Kai Yang, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Bob Liu, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Michael S. Gee, MD, PhD, Boston, MA (*Abstract Co-Author*) Nothing to Disclose  
Sjirk J. Westra, MD, Boston, MA (*Presenter*) Nothing to Disclose

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### PURPOSE

We introduce Dose Line Integral (DLI), a new metric that allows adding radiation dose in children undergoing multiple multi-series CT scans obtained with tube current modulation (TCM) with different z-axis coverage

### METHOD AND MATERIALS

Our institutional review board approved study included children in four different age categories who underwent multiple CT (3-5) of the abdomen on various scanner platforms within 1 year from 2017-2018. All patients were scanned with fixed kV and TCM. In each series, mA was recorded for each slice to evaluate the cross-sectional average dose along the z-axis. With a multi-series examination, the dose at each z-location was accumulated over all acquisition series. This method was applied to 13 clinical CT examinations (16 acquisition, patient age; 0-1 (n=2), 5-6 (n=2), 10-11 (n=4), 15-16 (n=5) yrs-old). DLI profile of each acquisition was compared with conventional dose parameters CTDIvol, and SSDE, and the sum of all recorded doses as a function of z-axis location was compared with DLP

### RESULTS

We generated a graphic display of mA and dose as a function of the z-axis location for each acquisition series and for the whole exam. Differences ranging from 32.4% (23.1 vs 7.5 mGy) and 48.3% (25.1 vs 12.1 mGy) were observed between the maximum value of the accumulated dose profile and the conventional CTDIvol and SSDE, respectively. The sum of all DLIs per patient exceeded the sum of all DLPs by an average of more than 100% (438,94,564,1057 mGy.cm vs 148,39,273 and 545 mGy.cm, respectively)

## CONCLUSION

The graphic overall dose profile gives a complete description of z-axis dose distribution for the studied CT examinations under a wide range of patient variables and acquisition conditions, including multiple acquisition series. Visualization of the dose profiles across and beyond the scan ranges provided a more valid tool for CT dose optimization than simple arithmetic summations of CTDIvol, SSDE and DLP

## CLINICAL RELEVANCE/APPLICATION

We present a new way to calculate cumulative doses from multiple multi-phase CT scans obtained with tube current modulation, which better satisfies legal requirements and serves as a tool for individual long term dose monitoring in children

### RC613-14 Impact of Patient Off-Centering on Organ Radiation Doses in Pediatric CT of the Head and Trunk

Thursday, Dec. 5 11:20AM - 11:30AM Room: S502AB

#### Participants

Andre Euler, MD, Zurich, Switzerland (*Presenter*) Nothing to Disclose  
Natalia Saltybaeva, PhD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose  
Hatem Alkadhi, MD, Zurich, Switzerland (*Abstract Co-Author*) Nothing to Disclose

## PURPOSE

To assess the impact of patient positioning on organ dose of head and trunk CT in a pediatric phantom.

## METHOD AND MATERIALS

An anthropomorphic phantom simulating a 5-year-old child was used. Semiconductor dosimeters were placed in various organs of the head and trunk. CT of the head and trunk using automatic tube current modulation (ATCM) and default bowtie filters were performed. The phantom was imaged repeatedly at vertical table positions ranging from -6 to +6 cm from the 0-position. Tube current time products, organ doses, and image noise were recorded. Scatter radiation was measured in the thyroid for head CT. The effect of ATCM and bowtie filters was assessed.

## RESULTS

Depending on patient position, organ doses differed up to 22% for the supratentorial brain, 34% for the infratentorial brain, 19% for the eyes, 28% for the lungs, 25% for the stomach, and 22% for the liver compared to the 0-position. The relation between position and dose was linear and mainly affected by the bowtie filter in head CT while it was quadratic and affected by ATCM and bowtie filter in trunk CT. It further depended on the relative position of each organ to the isocenter. Image noise was inversely related to organ dose. Scatter radiation in the thyroid was not significantly related to patient position ( $P=0.21$ ).

## CONCLUSION

In pediatric CT, vertical patient positioning had a substantial impact on radiation dose with differences of up to 34%. This effect depended on the body region and location of each individual organ.

## CLINICAL RELEVANCE/APPLICATION

Proper patient positioning is crucial in the pediatric population to avoid unintended irradiation of radiosensitive organs.

### RC613-15 Accurate Camera-Based Positioning of Pediatric Patients Undergoing Chest, Abdominal and Pelvic CT Examinations

Thursday, Dec. 5 11:30AM - 11:40AM Room: S502AB

#### Participants

Marilyn J. Siegel, MD, Saint Louis, MO (*Abstract Co-Author*) Speakers Bureau, Siemens AG Spouse, Consultant, General Electric Company  
Juan Carlos Ramirez-Giraldo, PhD, Cary, NC (*Abstract Co-Author*) Employee, Siemens AG  
Philipp Hoelzer, PhD, DIPL ENG, Malvern, PA (*Presenter*) Employee, Siemens AG

## PURPOSE

To compare vertical isocenter offsets and its impact on radiation exposure of manually versus automated 3d-camera-based positioning for pediatric body CT exams

## METHOD AND MATERIALS

In this retrospective, IRB approved study, vertical isocenter offsets and radiation exposures of pediatric patients undergoing body CT exams (chest, abdomen-pelvis, and chest-abdomen-pelvis) between Nov 2, 2018 and February 20, 2019 were retrospectively analyzed using dose tracking software. The patient cohort included CT exams of a total of 413 patients ranging from 3 years to 24 years. Automatic positioning was achieved with the help of a 3d camera (FAST 3D Camera, Siemens) that captures the depth profile of the patient lying on the patient bed and through an Artificial Intelligence algorithm automatically adjusts the table vertically. Patient's effective diameter (in mm), isocenter offset (in mm) and, CTDIvol (in mGy) were recorded. Patients were categorized as either manually or automatically positioned with the 3d camera. Unpaired statistical comparisons were performed.

## RESULTS

A total of 33 patients were automatically positioned with the camera, while the other 380 patients were positioned manually. The isocenter offset was smaller for patients automatically positioned with the camera with a median [25th to 75th quartile] -0.6 [-4.2 to 4.2] mm versus manually positioned patients with -10.9 [-21.9 to -2.2] mm ( $P? 0.05$ ).

## CONCLUSION

The use of the 3d camera significantly reduced patient off-centering in the vertical direction for pediatric CT examinations of the body.

#### **CLINICAL RELEVANCE/APPLICATION**

Our results suggest that 3d-camera based positioning can lead to consistent patient centering that is expected to reduce variability in radiation exposure and image quality in pediatric body CT examinations. Future studies with larger sample sizes should look into the impact of the camera on radiation exposure and image quality.

#### **RC613-16 Engaging Patients and Families in Pediatric Radiology**

Thursday, Dec. 5 11:40AM - 12:00PM Room: S502AB

Participants

Nadja Kadom, MD, Atlanta, GA (*Presenter*) Nothing to Disclose

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#### **LEARNING OBJECTIVES**

1) Identify opportunities for patient engagement in pediatric radiology. 2) Develop patient-centered initiatives in pediatric radiology.

#### **ABSTRACT**

n/a

Printed on: 10/29/20



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### ASRT@RSNA 2019: CT Dose Awareness and Reduction

Thursday, Dec. 5 9:15AM - 10:15AM Room: N230B



AMA PRA Category 1 Credit™: 1.00  
ARRT Category A+ Credit: 1.00

#### Participants

Jia Wang, PhD, Stanford, CA (*Presenter*) Nothing to Disclose

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#### LEARNING OBJECTIVES

1) To learn the basic CT acquisition factors that can affect CT Dose. 2) To learn CT dose reduction techniques, including automatic exposure control, tube current modulation, iterative reconstruction and more. 3) To learn regulatory requirements on CT dose management and tools to help monitor and raise awareness of CT dose for patient safety.

Printed on: 10/29/20



SSQ19

## Physics (Deep Learning - Dose Reduction and Image Quality)

Thursday, Dec. 5 10:30AM - 12:00PM Room: E353B

AI CT PH SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

FDA Discussions may include off-label uses.

### Participants

Lubomir M. Hadjiiski, PhD, Ann Arbor, MI (*Moderator*) Nothing to Disclose  
Patrick J. La Riviere, PhD, Chicago, IL (*Moderator*) Research funded, Canon Medical Systems Corporation; Research funded, Accuray Incorporated; Research Consultant, MetriTrack, Inc

### Sub-Events

#### SSQ19-01 Radiation Dose Reduction for CT Assessment of Urolithiasis Using Deep Learning Reconstruction Algorithm: A Prospective Intra-Individual Study

Thursday, Dec. 5 10:30AM - 10:40AM Room: E353B

### Participants

Xiaohu Li, MD, Hefei, China (*Presenter*) Nothing to Disclose  
Jiaying Li, Beijing, China (*Abstract Co-Author*) Employee, General Electric Company  
Huayang Liu, MD, Beijing, China (*Abstract Co-Author*) Employee, General Electric Company  
Yongqiang Yu, MD, Hefei, China (*Abstract Co-Author*) Nothing to Disclose

### PURPOSE

To assess the performance of ASIR-V and Deep learning reconstruction algorithm(DL) in patients with urolithiasis at ultralow-dose CT

### METHOD AND MATERIALS

13 patients scheduled for unenhanced abdominal CT for follow-up of urolithiasis were prospectively included. Routine dose acquisition was followed by two low-dose acquisitions at 60% and 90% reduced doses. All images were reconstructed with FBP, ASIR-V and DL. Urolithiasis detection rates, gall bladder, appendix and rectosigmoid evaluation and overall subjective image quality were evaluated by two observers.

### RESULTS

52 stones were present in 13 patients. 65% stones were not detected on FBP at the lowest dose level, but this improved with DL to a sensitivity of 100%. ASIR-V resulted in a slight decrease in sensitivity at the lowest dose to 82 %, but out performed FBP. Evaluation of other structures with ASIR-V at 60% and with DL at 90% dose reductions was comparable to FBP at routine dose, but 80% and 90% dose reduction resulted in non-evaluable images.

### CONCLUSION

CT radiation dose for urolithiasis detection can be safely reduced by 60(ASIR-V)-90(DL)% without affecting assessment of urolithiasis, possible extra-urinary tract pathology or overall image quality.

### CLINICAL RELEVANCE/APPLICATION

The most frequent cause of acute flank pain is urolithiasis, which affects 3-5% of the population. Technical advancements like iterative reconstruction (IR) algorithms have resulted in substantial radiation dose reductions. IR results in reduced noise, allowing acquisition of images at reduced radiation dose levels without intrinsically hampering image quality.

#### SSQ19-02 Radiation Dose Reduction in Chest CT at a Micro-Dose (mD) Level by Noise Simulation and Noise-Specific Anatomic Neural Network Convolution (NNC) Deep-Learning (DL) with K-Means Clustering

Thursday, Dec. 5 10:40AM - 10:50AM Room: E353B

### Participants

Yuji Zhao, MSc, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Amin Zarshenas, MSc, Chicago, IL (*Abstract Co-Author*) Nothing to Disclose  
Toru Higaki, PhD, Hiroshima, Japan (*Abstract Co-Author*) Nothing to Disclose  
Kazuo Awai, MD, Hiroshima, Japan (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation; Research Grant, Hitachi, Ltd; Research Grant, Fujitsu Limited; Research Grant, Bayer AG; Research Grant, DAIICHI SANKYO Group; Research Grant, Eisai Co, Ltd;  
Kenji Suzuki, PhD, Chicago, IL (*Presenter*) Nothing to Disclose

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## PURPOSE

Radiation dose reduction in chest CT is highly demanded since current radiation dose is high for lung cancer screening. Our purpose was to develop new noise-specific 3D NNC DL experts by means of K-means clustering with mDCT simulation to convert mDCT to 'virtual' high-dose (HD) CT where noise and artifacts are significantly reduced.

## METHOD AND MATERIALS

We developed a mixture of noise-specific, anatomical NNC experts, employing volume-based neural network regression in a convolutional manner, with soft-gating layers to convert mDCT to HD-like CT. We trained 9 noise-specific, anatomical NNC models for 3 noise-specific clusters in 3 anatomic areas by means of K-means clustering. We trained our NNCs with simulated mDCT as input and corresponding HDCT (120 kVp, 92 mAs, 3.0 mSv) from our diagnostic CT database as 'teaching' images. Our mDCT simulation consisted of forward-projection of HDCT, addition of photons and electric noise to sinogram images, filtered back-projection of the noise component, and addition of the noise image to the original HDCT. Through training, our noise-specific, anatomical NNCs learned to convert lower-dose CT to HD-like CT, where noise and artifacts are substantially reduced; thus, termed 'virtual' HD (VHD) CT. To evaluate the performance, we collected mD (120 kVp, 5 mAs, 0.2 mSv) and full-dose (120 kVp, 50 mAs, 2.0 mSv) CT (Aquilion One, Toshiba, Japan) of 50 clinical cases including 30 cases with solid nodule and ground-glass (GG) nodule.

## RESULTS

Our new VHD technology with clustering converted mDCT to 'virtual' HDCT and improved the image quality by reducing noise and artifacts substantially, while anatomic structures and pathological characteristics of both solid and GG nodules were well preserved. With our NNCs trained with simulated mDCT, contrast-to-noise-ratio (CNR) of mDCT of clinical cases was improved from  $4.1\pm 3.9$  dB to  $22.9\pm 3.4$  dB, which was also higher than that of 'reference-standard' full-dose CT (CNR:  $13.4\pm 5.1$  dB).

## CONCLUSION

Our noise-specific anatomical NNC models trained with simulated mDCT images was able to convert thin-slice mDCT of clinical cases to VHDCT that have higher image quality (in terms of CNR) than 'reference-standard' full-dose CT, achieving 90% dose reduction.

## CLINICAL RELEVANCE/APPLICATION

Substantial reduction of radiation dose in CT by our new noise-specific VHD technology would potentially make mDCT screening possible, and it would be beneficial to screening population.

## SSQ19-03 A Deep-Learning-Based Framework for Synthesizing Virtual CT Exams in the Image Domain

Thursday, Dec. 5 10:50AM - 11:00AM Room: E353B

### Participants

Hao Gong, PhD, Rochester, MN (*Presenter*) Nothing to Disclose

Shuai Leng, PHD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

Joel G. Fletcher, MD, Rochester, MN (*Abstract Co-Author*) Grant, Siemens AG; Consultant, Medtronic plc; Consultant, Takeda Pharmaceutical Company Limited; Grant, Takeda Pharmaceutical Company Limited; ;

Cynthia H. McCollough, PhD, Rochester, MN (*Abstract Co-Author*) Research Grant, Siemens AG

Lifeng Yu, PhD, Rochester, MN (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

To develop a deep convolutional-neural-network (CNN) based framework to synthesize virtual patient CT exams having varying lesion characteristics and simulating varying radiation dose levels.

## METHOD AND MATERIALS

The developed framework consists of a lesion-insertion CNN (CNNLesion) and a noise-insertion CNN (CNNNoise). Both CNNs were implemented with in-house-developed network architectures. CNNLesion inserts lesions into different locations of patient images by fusing multi-scaled features of patient lesion models with anatomical background. A cohort of lesion-free abdominal CT patient cases (n=10) was used to generate training data and validate CNNLesion. A previously-validated projection-based lesion insertion technique was used to generate reference images across 10 conditions: lesion sizes 5 - 11 mm, contrast levels 15 - 25 HU, and reconstruction types (filtered-backprojection and iterative reconstruction). CNNNoise used routine dose CT images and white noise as inputs to synthesize image noise magnitude and texture at lower dose levels. The architecture of CNNNoise approximates the underlying noise correlation in CT images. The loss function of CNNNoise consisted of a perceptual loss, a frequency-spectrum loss, and a diversity loss. Patient cases from the NIBIB/AAPM Low Dose CT Grand Challenge and water phantom scans were used to train and validate CNNNoise.

## RESULTS

The CNNLesion-synthesized lesion-present images showed strong perceptual similarity compared to the reference images. The mean structural similarity index and the mean absolute CT number difference between the CNNLesion-inserted lesions and the reference were  $0.983\pm 0.004$  and  $1.9\pm 0.3$  HU, respectively. The CNNNoise-synthesized low-dose images had comparable noise texture to that of the reference images. The mean absolute percent difference of noise measured in the liver parenchyma was <3%. The noise power spectra measured from CNNNoise-synthesized water phantom scans were very close to those from real scans (mean absolute difference <  $1.1$  HU $^2$ cm $^2$ ).

## CONCLUSION

The developed deep CNN-based framework accurately and efficiently synthesized virtual patient CT exams with prescribed lesion characteristics and radiation dose levels.

## CLINICAL RELEVANCE/APPLICATION

The developed CNN-based method can accurately and efficiently create patient cases with known pathology and dose to perform virtual clinical trials in CT for radiation dose and protocol optimization.

## SSQ19-04 Nonlinear Analysis of Machine Learning in CT Image Formation

Thursday, Dec. 5 11:00AM - 11:10AM Room: E353B

### Participants

Grace J. Gang, PHD, Baltimore, MD (*Presenter*) Nothing to Disclose  
Xueqi Guo, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Cheng Ting Lin, MD, Baltimore, MD (*Abstract Co-Author*) Nothing to Disclose  
Joseph W. Stayman, PhD, Baltimore, MD (*Abstract Co-Author*) Research Grant, Canon Medical Systems Corporation; Research Grant, Carestream Health, Inc; Research Grant, Elekta AB; Research Grant, Fischer Medical; Research Grant, Medtronic plc; Research collaboration, Koninklijke Philips NV; Research collaboration, Varex Imaging Corporation; Research Grant, Siemens AG; Research Grant, General Electric Company;

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### PURPOSE

The proliferation of nonlinear machine learning algorithms poses significant challenges to image quality assessment. Performance characterization typically relies on qualitative 'beauty contests' or metrics like resolution and structural similarity which may not relate to diagnostic outcome. We propose a quantitative image quality metric for nonlinear algorithm analysis and present example applications in a neural network denoising algorithm in low dose CT imaging of the lung.

### METHOD AND MATERIALS

We propose perturbation response analysis as a quantitative measure of image quality suitable for general nonlinear algorithms. Perturbation response is defined as the difference in the mean output between an image with a stimulus and an image without. Such analysis captures the various dependencies of the algorithms, including that on the stimulus itself. We performed the analysis for an example denoising algorithm based on a convolutional neural network. For stimuli inputs, we developed procedurally generated lesions to systematically sample ranges of clinically relevant features, including size, contrast, and spiculation characteristics. The lesions were inserted into the projection data and propagated through the imaging chain.

### RESULTS

The perturbation response for FBP reconstruction exhibits linear behavior. The denoising algorithm is effective in reducing noise in the image. However, perturbation response analysis reveals highly nonlinear behavior on the lesion stimuli. Spherical lesions of lower contrast may disappear completely (for contrast at  $\sim 0.001$  mm<sup>-1</sup>) or appear at the right contrast but smaller in size (for contrast at  $\sim 0.005$  mm<sup>-1</sup>). Lesions with thinner and shorter spiculations can appear with smooth boundaries. These results allow quantitative characterization that identify the range of lesion features that cannot be admitted or faithfully represented by the algorithm.

### CONCLUSION

We applied perturbation response analysis in identifying the performance limits of an algorithm in terms of lesion contrast, size, and spiculation. This work provides a quantitative method for characterizing the performance of nonlinear algorithms in relation to clinically relevant features.

### CLINICAL RELEVANCE/APPLICATION

This work provides an image quality analysis method that is generally applicable to nonlinear image processing. The analysis allows quantitative image quality assessment and can be used to guide algorithm development.

## SSQ19-05 Quantitative Comparison of a Deep Learning-Based CT Reconstruction Algorithm (AiCE) to Other Reconstruction Techniques

Thursday, Dec. 5 11:10AM - 11:20AM Room: E353B

### Participants

Samuel L. Brady, PHD, Cincinnati, OH (*Presenter*) Nothing to Disclose  
Elanchezhian Somasundaram, Cincinnati, OH (*Abstract Co-Author*) Nothing to Disclose  
Andrew T. Trout, MD, Cincinnati, OH (*Abstract Co-Author*) Author, Reed Elsevier; Author, Wolters Kluwer nv; Research Grant, Canon Medical Systems Corporation; Board Member, Joint Review Committee on Educational Programs in Nuclear Medicine Technology; Speakers Bureau, Reed Elsevier; Speakers Bureau, iCME  
Jonathan R. Dillman, MD, MSc, Cincinnati, OH (*Abstract Co-Author*) Research Grant, Siemens AG; Research Grant, Guerbet SA; Travel support, Koninklijke Philips NV; Research Grant, Canon Medical Systems Corporation; Research Grant, Bracco Group

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### PURPOSE

To compare, in pediatric patients, a deep learning-based (DL) CT reconstruction algorithm (AiCE) to filtered back projection (FBP), statistical-based (AIDR3D), and model-based iterative (FIRST) reconstruction algorithms at different contrast levels and object sizes using quantitative image analysis.

### METHOD AND MATERIALS

Patient raw image data acquired on a Genesis CT scanner (Canon Medical Systems) were reconstructed axially using FBP, AIDR3D, FIRST, and AiCE at 0.5mm and 3mm thicknesses. AiCE used a Deep Convolutional Neural Network (DCNN) in the regularization term of its iterative reconstruction algorithm. The DCNN was trained to differentiate signal from noise to reduce noise in the image. A non-prewhitening matched observer model with eye filter (d'NPWE) was used to characterize the signal-to-noise ratio (SNR) of objects of varying sizes (1-10mm) at three different CT contrast levels (-100, 100, & 350HU). To calculate d'NPWE, a Task Transfer Function for each reconstruction algorithm and contrast level was calculated using a water phantom with sensitometry inserts. A power spectrum was calculated by sampling noise characteristics from uniform regions of the patients' liver parenchyma.

Object signal differentiation due to reconstruction algorithm was estimated by calculating the area under the curve (AUC). AUC results for FBP, FIRST, and AiCE were normalized to AIDR3D, the routinely clinically employed reconstruction algorithm for this scanner.

## RESULTS

Power spectrum magnitude for 3mm AiCE images were an average 58% lower (range: 45-70%) than 3mm AIDR3D images. Power spectrum frequency content of AiCE agrees to better than 28% with AIDR3D compared to 50% for FIRST. On average, AiCE 3mm images demonstrated greater distinction for all object sizes and contrast levels than all other algorithms. AiCE 0.5mm SNR agreed with 3mm AIDR3D to better than 0.4%.

## CONCLUSION

Analysis demonstrates substantial improvement of object signal detection and noise magnitude using DL CT reconstruction (AiCE) leading to less noisy images with noise texture comparable with AIDR3D. Noise magnitude of AiCE 0.5mm images is comparable to AIDR 3mm images showing substantial dose reduction potential of AiCE.

## CLINICAL RELEVANCE/APPLICATION

Deep learning-based CT reconstruction (AiCE) improves image signal detection of objects down to 1 mm in diameter at all contrast levels with the potential to substantially reduce dose without compromising image quality.

### SSQ19-06 The Image Quality of the Newest Deep Learning Image Reconstruction on Chest CT

Thursday, Dec. 5 11:20AM - 11:30AM Room: E353B

#### Participants

Akinori Hata, MD, Suita, Japan (*Presenter*) Support, Canon Medical Systems Corporation  
Masahiro Yanagawa, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Yuriko Yoshida, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Tomo Miyata, MD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Osamu Honda, MD, PhD, Amagasaki, Japan (*Abstract Co-Author*) Nothing to Disclose  
Noriyuki Tomiyama, MD, PhD, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose  
Noriko Kikuchi, Suita, Japan (*Abstract Co-Author*) Nothing to Disclose

#### PURPOSE

To assess the image quality of the newest deep learning image reconstruction (DLIR) on chest CT in comparison with filtered back projection (FBP) and iterative reconstruction (IR).

#### METHOD AND MATERIALS

Thirty-six patients were evaluated retrospectively. All patients underwent routine contrast enhanced CTs (Revolution CT, GE Healthcare, WI) and images with 0.625-mm slice thickness were reconstructed using FBP, hybrid IR (ASiR-V), and DLIR (Truefidelity, GE Healthcare). The three settings of DLIR (low, medium, and high) and ASiR-V 60% were used. Regions of interest were placed at the axillary fat and the pectoralis major muscle, and the standard deviation (SD), the signal-to-noise ratio (SNR), and the contrast-to-noise ratio (CNR) were calculated objectively on the five image sets (FBP, ASiR-V, DLIR-low, DLIR-med, and DLIR-high). Two independent radiologists evaluated ASiR-V, DLIR-low, DLIR-med, and DLIR-high comparing with FBP on a 5-point scale (1=worst<2<3<4<5=best) in terms of noise, streak artifact, the visibility of lymph nodes, the clarity of small vessels in the chest wall, and overall image quality on mediastinum window setting (width 400 HU; level 60 HU). The objective parameters were analyzed statistically using one-way repeated measures ANOVA and the post hoc Tukey-Kramer test. The subjective scores were analyzed using the Wilcoxon signed-rank test with the Bonferroni correction.

## RESULTS

DLIR-high significantly showed the least SD and the largest SNR and CNR among the reconstructions ( $p < 0.001$ ). The higher the DLIR setting, the lower the SD and the higher the SNR and CNR ( $p < 0.01$ ). In the subjective analysis, DLIR-high showed the best score in terms of noise, streak artifact, and overall image quality among the reconstructions (significant in both readers' result:  $p < 0.001$ ). The scores of DLIR-med and DLIR-high tended to be better in terms of lymph nodes and poor in terms of small vessels compared with ASiR-V (significant in 1 reader's result:  $p \leq 0.005$ ).

## CONCLUSION

DLIR-high improved the objective parameters and the subjective image quality compared with ASiR-V by reducing noise and streak artifact on chest CT.

## CLINICAL RELEVANCE/APPLICATION

With improved image quality, the DLIR may contribute to the diagnosis and the clinical practice on the chest CT.

### SSQ19-07 Quantitative Comparison of Noise Texture between CT Images Reconstructed Using Filtered Back-Projection (FBP), Iterative Reconstruction, and Deep Learning Techniques

Thursday, Dec. 5 11:30AM - 11:40AM Room: E353B

#### Participants

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## PURPOSE

To quantitatively compare noise texture via noise power spectra of computed tomography (CT) images reconstructed using filtered back-projection (FBP), iterative reconstruction (ASiR-V), and TrueFidelity (TF) deep learning image reconstruction (DLIR) at different dose levels.

## METHOD AND MATERIALS

To measure the noise texture across image reconstruction algorithms, we calculated the normalized noise power spectra (nNPS) of uniform phantom images acquired at six dose levels (CTDIvol 2.5, 4.9, 7.4, 10.2, 12.6, 15.1mGy), and reconstructed using FBP, iterative reconstruction (ASiR-V, 100%), and deep learning (TrueFidelity DLIR, high). A 20cm water phantom was scanned on Revolution CT (GE Healthcare, five scans per condition), and images were reconstructed using the three algorithms above. From each scan, the difference-image was calculated between two 2.5mm-thick slices 2.5mm above and below the axial center. Then, the 2D NPS of the difference image was calculated, normalized to its own area, and radially averaged to yield the final 1-D normalized NPS (nNPS). To compare the nNPS, the average frequencies  $f_a$  were calculated as first-order moments of nNPS normalized by the area under the curves. In addition, the root-mean squared of nNPS difference (RMSD) between nNPS of ASiR-V/TF and the corresponding nNPS of FBP was calculated.

## RESULTS

nNPS of Images reconstructed with TF DLIR and FBP show a close match, with a slight shift towards lower frequencies occurring in TF images at CTDIvol of 2.5mGy. For all dose levels studied,  $f_a$  of TF images was only 0.20 +/- 0.08lp/cm below that of FBP (a 6% difference), while  $f_a$  of ASiR-V was 1.37 +/- 0.01lp/cm below FBP (42% difference). RMSD\_TF was 0.10 +/- 0.04mm<sup>2</sup> and RMSD\_ASiR-V was 1.14 +/- 0.01mm<sup>2</sup>.

## CONCLUSION

Consistent with previous reports, normalized NPS of ASiR-V images is shifted towards lower spatial frequencies. The normalized NPS of TrueFidelity DLIR closely matches that of traditional high dose FBP images across a wide range of dose levels as quantified via RMSD and average frequency.

## CLINICAL RELEVANCE/APPLICATION

Without the typical compromises in image texture occasioned by iterative methods even when the dose is reduced, deep learning image reconstruction (TrueFidelity, GE Healthcare) should help accelerate the adoption of low dose techniques into routine clinical practice.

## SSQ19-08 Deep Learning-Based Metal Artifact Reduction in CT for Total Knee Arthroplasty

Thursday, Dec. 5 11:40AM - 11:50AM Room: E353B

### Participants

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## PURPOSE

To investigate the metal artifact reduction (MAR) performance of deep learning (DL)-based MAR technique in the evaluation of postoperative CT of total knee arthroplasty (TKA) patients

## METHOD AND MATERIALS

The training dataset consisted of 640 image pairs obtained from 10 lower extremity CT scans without a metal prosthesis. Each image pair consists of a metal artifact-free image with a virtual metal shape embedded in the original image and a metal artifact image simulated through sinogram handling. Our DL network is a convolutional neural network (CNN) with encoder-decoder structure and skip connections. The summation of MSE and SSIM losses were implemented for parameter updating. For the test dataset, we used 10 lower extremity CT examinations from 10 patients who had a previous history of TKA (7 patients with unilateral TKA; 3 patients with bilateral TKA), and a total of 13 knee joints were used for analysis. To evaluate the metal artifacts quantitatively, the area, mean attenuation, and artifact index (AI) within the dark streak artifacts were calculated in the original, O-MAR, and DL-MAR images. For qualitative analysis, images were rated with a 5-point Likert scale regarding the degree of overall metal artifacts, conspicuity of bone cortex and trabeculae, and assessment of soft tissue around the prosthesis. Continuous variables were compared between different MAR protocols using the repeated measures ANOVA and qualitative grading results were analyzed by using the Friedman test.

## RESULTS

The O-MAR showed a 24% reduction in metal artifact area, while the DL-MAR showed an area reduction of more than 99%, almost completely eliminating the dark streak artifact. In terms of mean attenuation and AI, DL-MAR also showed better performance than O-MAR ( $P < 0.001$ ). In qualitative analysis, DL-MAR showed significantly lower overall metal artifacts ( $P = 0.008$ ) and better bone delineation ( $P = 0.020$ ) compared to O-MAR. However, there was no significant difference in the assessment of soft tissue between two MAR protocols ( $P = 0.054$ ), and DL-MAR showed unusual blurring of periarticular soft tissue.

## CONCLUSION

The DL-MAR technique has been successfully developed and shown comparable performance with conventional projection

completion algorithm.

#### CLINICAL RELEVANCE/APPLICATION

The DL-MAR can effectively reduce severe metal artifacts caused by large TKA components, hence enabling its use in the diagnosis of postoperative complications of TKA.

#### SSQ19-09 Basic CT Physics Scaling Laws for Noise and CNR as a Function of Slice Thickness and Dose for a New Deep-Learning CT Image Reconstruction Method

Thursday, Dec. 5 11:50AM - 12:00PM Room: E353B

#### Participants

Timothy P. Szczykutowicz, PhD, Madison, WI (*Presenter*) Equipment support, General Electric Company; License agreement, General Electric Company; Founder, Protocolshare.org LLC; Medical Advisory Board, medInt Holdings, LLC; Consultant, General Electric Company; Consultant, Takeda Pharmaceutical Company Limited  
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#### PURPOSE

The relationships between noise, slice thickness, and dose in CT are well understood for filtered back projection. This work characterizes these relationships for an implementation of TrueFidelity, a new deep learning image reconstruction (DLIR) approach.

#### METHOD AND MATERIALS

We imaged an ACR phantom at 5 slice thicknesses: 0.625, 1.25, 2.5, 3.75, and 5 mm. We imaged at doses of 16, 8, and 4 mGy using 120 kV, 80 mm collimation, and 0.992:1 pitch. All measurements were repeated 5 times. Images were reconstructed using: filtered back projection (FBP), two levels of a statistical iterative reconstruction (ASiR-V), and three levels of a vendor's deep learning image reconstruction (DLIR) approach. The ASiR-V levels were chosen based on institution (20%) and vendor (50%) recommendations. We fit image noise and CNR as a function of dose and slice thickness. Confidence intervals for all fit parameters were determined.

#### RESULTS

FBP and ASIR-V 20%/50% had similar scaling exponents: for CNR as a function of slice thickness 0.47(0.43-0.51) and 0.46(0.43-0.50)/0.45(0.36-0.54) and for noise as a function of slice thickness -0.49(-0.50 -0.48) and -0.49(-0.52 -0.47)/-0.49(-0.59 -0.39) respectively. DLIR low/medium/high had exponents of 0.37(0.23-0.51)/0.37(0.20-0.53)/0.36(0.15-0.56) for CNR as a function of slice thickness and of -0.39(-0.51 -0.28)/-0.38(-0.51 -0.26)/-0.37(-0.51 -0.23) for noise as a function of slice thickness. For noise and CNR as a function of dose, all methods had similar scaling exponents across slice thickness. As a function of dose at 5 mm, the image noise exponents for FBP and ASIR-V 20%/50% were: -0.48(-0.66 -0.30) and -0.48(-0.65 -0.31)/-0.47(-0.65 -0.29). DLIR low/medium/high for noise as a function of dose at 5 mm had scaling exponents of -0.44(-0.72 -0.17)/-0.44(-0.88 0.00)/-0.42(-1.08 0.23).

#### CONCLUSION

The CNR and noise scaling laws for FBP were found to hold for all recon methods. TrueFidelity DLIR did tend to have smaller changes in CNR and noise as the slice thickness/dose was reduced. The performance of DLIR was predictable and better than FBP and ASiR-V at all slice thicknesses and doses.

#### CLINICAL RELEVANCE/APPLICATION

New deep-learning based CT reconstruction (TrueFidelity, GE Healthcare) follows the noise and CNR rules of FBP reconstruction. This new reconstruction approach can mitigate some of the noise penalty incurred by reducing slice thickness or dose.

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QIE-THA

## Quality Improvement Reports Thursday Poster Discussions

Thursday, Dec. 5 12:15PM - 12:45PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI128-ED-THA1 Dose Optimisation in Multiphasic Computed Tomography Imaging of the Liver with High-concentration Contrast Media

Station #1

##### Participants

Sergio Cavalieri, MBBS, Novara, Italy (*Presenter*) Speaker, Bracco Group  
Alessandra Ferrari, MBBS, Novara, Italy (*Abstract Co-Author*) Speaker, Bracco Group  
Marco Brambilla, Novara, Italy (*Abstract Co-Author*) Nothing to Disclose  
Ilaria Percivale, Novara, Italy (*Abstract Co-Author*) Nothing to Disclose  
Alessandro Stecco, MD, Vercelli, Italy (*Abstract Co-Author*) Nothing to Disclose  
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##### PURPOSE

To reduce radiation dose to patients undergoing multiphasic CT of the liver by exploiting the intrinsic properties of iodine enhancement at low kVp.

##### METHODS

59 oncology patients underwent multiphasic CT of the liver using a 256 slices scanner either with our standard acquisition protocol (100 kVp in all phases; N=27) or an optimised weight-based acquisition protocol in the arterial phase (80 kVp in patients  $\leq 80$  kg; N=21 with an average BMI of 23,2 and 100 kVp in patients  $>80$  kg; N=11, average BMI 30,1). High-concentration contrast agent (Iomeprol 400 mgI/ml) at 1,3 ml/kg with a 3 ml/s injection rate and automatic tube current modulation were used in all patients. The standard dose and the optimised protocols were compared with t test for average CTDIvol, liver dose, and peak aortic enhancement measured in the aorta at the level of the coeliac trunk (significance threshold  $p < 0.05$ ).

##### RESULTS

When the optimised protocol was used, patients  $\leq 80$  kg showed a significant increase in peak aortic enhancement ( $466 \pm 134$  HU vs  $324 \pm 59$  HU;  $p=0,003$ ) and a significant reduction in average CTDIvol (from  $14 \pm 4.8$  to  $8.6 \pm 1.5$  mGy;  $p=0,000001$ ) and liver dose (from  $17.7 \pm 5.9$  to  $10.7 \pm 1.8$  mSv;  $p=0,002$ ) for the arterial phase. As expected, patients  $>80$  kg did not show any significant difference in aortic enhancement and radiation dose compared to the standard protocol.

##### CONCLUSION

Our optimised protocol with use of 80 kVp and high iodine concentration resulted in a substantial improvement of aortic attenuation and radiation dose reduction in patients  $\leq 80$  kg undergo a multiphasic CT of the liver. Adopting a tailored approach to the individual patient has been a success: we have seen an increase in peak aortic enhancement by 44% and a reduction to liver dose by 40% in the arterial phase. The optimised protocol has been successfully implemented in our institution and it is now the standard protocol for patients within normal BMI range. This has been a pilot project for the dose team, which is gradually overhauling all CT protocols in our institution.

#### QI129-ED-THA2 Cross-sectional Interventional Procedures in A Diagnostic Radiology Residency: Establishment of an Effective Comprehensive Simulation Based Procedural Training Program

Station #2

##### Participants

Brianna Oliver, MD, Ann Arbor, MI (*Presenter*) Nothing to Disclose  
Mishal Mendiratta-Lala, MD, Ann Arbor, MI (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

Patient care and procedural skills is one of 6 competency-based American Board of Radiology (ABR) milestones for radiology residents, the components are largely assessed during procedural rotations. While the basics of performing a procedure are constant, there is variability in how each faculty performs and teach procedures, as well as methods utilized to perform the procedure depending; thus it is difficult to homogenize training and to accurately assess procedural competence. Moreover, exposure to procedural rotations and ability to perform a procedure varies tremendously. These are challenges when trying to safeguard adequate training of procedures in order to ensure competence. Literature shows that hands-on simulation is a way to provide 'deliberate' training in a safe environment. The purpose of this project was to create a simulation-based training program for radiology residents in order to enhance the basic procedural education. The simulation-based training program focused on education pertaining to multiple aspects of cross-sectional procedures, including: pre-procedure, intra-procedural and post-procedural care, and ultrasound-guided procedural skills using a physical phantom for training.

## METHODS

An initial curriculum structure was developed for cross-sectional interventional radiology (CSIR) procedural training in order to: 1. improve knowledge by providing an understanding of pre-, intra- and post-procedure details, including indications and contraindications for procedures, procedure technique, and post-procedure management, and 2. improve procedural skills, particularly dexterity with ultrasound when performing percutaneous biopsies and catheter placement. In order to ensure maximum resident participation, the program was built into the pre-existing noon-conference schedule, and occurred at the institutional simulation center. There were four components to the curriculum: initial pre-training written test, 2-hour didactic lecture, small group hands-on procedural training, and post-training written exam. Post-training survey evaluation allowed residents to subjectively evaluate the effectiveness of the program. Written pre- and post-test allowed objective evaluation of knowledge. Hands-on simulation training required trainees to follow a check list of steps (n=23 steps) to successfully perform ultrasound guided targeting of "lesions" on a chicken phantom. Utilizing a whole chicken as the phantom allowed a semi-real time experience, with skin, subcutaneous fat, bone, and muscle. At the end of the session one CSIR faculty evaluated each resident perform a procedure, with evaluation criteria being the procedural checklist residents used during the hands-on training session.

## RESULTS

Written pre-test examination was administered to identify baseline gaps in knowledge and measure improvement after simulation based training. Written pre-test assessed patient care and procedural knowledge, questions covered medications, indications, anatomy and procedural techniques and was followed by a 2-hour didactic session. Thereafter, small group (n=6-8) hands-on didactic training sessions occurred, each with one CSIR faculty who reviewed cases with residents as they practiced US-guided needle placement. After training, the CSIR faculty administered a practical test, in which each resident performed a procedure using the checklist steps. Finally, a written post-test was administered. Improvement in written test results were evaluated for each trainee (n=34), each year of training as a group (n=4), and overall as a residency group (n=1). The largest increase in results was 30%. The PGY-2 year (first year of radiology residency), demonstrated the largest gains, with an average increase of 11.8%. All residents successfully completed the practical test, with an average checklist score of 20/23. Post-simulation questionnaire utilizing a Likert scale was administered to allow each trainee to objectively assess the program, improvement in skills and knowledge, increase in procedural confidence, and if this program should be implemented in residency training. 64.7% of trainees reported inadequate procedural skills and knowledge pre-simulation training and 100% of trainees reported gains in knowledge post-training. 100% agreed simulation training should become a part of the residency curriculum.

## CONCLUSION

Effective procedural training is a critical component of radiology residency training and has become one of the ABR core competency milestones. CSIR procedural training is an important tool to help radiology residents become proficient in percutaneous procedures; a skill necessary for almost all subspecialties of radiology. Our simulation-based CSIR training program has shown to improve trainees' confidence in performing the technical aspects of a procedure, as well as improve a trainees' knowledge base on subjective measures. Further studies showing the translation of these skills into real-time clinical work is still necessary.

## Q1001-EB-THA Strategies for Implementing and Three Years Results of a National Quality Accreditation Program in Diagnostic Imaging in a Developing Country

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### Participants

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## PURPOSE

Radiology is a core specialty for most clinical and surgical practice nationwide. Therefore, improving Quality and Safety in Radiology have major impact on the national's healthcare system. To address the issue, the National Health Agency and the College of Radiologists joined efforts to structure a National Accreditation Program that will help diagnostic imaging facilities achieve minimum quality and safety requirements and spread the culture of constant improvement. We present the steps that made it possible to develop the first National Accreditation Program for radiology. The results of the first three years are shown and discussed. A critical analysis is made demonstrating the strengths, weaknesses and the opportunities of betterment. We aim to share our experience and doing so contribute to amplify the awareness on the importance of quality for radiology.

## METHODS

The following steps were taken to create the National Accreditation Program: 1. Creation of a committee to manage the accreditation program: formed by radiologists, a nuclear medicine specialist, a medical quality specialist, and a radiologic administrator. The mission of the committee was to foster the idea of the radiology providing a medical service in a more comprehensive way, and guaranteeing the quality not only as the excellence in the execution of the imaging tests, but quality as a whole that could beneficiate the patient. 2. Elaboration of the Program Requirements: A research was made in all the normative resolutions published by the National Council of Health since 1988. These resolutions were then organized and detailed to simplify the understanding and help facilities meet the requirements. The National College of Radiology reached for the radiology subspecialty commissions to contribute to the construction of the requirements in each particular area: neuroradiology, head and neck, thoracic, cardiovascular, abdominal, musculoskeletal, mammary radiology and ultrasound. 3. Public consultation, discussion and adequation of the requirements to meet the mission of the committee. 4. Submission of the document to an international

accreditation of quality programs (International Society for Quality in Healthcare - ISQua). 5. Accreditation of auditors: periodic auditor courses throughout the country were performed to spread the word of quality and accredit internal and program auditors to rapidly increase the reach and the understanding of the Quality Program. 6. Recognition of the Program by The National Healthcare Agency: the Quality Program was recognized by our national agency which recommended that an accredited radiology facility should have reimbursement advantages.

## RESULTS

The Program Requirements were successfully completed after two years, producing a final document with 191 items covering six major topics: 1. governance, 2. executive / finance management, 3. quality (planning and documentation, risk assessment and safety management, non-compliance management, patient satisfaction, adverse events, quality improvement planning), 4. Service performance (customer service, imaging exam deliver process, radiologic reporting, post analytic management), 5. Diagnostic support service (human resources management, worker's safety, equipment / products / services acquisition process, equipment maintenance, information technology, sanitation, disinfection and sterilization, clothing processing), 6. Infrastructure, radiation and environmental safety. The technical guidelines containing the best practices requisites were also created and published online in seven documents each one representing one of the radiologic methods: computerized tomography, magnetic resonance, sonography, radiography, nuclear medicine, osseous densitometry and interventional radiology. During the first three years of the program, 80 facilities have applied, five failed, and 19 were approved. Thirty program auditors and more than 400 internal auditors were trained. Twenty eight local audits were performed. The mean cycle of the program was 100 days. The main causes of failure were exams reproval, and failure to demonstrate quality and safety documentation. Satisfaction with the process of accreditation was high as expressed by the net promoter score of 56, assessed by a self-assessment questionnaire. The same assessment indicated the positive impacts were: executive management improvement (100% totally or partially agree); exam process improvement and reduction of adverse event risks (78% totally or partially agree). A negative aspect, pointed by 61% was the perception that the accreditation haven't brought additional financial gain. However, the majority of the facilities declared that some non-quantifiable gain was achieved.

## CONCLUSION

We presented the steps and challenges to structure a National Program of Accreditation in Radiology with the mission of promoting quality and safety for our specialty, which will certainly influence the improvement of healthcare delivery countrywide.

### Q1020-EB- THA Lean MRI Protocol Process Improvement and Software Solution

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#### Participants

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## PURPOSE

Lean is a philosophy that embraces the power of continuous process improvement to add value to customers (patients) and society, while empowering employees and building people and teams as part of "learning organizations" that can adapt and thrive in challenging environments.<sup>1</sup> The Institute of Medicine recognizes such continuous learning and improvement as the key to addressing the increasing costs and "unmanageable complexity" of the science of health care,<sup>2</sup> and reducing diagnostic error.<sup>3</sup> Lean improvement may also reduce burnout through participants' empowerment and engagement, team building and efficiencies allowing more time for personally meaningful work activities. 4-6 9 years ago, our neuroradiologists commonly worked 11+ hours per day. The most visible cause of this problem was the late (5:30-6pm) arrival of folders containing imaging protocols and contrast prescriptions to be completed for the next day. We initiated a lean improvement project targeted toward increasing time available for meaningful activities by eliminating waste from the imaging and contrast prescription process.

## METHODS

1. Employed Toyota's Practical Problem Solving Process including the "Five Whys" to define and clarify the problem, identify the root cause and iteratively develop countermeasures 2. Standardized MR imaging protocols through consensus, beginning with most frequently used protocols, based on a clear set of principles and a checklist for implementation 3. With a multidisciplinary team, developed software to support radiologist and technologist workflow that integrated a new protocol database with curated clinical information from the EMR (labs, history, allergies, medical device MRI compatibility), capability to prescribe contrast bounded by ACR guidelines, and permitted archiving of radiologist/technologist notes and protocol customization 4. Developed and implemented a plan/checklist for folder/paper retirement 5. Developed a workflow for continuous imaging protocol improvement (DRIVE - Development, Review, Implementation, Vaulting/archiving and (re)Evaluation). Technologist and radiologist labor time was assessed before and after implementation through surveys and observation, and descriptive statistics calculated.

## RESULTS

Radiologists' protocol process time was reduced by approximately 60%, or the equivalent of 1 academic day (8 hours). Overall, technologist process time was reduced by approximately 70% (100% for Technologist 1, 50% for Technologist 2), saving 37.5 technologist hours per week (almost 1 FTE). This translated into shorter reading room days for neuroradiologists, and increased technologist availability for advanced image processing and other value-added and meaningful tasks, gains which have been maintained despite steadily increasing imaging volumes. Other benefits: • Consistency of imaging protocols, facilitating acquisition and improving comparison and diagnosis • Standardization permitted differentiation of clinical versus research imaging, facilitating billing • Compliance with electronic medical record mandate • Enhanced safety of intravenous contrast prescription • Electronic record of patient-specific imaging needs, improving patient experience • Process for continued imaging improvement (DRIVE - Development, Review, Implementation, Vaulting/archiving and (re)Evaluation). Technologist and radiologist labor time was assessed before and after implementation through surveys and observation, and descriptive statistics calculated. Lessons learned: • Processes that worked 10 years ago may not be scalable to increasing imaging volumes and complexity. • Software alone is not a solution for inefficient or poorly defined processes, which should be aggressively reviewed and streamlined before a

software solution is considered. • Software is logical, while people frequently are not. Hiccups in software development/implementation usually indicate ambiguity in processes and should be considered an opportunity for process review and improvement. • Participation and buy-in of key end users is critical to the success of any process improvement effort.

## CONCLUSION

Lean process improvement can introduce efficiencies accommodating increasing imaging volumes and meaningful value-added activities, while enhancing consistency and safety in patient imaging care and promoting a culture of continuous improvement. With judicious implementation, the inherent logic of software can be leveraged for further process improvement.

## Q1025-EB-THA Improving Radiology Protocols Efficiency through Quality Improvement: An Initiative to Improve Resident Productivity and Speed of Patient Diagnosis

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### Participants

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## PURPOSE

In most radiology residencies across the nation, protocoling is primarily the responsibility of radiology residents. The process is an essential skill to learn, but is also quite laborious, erroneous and more importantly can detract from learning imaging interpretation, diagnosis, and management. To this end, we aimed to improve radiologist protocoling workflow efficiency by decreasing time spent on protocoling studies that could be better spent on interpreting studies as well as improve order-to-reporting time.

## METHODS

We utilized a Plan-Do-Study-Act (PDSA) cycle and A3 problem solving methodology to investigate the workflow for CT exams from ordering to protocol completion. We surveyed our institution's radiology residents to identify major areas of waste and gauge resident satisfaction towards our program's protocoling process. We also surveyed other radiology residencies for comparison. Root cause analysis was performed and we determined the first phase was to streamline the protocoling dashboard interface. Proposed changes were approved by key stakeholders and subsequently implemented in the Abdominal Division of our Radiology Department. Data on resident protocoling, study interpretation, dashboard length, and protocoling time (by a first and third year radiology resident) were obtained before and after interventions. Post-implementation feedback and EPIC error reporting metrics were monitored.

## RESULTS

Retrospective analysis of data between June and September 2018 revealed that our residents protocolled 79% of the protocoling volume while only reading 24% of the imaging volume. Compared with other radiology residents, our residents spent more time protocoling and less time reading and interpreting CT studies and 84% were dissatisfied with the current protocoling workflow as compared with 36% from other institutions. Changes included development of a more user-friendly dashboard interface, strategic reorganization of essential information, and elimination of irrelevant information and protocols. Post-implementation, we decreased patient information for each study by greater than 80%, thereby reducing excessive time and energy spent on locating relevant information. The average protocoling time was 39.8 seconds before implementation and 23.4 seconds after implementation, which represents a 41% reduction in time spent per protocol and nearly met our target goal of 50% reduction. Overall feedback from the faculty, residents, and technicians were positive and only 1% of all errors reported through the Epic QA reporting system were attributed to incorrectly protocolled exams by radiologists.

## CONCLUSION

Streamlining the protocoling dashboard at our institution has improved our protocoling workflow efficiency. Post-implementation, residents can more quickly complete protocols for ordered exams and dedicate more time to interpreting studies, thereby minimizing delays in patient diagnosis and clinical care due to protocoling. By making additional changes going forward based on our root cause analysis, continued feedback, and careful monitoring of error metrics, we believe we are one step closer to optimizing radiologist productivity.

Printed on: 10/29/20



RCC53

## Next Generation Reporting: Informatics to Improve the Value of Reporting

Thursday, Dec. 5 12:30PM - 2:00PM Room: E351



AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Arun Krishnaraj, MD, MPH, Charlottesville, VA (*Moderator*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Identify unmet needs of current and future practices with regards to radiology reporting. 2) Apply existing and emerging informatics applications to improve report generation, including a focus on patient centered reporting. 3) Demonstrate an understanding of how best to apply emerging machine intelligence tools to create structured automated recommendations.

### Sub-Events

#### RCC53A The Actionable Patient Facing Report

##### Participants

Arun Krishnaraj, MD, MPH, Charlottesville, VA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Appreciate the current state of radiology reporting in the United States. 2) Identify areas for improvement in reporting. 3) Demonstrate an understanding of the potential of patient portals. 4) Understand how patient facing actionable reports can lead to better care through shared decision making

#### RCC53B The Multimedia Report: Ready for Prime Time?

##### Participants

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### LEARNING OBJECTIVES

1) Identify characteristics of an interactive multimedia radiology report. 2) Comprehend the value of improved communication that occurs with interactive multimedia reporting. 3) Describe barriers to overcome during the implementation of interactive multimedia reporting and integration of advanced reports into the electronic health record.

#### RCC53C Interactive Reporting

##### Participants

Les R. Folio, MPH,DO, Bethesda, MD (*Presenter*) Institutional research agreement, Carestream Health, Inc

### LEARNING OBJECTIVES

1) Comprehend the difference between plain text and interactive multimedia radiology reports. 2) Identify characteristics and components suitable for an interactive multimedia radiology report. 3) Demonstrate objective evidence of radiology report value using interactive reports now that we can analyze click through behaviours of hyperlinked text.

### ABSTRACT

For the past several years, the NIH Clinical Center has been routinely producing multimedia-enhanced interactive reports (Folio L. Multimedia Reports. Radiographics. April/ May 2018) in which radiologist reports contain hyperlinked text, directing clinicians to the corresponding image annotation (most often two-diameter measurements). Our prior studies have also demonstrated notable time savings for oncologists (three times faster) when they use the hyperlinked target lesion measurements for their patients (Folio L. RSNA 2015) as they spend significantly less time "hunting" for measurements in the previous text-only reports. Bookmark tables within our PACS (VuePACS V12, Carestream Health, Rochester, NY) contain fields where "radiologist assistants" (RAs) can label target lesions. In one ongoing study (Toscano A. SCBT.MR 2018), RAs simulate an AI workflow where target lesions are measured before radiologists open the exam for interpretation. This improves target lesion selection and measurement concordance while saving radiologists time by not having to identify or measure these lesions. Once verified, radiologists import the active annotation as a link into our report by dictating the word "hyperlink," which minimizes the potential transcription error of three sets of numbers (measurement, series and image numbers) and other metadata (e.g. x,y image and z table space, comparison of current with prior measurements for RECIST calculations, lesion measurement creator). We have followed adoption of hyperlinks since we started the capability and showed a rapid rise of use and that body radiologists use the most hyperlinks (about 80% of all CT), followed by body MR, PET CT and neuroradiology. We also collect data on use of annotations, with two-diameter the most frequent, followed by linear, ovals then arrows (least frequent). Preliminary work indicates that two-diameter and ovals better guide bounding boxes for deep learning with the annotations directly associated with the the hyperlinked text. Lastly, we have been analyzing clinician click-through behaviors where we can objectively demonstrate report value as a function of number of clicks on linked text, thus

verifying clinician interaction with radiologist reports. We can also analyze radiologists' clicks on prior report text and noted that body radiologists (for example) frequently click on these reports while dictating their interpretations.

## **RCC53D    Structured Automated Recommendations: Reporting in the Era of Artificial Intelligence**

### Participants

Tarik K. Alkasab, MD,PhD, Boston, MA (*Presenter*) Consultant, Nuance Communications, Inc

Printed on: 10/29/20



QIE-THB

## Quality Improvement Reports Thursday Poster Discussions

Thursday, Dec. 5 12:45PM - 1:15PM Room: QR Community, Learning Center

SQ

AMA PRA Category 1 Credit™: .50

### Sub-Events

#### QI130-ED-THB1 Verification of Operational Database for MRI and Evaluation Analysis on Tasks for Safety Management

Station #1

##### Participants

Minoru Kawamata, PhD, Osaka, Japan (*Presenter*) Nothing to Disclose  
Yasuhiko Yamane, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Akitoshi Yoneda, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Katsuyuki Nakanishi, MD, PhD, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose  
Akira Masaoka, Osaka-City, Japan (*Abstract Co-Author*) Nothing to Disclose  
Souchiro Tateishi, Osaka, Japan (*Abstract Co-Author*) Nothing to Disclose

##### PURPOSE

The environment surrounding medical care is constantly changing. While MRI imaging continues to innovate rapidly (with various applications being researched and developed) as the magnetic field of devices increases, there are very few examples that systematically evaluate the safety of the examination. In this research, the tasks of MRI examination are systematized and classified according to the evaluation items. We investigate which components are important in the safety management.

##### METHODS

We examine the important tasks in MRI Examination by the following methods. 1. Draw Activity Diagram using Unified Modeling Language UML is a unified modeling language for object-oriented analysis and design. 2. Create evaluation items using brainstorming and Assign evaluation items to the tasks from Activity Diagram. 3. Perform ISM (Interpretive Structural Modeling) analysis on the components related to medical safety and Evaluate the relevance and impact of each components. The ISM method to which graph theory is applied is one of the structural modeling methods proposed by J.N. Warfield. In addition, it is possible to correct the contradiction of recognition based on human empirical judgment, to clarify the problem more objectively, and to create a directed graph by pairwise comparison of components. The generated model can be interpreted and examined for more objective problem solving and is applied in many fields.

##### RESULTS

1. In the Activity Diagram, there were 72 items in the MRI examination. 2. As a result of brainstorming, the work of MRI Examination could be classified into quality control, safety management and image management. There were 30 components classified as safety management. 3. In the MR, the components related to safety management were "confirmation of patient identification", "confirmation concerning the contrast examination" and "confirmation of the order contents and patient condition" and these components were affecting other work.

##### CONCLUSION

We could identify components related to medical safety and clarify the degree of influence of the items in the Activity Diagram. We were also able to systematize the work of the radiographers by drawing business flows. This raised the awareness of medical staff for safety in our hospital has increased.

#### QI131-ED-THB2 Sustained Increases in The Quality of Imaging Histories Provided by Ordering Providers Resulting from Cross-functional Collaboration and Systems Design

Station #2

##### Participants

Daniel S. Bor, BS, Denver, CO (*Presenter*) Nothing to Disclose  
Richard E. Sharpe JR, MD, MBA, Denver, CO (*Abstract Co-Author*) Nothing to Disclose  
George Payan, BS, RT, Denver, CO (*Abstract Co-Author*) Nothing to Disclose  
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##### PURPOSE

Providing a complete imaging history supports high quality, accurate and efficient interpretations by radiologists. Many imaging orders submitted to radiology departments are missing key components of a complete imaging history. This can result in the radiologist having an unclear understanding of the clinical scenario requiring imaging and the question the ordering provider is seeking to have answered, potentially resulting in missed diagnoses and/or recommendations for additional unnecessary imaging.

The purpose of this quality improvement project was to create sustained improvement in the frequency of complete imaging histories provided with imaging examinations submitted directly by ordering providers. A secondary outcome was to increase the amount of information submitted by ordering providers with imaging examinations.

## METHODS

A cross-functional team of radiologists, primary care providers, physician assistants, a primary care supervisor, a process improvement expert, and an analyst collaborated to improve the quality of imaging histories. The team defined the components of a complete imaging history and tested the definition. Data was obtained and consecutive meetings allowed for iterative improvement cycles improving the standardized definition of a complete imaging history. Audits were regularly performed using consensus, and the project team regularly evaluated performance. The final components of the definition of a complete imaging history included: 'What happened?', 'When did it happen?', 'Where to focus?' and [what are you] 'Concerned for?' These prompts were subsequently inserted into the electronic physician order entry process and performance was monitored for an additional 18 months. The average number of complete imaging history components provided was analyzed via a u type control chart. Subset analysis was performed by each history question and by ordering provider.

## RESULTS

10,236 orders were placed by providers in the study clinic from March 13, 2017, to December 16, 2018. 1,593 (15.6%) of all provided imaging histories were scored. 16.0% (72/449) of orders scored in the baseline period contained all four history components, which increased to 55.0% (928/1688, an absolute increase of +39.0%, a relative increase of +243.8%,  $P < 0.0001$ ) in the subsequent periods. Figure 1 demonstrates an average of 2.1 history components were provided during the baseline period, which increased to 3.1 (+47.6%) in subsequent periods. This average was sustained for more than a year, from May 29, 2017, through December 16, 2018. Figure 2 demonstrates that the frequency of orders placed with four complete history items increased from 16% at baseline, and was sustained throughout the project (64% during the implementation phase and 49% during the sustainability phase). It further demonstrates that at baseline, 11% of orders had one complete history component provided, which decreased to 0 to 2% during implementation and sustainability, respectively. All providers experienced a higher average number of components provided after the intervention, ranging from +1.5 to +0.3 more history components provided after the intervention. For 5 of 16 providers, this change was statistically significant in a per provider subset analysis. Table 1 provides examples of histories provided before and after the intervention. After the intervention, more details were provided, such as specific anatomic sites of concern, more complete medical history information, specific clinical exam findings, and suspected diagnoses, to support the interpreting radiologist in providing an accurate and clinically relevant interpretation. While sustained improvements were observed for each history component, some questions were more commonly submitted than others. Providers tended to more frequently provide information about 'What happened?' and 'Where to focus?' than 'When did it happen?' and [what are you] 'Concerned for?' (Figure 3). The average number of characters providers entered in the imaging histories they submitted increased from 45.4 characters per order during the baseline period to 75.4 (+66.1%,  $P < 0.0001$ ) after the intervention (Figure 4).

## CONCLUSION

By collaborating with ordering providers and a collaborative cross-functional team, we created a standardized definition of an imaging history and engineered our systems to include supportive prompts into the order entry interface that were designed by and for ordering providers. By designing systems to support consistent, high-quality care and the provision of complete histories, we were able to hardwire excellence and sustained improvement.

## Q1132-ED-THB3 Creating a Community Standard and Promoting Artificial Intelligence Research in Multiple Sclerosis: A Pre- and Post-Intervention Assessment of the Frequency of Common Data Element (CDE) Reporting

Station #3

### Participants

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Ajay Malhotra, MD, Stamford, CT (*Abstract Co-Author*) Nothing to Disclose  
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## PURPOSE

This retrospective study was performed as part of a quality assurance initiative to evaluate the completeness of neuroradiology reports for the evaluation of multiple sclerosis (MS) for MRI examinations. The RSNA-ASNR-ACR Common Data Elements (CDE) Neuroradiology Working group has produced reporting templates in an effort to promote best-practice reporting, standardize reports, and facilitate research such as artificial intelligence and machine learning. We hypothesize there are aspects of MS that are not reported consistently, and that intervening with structured templates will increase the frequency with which they are reported. By comparing the reporting frequency of CDE before and after the introduction of the reporting templates, we can assess for improvements in reporting consistency.

## METHODS

The PACS was queried for all MRI spine exams performed 7/1/2017-5/1/2018. Reports were excluded in the settings of non-MS pathology (degenerative spine disease, osteomyelitis, metastatic disease, etc). Reports were reviewed for the explicit inclusion of each of the reporting fields in the RSNA-ASNR-ACR CDE MRI Multiple Sclerosis Spine template. Following the introduction of CDE templates to the neuroradiology department on 1/1/2019, the PACS was queried for all MRI Spine exams performed 1/1/2019-4/6/2019. Again, reports were reviewed for the explicit inclusion of each of the reporting fields in the RSNA-ASNR-ACR CDE MRI Multiple Sclerosis template. The primary outcome was the change in reporting of CDE fields before and after the formal introduction of the CDE template, along with the percentage of the 11 CDE fields explicitly reported in each report. The secondary outcome was the adoption rate of CDE templates (these templates do not automatically populate for each report, and must be inserted when indicated).

## RESULTS

From the pre-intervention study period, 49 reports were reviewed. Of the 49 reports, the most frequently reported Common Data

Elements were: cervical or thoracic location (95.9%), enhancement (93.8%), and lesion span (22.4%). The least consistently reported CDE were: lesion number (0%), T1-appearance (0%), and cord edema (0%). The post-intervention study period included 25 reports during template creation and initial implementation. Of the 25 reports, 15 reports used the Common Data Element template (60% adoption rate). The most frequently reported Common Data Elements were: enhancement (96%), cervical or thoracic location (92%), and largest lesion identified (76%). Additionally, the pre-intervention CDE's that had been reported least frequently showed post-intervention improvement, as follows: lesion number (36%), T-1 appearance (52%), and cord edema (56%). Reporting of all of the Common Data Elements increased across all fields following the intervention of introducing formal CDE templates, except in the case of location (96% pre-intervention and 92% post-intervention).

## CONCLUSION

While the overall core concepts of normal anatomy may be conveyed in reports, major concepts in multiple sclerosis evaluation may not be explicitly reported. Although reports including very broad general statements and lacking a description of the pathology may quicken reporting as well as information consumption by ordering physicians, this practice could potentially leave some ambiguity. In addition to hindering quality assurance checks, the use of natural language processing and machine learning is also hindered by the use of broad general statements. The RSNA-ASNR-ACR CDE reporting templates provide a starting point for best-practice reporting. Based on the results of this study, a formal introduction of CDE templates into a neuroradiology section leads to a dramatic increase in the frequency by which these disease-specific common data elements are reported. This may have a beneficial impact on patient care by leading to the development of community standards to report disease-specific findings for multiple sclerosis and many other major illnesses. Such community standards could increase the clarity of the reports, decrease the risk of omitting findings, and lead to improved data curation for research purposes including deep learning algorithms. CDE templates also guide trainees' review of pertinent positives/negatives for specific disease entities, holding a great potential educational value.

## Q1134-ED-THB4 RadPath: Automated Radiology-Pathology Notification System Improves Breast Procedure Addendum Turnaround Time

Station #4

### Participants

Erin P. Crane, MD, Washington, DC (*Presenter*) Nothing to Disclose

Nirali Shah, MS, MD, Springfield, VA (*Abstract Co-Author*) Nothing to Disclose

Ross W. Filice, MD, Washington, DC (*Abstract Co-Author*) Co-founder, DexNote LLC; Research Grant, NVIDIA Corporation; Advisor, BunkerHill Health, Inc

## PURPOSE

Radiologists perform a variety of image-guided procedures in practice. Histopathological results are particularly scrutinized in breast imaging for radiologic-pathologic concordance, which is addended to the final reports. Expedient notification and documentation of these results is important for patients and referring clinicians as well as for quality assurance purposes. We have a user-friendly, automated, semi-intelligent radiology-pathology correlation system (RadPath) for all radiology reports and procedures in our enterprise and have recently initiated automated email notifications of results. These emails link the user directly to the RadPath system, present the radiology and pathology reports, and allow direct launch of images aiding radiology-pathology concordance assessment. Our hypothesis is that these notifications result in improved turnaround time for documentation of pathology results on breast imaging procedures resulting in more timely radiologic-pathologic concordance.

## METHODS

IRB exemption was obtained. We searched our RadPath system for pathology matches corresponding to image-guided breast interventions at our flagship academic site during a 3 month period before and after the initiation of our notification system. To test our hypothesis, we analyzed turnaround time from finalized report to finalized addendum based on automatically generated report timestamps for these breast procedures. We excluded reports that had been addended less than 2 days after the final reports as our pathology results are not returned that quickly; this was felt to be reasonable exclusion of addenda not related to pathology concordance documentation.

## RESULTS

A total of 44 image-guided breast biopsies were performed in the 3 month period prior to the initiation of notifications with a mean turnaround time of 10.1 days from finalized report to finalized addendum. A total of 38 image-guided breast biopsies were performed during the 3 month period after initiation with a decreased mean turnaround time of 7.2 days. A two-sample unequal variance t-test showed this to be a statistically significant decrease with a p value of 0.045.

## CONCLUSION

We have shown a statistically significant decrease in turnaround time from procedure report finalization to pathology addendum in image-guided breast biopsies following initiation of the RadPath notification system. This is important for radiologists performing these procedures as timely notification and documentation of pathology results and establishment of radiologic-pathologic concordance is crucial for patient care and quality assurance. We believe patient and referring clinician satisfaction will also be improved and that this pattern will hold true across our enterprise. We plan to explore both of these hypotheses and also extend our analysis across our entire enterprise as future directions.

## Q1133-ED-THB5 Rapid On-site Evaluation of Ultrasound Guided Fine Needle Aspiration Thyroid Nodule Biopsy: Does it Have a Role in the Reduction of Non-diagnostic Sample Rate?

Station #5

### Participants

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Matthew A. Gubbels, Omaha, NE (*Abstract Co-Author*) Nothing to Disclose

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Xing Zhao, Omaha, NE (*Abstract Co-Author*) Nothing to Disclose

Sarah Aurit, Omaha, NE (*Abstract Co-Author*) Nothing to Disclose

Joseph M. Stavas, MD, MPH, Omaha, NE (*Abstract Co-Author*) Consultant, inRegen Biotechnology Consultant, Excelerate Health Ventures

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## PURPOSE

Thyroid nodules are one of the most common incidental findings. Criteria for following and managing those nodules have been under continuous development and update. When tissue sampling is required, ultrasound guided fine needle aspiration (US-FNA) represents an easy and effective way of getting the needed tissue with minimal risk. Despite the use of ultrasound to guide our choice for biopsy site, obtaining inadequate sample for diagnosis can be a frustrating consequence of this procedure, mainly due to obtaining few or no cells. This can result in repeating the procedure which subsequently contributes towards increasing cost and patient anxiety. The use of on-site cytological evaluation of fine-needle aspiration biopsy specimens can help in the determination of adequacy of specimens and even providing a specific preliminary diagnosis. In our study, we evaluated the impact of implementation of an on-site assessment of thyroid FNA biopsy performed under ultrasound guidance on overall sample adequacy and rebiopsy rate. Our aim was to detect the effect of rapid on site evaluation on the success of obtaining adequate diagnostic samples and decreasing rebiopsy rate.

## METHODS

After co-ordination with our pathology department, We implemented an on-site immediate cytological evaluation of the adequacy of the obtained sample starting in 2017 at our institution. We then performed a retrospective analysis of the overall adequacy of samples obtained before and after the rapid on site evaluation. Patients who had ultrasound guided FNA of thyroid nodules performed at our institution from mid 2017 till the end of 2018 were identified. The adequacy of the sample and the performance of on-site cytological exam for each case was recorded. The relationship between adequacy and performance of on-site cytological evaluation was examined with the chi-square test and Fischer's exact test. Two subsets of these data were analyzed in a similar fashion, which included cases with a maximum nodule size of less than or equal to 3 cm (maximum diameter) and less than or equal to 2 cm. SAS Version 9.4. was used for analysis.

## RESULTS

355 patients with 443 nodules were reviewed. On-site cytological exam was performed in 60 cases (17%) with 65 nodules. 12.3% of nodules biopsied with on-site cytology performed had inadequate sample, compared to 15.2% when it was not performed (RR =0.8,  $p = 0.839$ ). However in nodules less than or equal 2 cm in maximum dimension the risk of obtaining non-diagnostic sample decreased significantly, nearly no samples were labeled as inadequate compared to 15.5% of cases without on-site cytological exam performed ( $p = 0.034$ ).

## CONCLUSION

FNA biopsy of thyroid nodules is one of the most commonly performed procedures. Inadequate sample is frustrating for the patient, results in rebiopsy, and increases cost. Performing rapid on-site cytological exam, particularly in nodules less than 2 cm resulted in reduction of the incidence of obtaining inadequate sample. In our experience, this has led to improving the quality and safety of patient care.

## Q1008-EB- Pushing Limits: Are We Scanning Too Far? THB

Hardcopy Backboard

### Participants

Orli Haken, MD, Fresh Meadows, NY (*Presenter*) Nothing to Disclose

Kenny Ye, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose

Jeffrey M. Levsky, MD, PhD, Bronx, NY (*Abstract Co-Author*) Nothing to Disclose

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## PURPOSE

CT-related x-ray doses are a public health concern with epidemiological evidence of a small increase in cancer risk. ALARA mandates that any radiation dose, no matter how small, without a direct benefit, should be avoided. There has been significant effort to reduce radiation dose in CT by adjusting parameters including number of scan phases, tube voltage and current, scan pitch, and applying iterative reconstruction techniques. Dose reduction protocols in chest CT primarily include limiting tube current and increasing pitch. However, the most basic facet of imaging seems to be overlooked when one reviews the existent practice standards aimed to reduce CT dose. Dose is directly proportional to the scan length, which can and should be reduced to the area of anatomic interest. Studies have shown that in almost every CT, the imaged volume is larger than the actual volume of interest, with an associated linear increase in dose. Historically, oncologic chest CTs were extended inferiorly to include the adrenal glands. Additionally, many CTAs extend the field of view to include the abdominal aorta. Since there are no mandated anatomic landmarks on the scout tomogram, it is left to the technician's discretion to determine the field of view. This has led to a "creep" phenomenon where many CTs extend far into the abdomen, providing extra radiation at the patient's expense. To address this concern, we introduced new practice standards to ensure patient safety by setting exact anatomic limits to chest CTs. The purpose of our study was to implement a lasting intervention to decrease unnecessary radiation dose by reduction of scan length. In this way we can assure a comparable, safe radiation dose to every patient without inter-technician variability. We planned to regularly reassess the intervention to ensure that the effect persists.

## METHODS

In September 2018, we created a task force to implement anatomic guidelines for CT chest exams. In collaboration with the chest division leadership, we trained radiologists, technical supervisors, and technicians to set the superior and inferior margins as the lung apices on the frontal scout view and the posterior costophrenic sulci on the lateral scout view, respectively. Technical supervisors provide daily support and assist technicians to enforce the new anatomic guidelines. There is continuous feedback from the physicians using our Radiology Information System which provides a messaging mechanism to alert technical staff about scan deficiencies at the time of interpretation. The primary outcome assessed is the radiation dose of our most common chest CT applications - routine non-contrast chest and contrast-enhanced pulmonary embolism protocol. Performance indicators are the dose-length product (DLP) and CT dose index (CTDIvol) values which are mined from every exam using the DoseMonitor software. The ACR instituted guidelines in 2014 to include only the lung parenchyma on lung cancer screening examinations which were implemented in our institution. These studies therefore served as negative controls. A quality management team, including a statistician, was formed to regularly analyze the outcome metrics in an ongoing basis. To assess the statistical significance of the dose reduction, we used linear regression models with the log-transformed CTDIvol and DLP as the response, pre and post time

periods as the explanatory variable, and age, gender, and weight as covariates.

## **RESULTS**

We reviewed CTDIvol and DLP values for 3110 routine chest CTs prior to and 3109 routine chest CTs after our intervention, for 1629 PE studies prior to and 1831 PE studies after our intervention, and 688 lung cancer screening studies prior to and 612 lung cancer screening studies after our intervention (Table 1). We found a statistically significant reduction in DLP in both the routine non-contrast (4.76%,  $P\text{-val}=1.1\text{e-}5$ ) and pulmonary embolism protocol (5.8%,  $P\text{-val}=3.4\text{e-}7$ ) chest CTs. As expected, there was no statistically significant reduction in CTDIvol or DLP in the lung cancer screening studies. There was a marginal reduction in CTDIvol in the routine chest CTs (1.93%,  $P\text{-val}=0.03$ ). Creation of smoothing lines showed no evidence of return to pre-intervention dose levels for several months post-intervention.

## **CONCLUSION**

Radiation dose is directly proportional to anatomic scan coverage. Using strict anatomic guidelines to only scan from the lung apices to the posterior costophrenic sulci, we were able to significantly reduce radiation dose to the patient for routine and pulmonary embolism protocol chest CTs. Further research will focus on the impact of better anatomic guidelines on incidental findings which may cause downstream imaging and expenses. Our aim is to further standardize scan lengths for other body regions in our institution and justify more exact global practice guidelines for routine CT imaging which are similar to those already instated for lung cancer screening studies.

Printed on: 10/29/20



RC723

## CT Radiation Dose Reduction: Techniques and Clinical Implementation

Thursday, Dec. 5 4:30PM - 6:00PM Room: S504AB

**CT** **PH** **SQ**

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Lifeng Yu, PhD, Rochester, MN (*Coordinator*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Review techniques that are currently available for radiation dose reduction. 2) Understand general dose management and optimization strategies and how they are implemented in adult CT. 3) Understand strategies to optimize scanning protocols in pediatric CT.

### ABSTRACT

This course will provide an overview of techniques and clinical implementations of radiation dose reduction in CT.

### Sub-Events

#### RC723A Overview of Technology for Radiation Dose Reduction

##### Participants

Joseph W. Stayman, PhD, Baltimore, MD (*Presenter*) Research Grant, Canon Medical Systems Corporation; Research Grant, Carestream Health, Inc; Research Grant, Elekta AB; Research Grant, Fischer Medical; Research Grant, Medtronic plc; Research collaboration, Koninklijke Philips NV; Research collaboration, Varex Imaging Corporation; Research Grant, Siemens AG; Research Grant, General Electric Company;

### LEARNING OBJECTIVES

1) Identify targets for radiation dose reductions in x-ray CT. 2) Gain an understanding of dose reduction strategies based on innovations in hardware design and development. 3) Gain an understanding of dose reduction strategies based on data processing chain improvements including iterative reconstruction methods. 4) Understand some of the trade-offs in dose reduction as well as limitations on dose reduction.

#### RC723B Dose Optimization Strategy and Clinical Implementation in Adult CT

##### Participants

Lifeng Yu, PhD, Rochester, MN (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Introduce dose management and optimization strategies in adult CT. 2) Describe how dose reduction techniques are clinical implemented in adult CT, including neuro, chest, abdominal, cardiovascular, and MSK.

#### RC723C Dose Reduction and Protocol Optimization in Pediatric CT

##### Participants

Robert MacDougall, PhD, Boston, MA (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Recognize the important of clinical indication on CT protocol design. 2) Describe the different commercial implementations of kV and mA modulation algorithms and understand methods of standardizing image quality across platforms. 3) Understand the effect of reconstruction algorithms on acquisition parameter selection in pediatric CT.

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RC832

## Radiology Benchmark: Productivity, Quality, and Compensation

Friday, Dec. 6 8:30AM - 10:00AM Room: E353A

HP LM SQ

AMA PRA Category 1 Credits™: 1.50  
ARRT Category A+ Credit: 1.75

### Participants

Vincent P. Mathews, MD, Hartland, WI (*Moderator*) Nothing to Disclose

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### Sub-Events

#### RC832A Measuring Radiology Productivity

##### Participants

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### LEARNING OBJECTIVES

1. WHY: Understand the economic rationale for measuring labor productivity 2. WHAT: Describe the options for measuring radiologist productivity 3. HOW: Discuss Implementation strategies in physician operations

#### RC832B Measuring Radiology Quality

##### Participants

Lauren P. Golding, MD, Summerfield, NC (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) Understand the role of Quality in the Merit Based Incentive Payment System. 2) Become familiar with the collection types available for reporting quality measures into MIPS. 3) Understand the history of Qualified Clinical Data Registries. 4) Learn how to implement radiology specific QCDR into your practice.

#### RC832C Radiology Compensation Benchmarks

##### Participants

Vincent P. Mathews, MD, Hartland, WI (*Presenter*) Nothing to Disclose

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### LEARNING OBJECTIVES

1) To learn about the implementation of fair market value compensation plans. 2) To understand the importance of utilizing appropriate benchmarks for clinical productivity measures.

#### RC832D The Financial Impact of Payment Reform on Radiology

##### Participants

Suresh K. Mukherji, MD, Carmel, IN (*Presenter*) Nothing to Disclose

### LEARNING OBJECTIVES

1) Review the different financial reforms that have affected radiology. 2) Explain the effects these reforms have had on radiology. 3) Discuss future strategies that can help mitigate the downward trends on radiology reimbursement.

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