Saturday, November 30, 2013
12:00-02:00 PM • SPPH01 • Room: E351 • AAPM/RSNA Physics Tutorial for Residents: Control of Dose in Computed Tomography
02:15-04:15 PM • SPPH02 • Room: E351 • AAPM/RSNA Tutorial on Equipment Selection: Imaging Systems Designed to Reduce CT Dose and Maintain Image Quali...

Sunday, December 01, 2013
10:30-11:30 AM • MSRA11 • Room: S402AB • Patient Assessment: Requirements, Reimbursement and Radiology Procedures (An Interactive Session)
10:45-12:15 PM • SSA03 • Room: S504AB • Cardiac (Radiation Dose Reduction)
10:45-12:15 PM • SSA06 • Room: E353A • Gastrointestinal (CT Dose Reduction I)
10:45-12:15 PM • SSA20 • Room: S404AB • Physics (Low-dose CT Imaging)
11:45-12:45 PM • MSRA12 • Room: S402AB • Patient Radiation Dose: Reduction and Recording (An Interactive Session)
02:00-03:00 PM • MSRA13 • Room: S402AB • Abdominal Imaging Clinical Pathways (An Interactive Session)
02:00-03:30 PM • RC107 • Room: N226 • Quality and Contrast Safety 2013: Best Practices, Radiation and Contrast Media
02:00-03:30 PM • RC126 • Room: S103AB • Health IT Tools to Improve Quality and Safety in Radiology (An Interactive Session)

Monday, December 02, 2013
08:30-10:00 AM • RC216 • Room: E450B • Vignette-based 'Disclosure of Medical Error in Radiology' (Sponsored by the RSNA Professionalism Committee) (A...
08:30-10:00 AM • RC223 • Room: S403B • Minicourse: Current Topics in Medical Physics-Practice Quality Improvement: Basics and Issues for Medical Phys...
08:30-10:00 AM • RC229 • Room: S402AB • Should I Scan That Patient? A Very Interactive session on MR Safety and Regulations (An Interactive Session)
08:30-10:00 AM • RC251 • Room: E261 • CT Dose Reduction: Diagnostic Information, Image Quality and CT Radiation Dose (How-to Workshop)
08:30-12:00 PM • VSG121 • Room: N227 • Gastrointestinal Series: Emerging Issues in Abdominal CT
10:10-12:00 PM • MSAS22 • Room: S105AB • Global Health: Dose Reduction is Business (Sponsored by the Associated Sciences Consortium) (An Interactiv...
LEARNING OBJECTIVES
1) To describe the underlying physics of CT Dose and the technical factors which affect patient dose. 2) To understand different approaches to image reconstruction and their contribution to patient dose reduction. 3) How to develop and review low dose protocols for CT.

AAPM/RSNA Tutorial on Equipment Selection: Imaging Systems Designed to Reduce CT Dose and Maintain Image Quality
Saturday, 02:15 PM - 04:15 PM • E351

SSA03 • Detection of Coronary Artery Stenosis with Sub millisievert Radiation Dose by Prospectively ECG-triggered High Pitch Spiral CT Angiography and Iterative Reconstruction
Wei-Hua Yin (Presenter) ; Bin Lu MD ; U. Joseph Schoepf MD * ; Zhi-Hui Hou MD ; Fang-Fang Yu ; Yang Gao ; Hui-Li Cao ; Zhi-Qiang Wang

PURPOSE
To evaluate the diagnostic accuracy of sub-milliSievert (mSv) coronary CT angiography (cCTA) using prospectively ECG-triggered high-pitch spiral CT acquisition combined with iterative image reconstruction.

METHOD AND MATERIALS
IRB approval and informed patient consent were obtained. Forty consecutive, unselected patients (52.9±8.7 years; 30 men) underwent contrast (370mgI/mL iopromide) enhanced dual-source cCTA using prospectively ECG-triggered high-pitch spiral acquisition. Tube current-time product was set to 50% of standard-of-care CT examinations. Images were reconstructed with sinogram-affirmed iterative reconstruction. Image quality was scored and diagnostic performance for detection of ≥50% stenosis was determined with catheter coronary angiography (CCA) as the reference standard.

RESULTS
CT examinations were successfully performed in all 40 patients. Of the 601 assessable coronary segments, 543 (90.3%) had diagnostic image quality. Per-patient sensitivity for detection of ≥50% stenosis was 95.7% (95% confidence interval [CI], 76.0-99.8%) and specificity was 94.1% (95% CI, 69.2-99.7%). Per-vessel sensitivity was 89.5% (95% CI, 77.8-95.6%) with 93.2% specificity (95% CI, 86.0-97.0%). The area under the receiver-operating characteristic curve on per-patient and per-vessel levels was 0.949 and 0.913, respectively. Mean effective dose was 0.58±0.17mSv. Mean size-specific dose estimate was 3.14±1.15mGy.
Impact of Model Based Iterative Reconstruction on Noise Reduction of Ultra Low-dose Coronary CT Angiography

Tobias A Fuchs MD (Presenter) ; Julia Stehli MD ; Sacha Bull MD, PhD ; Svetlana Dougoud MD ; Martin W Huelner MD ; Andreas Brauchlin MD ; Ronny R Buechel ; Oliver Gaemperli MD ; Martin W Huellner MD ; Takeshi Nakaura MD ; Shinichi Nakamura MD ; Kazunori Harada ; Shouzaburo Uemura ; Yasuuki Yamashita MD * ; Tomohiro Namimoto MD ; Naritsugu Sakaino MD

PURPOSE
The purpose of this study was to assess the impact of model-based iterative reconstruction (MBIR) on noise reduction in ultra-low-dose coronary computed tomography angiography (CCTA). The study aimed to determine if MBIR efficiently compensates for increased noise in ultra-low-dose CCTA, enabling higher beam attenuation by iodine in low tube voltage scanning while maintaining adequate image quality.

METHOD AND MATERIALS
Twenty-five patients underwent standard low-dose CCTA (100 -120 kV; 450 - 700 mA) and an additional same-day ultra-low-dose (ULD) CCTA (80 â 100 kV; 150 â 210 mA) using MBIR. After assessing attenuation in the left main (LMA) and right coronary artery (RCA) as well as noise in the aortic root, the signal-to-noise ratio (SNR) was calculated for LMA and RCA.

RESULTS
The mean body mass index of the study population was 25.4 ± 4.4 kg/m² (range 18.4 â 40.2 kg/m²), and the mean weight 75.1 ± 15.3 kg (range 46.5 â 112.0 kg). The mean effective radiation dose was 1.3 ± 0.4 mSv in standard and 0.2 ± 0.1 mSv in ULD CCTA (p < 0.001). Nevertheless, mean image noise decreased significantly from 32 ± 7 HU in standard CCTA to 21 ± 4 HU in ULD MBIR CCTA (p < 0.001). Interestingly, this was paralleled by an increase in mean attenuation in LMA from 466 ± 85 HU to 563 ± 119 HU, and in RCA from 446 ± 63 HU to 503 ± 83 HU (p < 0.001).

CONCLUSION
MBIR efficiently compensates for increased noise in ULD CCTA. In combination with the shift towards higher beam attenuation by iodine in low tube voltage scanning, this results in a SNR substantially higher than standard CCTA.
SSA03-05 • Dual Source Cardiac Computed Tomography Angiography: Comparison of Image Quality and Radiation Dose Using Three Different Scan Protocols

Florian Wolf MD (Presenter) ;  Dietrich Beitzke MD ;  Vanessa Berger-Kulemann ;  Richard Nolz ;  Gudrun Feuchtner MD * ;  Christian Loewe MD *

PURPOSE
Cardiac allograft vasculopathy represents a major cause of mortality in the later course of cardiac transplant. CCTA represents a valuable non-invasive imaging tool in the diagnosis of cardiac allograft vasculopathy with the disadvantage of radiation burden. Radiation dose reduction in CCTA of cardiac transplant is challenging as patients often present with elevated heart rates. The aim of this prospective randomized study was to evaluate image quality, diagnostic confidence, and radiation dose using 3 different CT scan protocols for dual-source CCTA in heart transplant recipients.

METHOD AND MATERIALS
Dual source CCTA was performed in 150 consecutive patients after heart transplantation using either the conventional retrospectively ECG-triggered spiral technique (120 kV/320 mA, tube current modulation) in group 1, the prospective ECG-gated sequence technique (120 kV/320 mA, main padding window 40-70%) in group 2, or the prospective ECG-gated sequence technique in the systolic phase with automated tube voltage selection (Automated kV, main padding window 35-45%) in group 3. Subjective image quality was rated using a 16 segment coronary artery model and a four-point scale (1=excellent, 2= good, 3= fair, 4 = non-diagnostic) for each segment. Effective dose (ED) was used to compare the differences in radiation dose.

RESULTS
No difference was observed in subjective image quality between the study groups regarding segments with excellent or good image quality (Group 1: 90.5%, group 2: 89.3%; group 3: 86.8%). The number of segments with non-diagnostic image quality was lowest in group 3 (Group 1: 1.8%, group 2: 2.1%; group 3: 1.1%) and did not differ between group 1 and 2. Mean ED did not differ significantly between group 1 and group 2 (9.9±2.7 mSv vs. 9.1±2.3 mSv; p=0.13), but was significantly lower in group 3 (4.6±1.9 mSv; p 0.01).

CONCLUSION
Radiation dose of dual source CCTA in heart transplant recipients can be significantly reduced by using the ECG-gated sequence technique in the systolic phase and automated tube voltage selection, compared to the ECG-gated sequence technique using a wide padding window and the conventional spiral technique, while diagnostic image quality is maintained.

CLINICAL RELEVANCE/APPLICATION
Coronary CTA in heart transplant patients can be performed using a scan technique with relevant dose reduction with maintained image quality compared to conventional scan modes with higher doses.

SSA03-06 • Sub-mSv Coronary CT Angiography for Normal Size Patient Population (BMI)

Qiang Ma (Presenter) ; Xiang Ren ; Naja Liu ; Shaoning Yan ; Zhiyuan Zhang ; Jinrui Bao

PURPOSE
To study the clinical feasibility of achieving sub-mSv radiation dose and acceptable image quality for normal size patient population (20.5 ± 2) in prospective ECG-triggered coronary CT angiography (CCTA) with low tube voltage.

METHOD AND MATERIALS
One hundred and eighty patients (heart rate: 56±4 bpm, 20.5±2, and 190 mAs if BMI 22.5-25.0 kg/m²). Radiation dose was recorded. CT value and image noise on aorta were measured, and signal-noise-ratio (SNR) was calculated. The image quality was evaluated blindly (5 for excellent). Independent-sample t-test was performed on dose and Mann-Whitney test on image quality scores.

RESULTS
The overall dose for group A with 100kV was 0.69mSv, 35% lower than the 1.06mSv for group B with 120kV. For the patient population with BMI<20, the radiation dose for group A was 0.55±0.11mSv, 32% lower than the 0.81±0.09mSv for group B (p<0.05). The radiation dose for group B was 0.73±0.09mSv, 35% lower than 1.13±0.16mSv for group B (p=0.05).

CONCLUSION
Prospective ECG-triggered CCTA with low tube voltage significantly reduces radiation exposure while maintaining acceptable image quality. For the patient population with BMI<20, sub-mSv CCTA is achievable with prospective ECG-triggering and 100kV tube voltage.

CLINICAL RELEVANCE/APPLICATION
The use of prospective ECG-triggering and 100kV tube voltage in CCTA can reduce radiation to patients, and achieve sub-mSv dose for patient population with BMI<20.

SSA03-07 • Low Tube Voltage and High Sensitive Detector Reduce the Radiation Dose of Coronary CTA

Jian Cao (Presenter) ; Yining Wang MD ; Lingyan Kong ; Lin Lu MD ; Huadan Xue MD ; Zhiwei Wang MD ; Zhengyu Jin MD

PURPOSE
To investigate the application of low tube voltage (80kV) for coronary artery computed tomography angiography (CCTA) in patients with normal body mass index (BMI) with second generation dual-source CT equipment with novel high sensitive detector.

METHOD AND MATERIALS
RESULTS
CONCLUSION
Tube voltage as 80kV in second generation dual-source CT equipped with novel high sensitive detector is feasible in patients with normal BMI. This scan mode can obviously reduce the radiation dose while with no influence on image quality.

CLINICAL RELEVANCE/APPLICATION
Tube voltage as 80kV in second generation dual-source CT equipped with novel high sensitive detector is feasible in patients with normal BMI.

SSA03-08 • Feasibility and Image Quality of Ultra-low Dose Submillisievert Radiation Exposure in Coronary CT Angiography Using Model Based Iterative Reconstruction: First Clinical Experience

Julia Stehli MD (Presenter) ; Tobias A Fuchs MD ; Sacha Bull MD, PhD ; Svetlana Dougoud MD ; Martin W Huellner MD ; Andreas Brauchlin MD ; Ronny R Buechel ; Oliver Gaemperli MD ; Philipp A Kaufmann MD

PURPOSE
To evaluate the feasibility and image quality of coronary CT angiography (CCTA) acquisition with a submillisievert fraction of effective radiation dose using model based iterative reconstruction (MBIR) for noise reduction.

METHOD AND MATERIALS
RESULTS
Over a wide range of weight (47 - 112 kg) and body mass index (18.4 - 40.2 kg/m²), the mean DLP from standard and ULD CT was 89.5 ± 29.4 mGycm (range 69.8 - 188.3 mGycm) and 15.9 ± 6.2 mGy cm (range 10.2 - 35.6 mGy cm) resulting in an estimated mean radiation dose exposure of 1.3 ± 0.4 mSv (range 1.0 - 2.6 mSv) for standard and 0.2 ± 0.1 mSv (range 0.1 - 0.5 mSv) for ULD CT (p < 0.001). Intravenous beta-blockers were administered for heart rate control prior to CT in 20 patients (80%) (10.8 ± 9.5mg, range 3 - 25 mg). The mean heart rate for standard and ULD CT was 57.5 ± 5.6 and 57.0 ± 5.9 bpm (p = ns).
A total of 100 vessels and 330 coronary artery segments with a diameter of = 1.5 mm were evaluated and revealed an inter-observer agreement of image quality of ? = 0.8. The mean image quality score per segment was 3.3 ± 0.5 in standard CT vs. 3.4 ± 0.6 in ULD MBIR (p < 0.05). Diagnostic image quality (score 2 - 4) was found in 319 coronary segments (97%) of standard CT, and 317 (96%) segments of ULD MBIR (p = ns).

CONCLUSION
Our results document the feasibility of CTCA acquisition with diagnostic image quality at an ultra-low radiation dose of 0.2 ± 0.1 mSv in combination with MBIR reconstruction.

CLINICAL RELEVANCE/APPLICATION
CTCA scanning with an ultra-low radiation dose may pave the way for the broad clinical implementation of CTCA as an alternative for the invasive coronary angiography.

Gastrointestinal (CT Dose Reduction I)

Sunday, 10:45 AM - 12:15 PM • E535A

SSA06 • AMA PRA Category 1 Credit™: 1.5 • ARRT Category A+ Credit:1.5

Moderator
Joel G Fletcher MD *
Moderator
Anno Graser MD *

SSA06-01 • Relevance of Abdominal CT Radiation Dose Reduction beyond Childhood: What Does New Data Show?

Sarabjeet Singh MD (Presenter) ; Monica Ghita PhD ; Atul Padole MD ; Ranish D Khawaja MBBS, MD ; Sarvenaz Pourjabbar MD ; Mannudeep K Kaира MD * ; James A Brink MD

PURPOSE
Recent data from lifespan study from Japanese Atomic Bombing estimate increased Excess Lifetime Risks (ELR) of certain radiation-induced solid cancers, when exposure occurs at middle age rather than in childhood. The purpose of our study was to assess population based estimated ELR for solid cancers following abdominal CT in different age groups using size adjusted CT protocols in a large tertiary health care center.

METHOD AND MATERIALS
Our IRB approved study included 2902 consecutive routine abdominal CT. Dose monitoring software (Exposure, Radimetrics) was used to obtain patient demographics, scanning parameters as well as radiation dose information (Size Specific Dose Estimate (SSDE) estimated effective doses (EED) and organ doses). Patients were stratified by age groups of 11-20, 21-30, so on, >70 years. Estimated ELR from the time of exposure from chest CT was estimated based on recently reported literature on risk estimation from radiation induced solid cancer risks published from 2007-2012.

RESULTS
SSDE for routine abdominal CT examinations were highest for age group 61-70 years (11 mGy) and lowest for 10-20 years (9.4 mGy). EED (ICRP 103) were 6.9-8.7 mSv and 11.4-9.1 mSv for these age groups (p < 0.001). Intravenous beta-blockers were administered for heart rate control prior to CT in 20 patients (80%) (10.8 ± 9.5mg, range 3 - 25 mg). The mean heart rate for standard and ULD CT was 57.5 ± 5.6 and 57.0 ± 5.9 bpm (p = ns).

CONCLUSION
Contrary to the prior belief, dose concerns are not only important for the younger age groups (0-20) but also for older patients (30-60
Combination with Automated Tube Current Modulation

SSA06-04 • Image Quality Perception Using an Adaptive Statistical Iterative Reconstruction Algorithm

Ajit H Goenka MD (Presenter) ; Brian R Herts MD * ; Nancy A Obuchowski PhD ; Andrew Primak PhD * ; Frank Dong PhD * ; Wadhia Karim RT ; Mark E Baker MD *

PURPOSE
To assess the effect of reduced radiation exposure and reconstruction method on detection of lesions that are low-contrast, low-attenuation (LCLA) relative to the background liver

METHOD AND MATERIALS
Semi-automorphomorphic phantom containing custom inserts with 36 spherical liver lesions of 3 sizes and attenuations (10 and 15-mm at 6, 12 and 18HGU, and 5-mm at 12, 18 and 24HGU below 90HU simulated liver) was scanned at 120kVp, 0.6-mm collimation, 200 (CTDIvol 13.49), 150, 100 and 50mA on a 128-slice MDCT scanner (Definition Flash, Siemens). Lesions were distributed non-uniformly to reduce memory bias. Images were reconstructed at 3-mm thickness using filtered backprojection (FBP) and sinogram-affirmed iterative reconstruction (SAFIRE, S3). A randomized dataset containing 256 images was generated for each reader (12 images with one lesion, 12 with two lesions and 8 without lesions, for each dose and reconstruction method). Eighteen Radiologists blinded to phantom and study design independently reported region-level lesion presence or absence on a 5-point diagnostic confidence scale. Statistical evaluation included multi-reader, multi-case (MRMC) ROC analysis using nonparametric methods with the area under the ROC curve (AUC) considered accuracy.

RESULTS
Pooled AUC decreased with each 25% reduction from 100% dose: 0.848, 0.842, 0.792 and 0.743 for FBP; and 0.862, 0.855, 0.785 and 0.735 for SAFIRE. At a given dose, improvement in AUC with SAFIRE was, however, not statistically significant. For both FBP and SAFIRE, accuracy at 75% dose was statistically equivalent to 100% dose FBP (p =0.002 and 0.808 for FBP, respectively). At 50% dose, SAFIRE was superior to FBP (p =0.022 and 0.017 for FBP, respectively). In this LCLA liver model, a 25% dose reduction did not reduce detection of the lesions studied. However, detection was inferior with each subsequent dose reduction regardless of reconstruction method. For lesions with attenuation differences larger than or equal to 12HU, lesion detection was not reduced even at 50% dose with FBP.

CONCLUSION
Estimates of loss of accuracy at reduced doses and limits of iterative reconstruction should be known especially for low contrast, low attenuation liver lesions to enable dose optimization in practice.

SSA06-03 • Effect of the Learning Curve on Radiologist’s Diagnostic Performance for Hypervascular Liver Lesion Detection and Image Quality Perception Using an Adaptive Statistical Iterative Reconstruction Algorithm

Daniele Marin MD (Presenter) ; Achille Mileto MD ; Lisa M Ho MD ; Brian C Allen MD ; Rajan T Gupta MD * ; Ehsan Samei PhD * ; Rendon C Nelson MD *

PURPOSE
To prospectively evaluate the effect of experience with an adaptive statistical iterative reconstruction (ASiR) algorithm on diagnostic accuracy and confidence for the diagnosis of hypervascular liver tumors, as well as reader’s perception of image quality, using dual energy CT (DECT).

METHOD AND MATERIALS
Patient consent was obtained for this IRB-approved, HIPAA-compliant, prospective study. The final study cohort comprised 40 patients (29 M; mean age, 60±8.4 years; mean BMI, 28±5.6 kg/m2) with 65 hypervascular liver tumors who underwent DECT during the hepatic arterial phase. The low energy (80 kVp) image set was reconstructed with standard filtered backprojection (FBP) and ASiR at 20%, 40%, 60%, and 80% levels of blending. Two readers (one attending and one fellow in abdominal imaging) inexperienced with the imaging appearance of ASiR reconstructions randomly assessed all image sets for confidence in detecting and characterizing liver lesions, as well as evaluation of image quality (1st session). The same cases were re-examined by the same readers after three years of readers’ experience with ASiR in their daily practice (2nd session).

RESULTS
For both reading session, there was no significant difference in diagnostic accuracy and sensitivity for lesion detection using different reconstruction algorithms, among different readers. Diagnostic accuracy did not change significantly between the 1st and 2nd session for both FBP (0.91 vs 0.89) and any levels of ASiR reconstruction (0.90 vs 0.92). However, while ASiR yielded a significant decrease in diagnostic accuracy for lesion detection compared to FBP during the 1st session (0.91 vs. 0.89, P<.001), no significant difference in specificity was observed between ASiR and FBP in the 2nd session. Readers’ perception of image quality improved significantly for any levels of ASiR reconstruction between the 1st and 2nd session (P<.001). Reader’s experience with ASiR does not significantly change diagnostic accuracy for hypervascular liver lesion detection, but may decrease the number of false positive findings as well as improve reader’s perception of image quality.

CONCLUSION
Reader’s experience with ASiR improves subjective perception of image quality and may significantly decrease false-positive findings.

SSA06-04 • Potential of Radiation Dose Savings in Abdominal and Chest CT Using Automated Tube Voltage Selection in Combination with Automated Tube Current Modulation

Mathias Meyer (Presenter) ; Caroline Mayer ; Christian Fink MD ; Bernhard Schmidt PhD * ; Martin U Sedlmair MS * ; Paul Apfaltrer MD ; Thomas G Flohr PhD * ; Stefan O Schoenberg MD, PhD * ; Thomas Henzler MD

PURPOSE
To evaluate the simultaneous use of automatic tube current modulation (ATCM) and automatic tube voltage selection (ATVS) for abdominal and thoracic contrast-enhanced CT examinations regarding radiation dose reduction and image quality.

METHOD AND MATERIALS
In total 617 consecutive patients were enrolled in this retrospective single center study who all either underwent a portal-venous abdominal CT examination or a contrast-enhanced arterial phase chest CT examination and were divided into two groups. In group A, 317 patients were enrolled using ATCM with a fixed body-mass-index adjusted tube voltage of either 120 kV or 100 kV. In group B, consisting of 300 patients, ATCM was used while maintaining adequate image quality and diagnostic confidence without use of ASiR. The ATVS tool reduced tube voltage effective in the majority of patients (49%) resulting in a dose reduction of 18%, demonstrating the potential of this new dose modulation tool.
SSA06-05 • Model Based Iterative Reconstruction Algorithm for Abdominal CT at Variable Radiation Doses: Assessment of Image Quality, Lesion Conspicuity and Radiation Dose in Anthromorphic Liver Phantoms

Jeong Hee Yoon MD (Presenter); Jeong-Min Lee MD *; Mi Hye Yu MD; Joon Koo Han MD; Byung Ihn Choi MD, PhD *

PURPOSE
To assess the image quality, lesion conspicuity and radiation dose of model-based iterative reconstruction algorithm (IMR) compared with filtered back projection (FBP) and hybrid iterative reconstruction algorithm (iDose) for the liver computed tomography (CT) at radiation dose.

METHOD AND MATERIALS
Small and large anthromorphic phantoms with 4 simulated hypervascular tumors and 4 hypovascular tumors were scanned using a 256-channel CT scanner using 120 and 100kVp with 20, 40, 60, 80, 100, 130, 150, 180 and 200mAs. CT images of both phantoms at the two kVp were classified by radiation dose: standard dose (200mAs); mild dose reduction (DR) (130-180mAs), moderate DR (60-100mAs), severe DR groups (20-40mAs). All scans were reconstructed using FBP, iDose level 4 and IMR. Signal-to-noise ratio (SNR) and contrast-to-noise ratio (CNR) were calculated in the organs and compared among the different reconstruction modes. In addition, two radiologists assessed the image quality and lesion conspicuity of 8 focal liver lesions (FLLs).

RESULTS
SNR and CNR of IMR images were significantly higher than those of others, at the same radiation dose in both phantoms by reducing noise effectively (p<0.05).

CONCLUSION
IMR significantly reduces noises and improved SNR and CNR compared with FBP and iDose, and provide the similar image quality with mild to moderate dose reduction in variable body habitus. However, IMR can improve FLL conspicuity only with mild to moderate dose reduction.

CLINICAL RELEVANCE/APPLICATION
IMR can reduce noise and improve image quality and allows use of lower radiation dose for abdominal CT. Lesion conspicuity can be improved with IMR at mild to moderate dose reduction, severe dose redu

SSA06-06 • Assessment of Hybrid and Pure Iterative Reconstruction with Filtered Back Projection Technique for Low Dose Abdominal CT

Atul Padole MD (Presenter); Sarabjeet Singh MD; Michael A Blake MBCh *; Garry Choy MD, MS; Sanjay Saini MD; Mannudeep K Kalra MD *; Synho Do PhD *; Ranish D Khawaja MBBS, MD; Sarvenaz Pourjabbar MD; Diego A Lira MD

PURPOSE
To evaluate standard and low dose abdominal CT images reconstructed with filtered back projection (FBP), hybrid (hIRT) and pure (pIRT) iterative reconstruction techniques.

METHOD AND MATERIALS
In an IRB approved, prospective clinical study, 20 patients (mean age 59 ± 14 years, mean weight 181±41 lbs, M:F 13:7, undergoing routine abdomen CT on a 64 channel MDCT (Discovery CT750 HD) gave written informed consent for acquisition of an additional sub-millisievert (submSv) abdomen CT series. The latter series were acquired with reduced tube current but identical scan length compared to the routine abdomen CT. Sinogram data of submSv series were reconstructed with FBP, hIRT (SS50, SS70, SS90 GE Healthcare) and pIRT (GE Healthcare) and compared with FBP images of standard dose chest CT (n= 6*35=210 series). Three board certified abdominal radiologists performed independent and blinded comparison for lesion detection, lesion margin, visibility of small structures and diagnostic acceptability. Objective measurements, noise spectral density was obtained.

RESULTS
Mean CTDIvol were 9.3±3.5 and 1.3±0.2 mGy for standard and submSv CT, respectively. Lesion conspicuity was improved from poorly visualized margins in FBP and hIRT images to well defined margins on submSv pIRT. All 3 radiologists found submSv series were reconstructed with FBP, hIRT (SS50, SS70, SS90 GE Healthcare) and pIRT (GE Healthcare) and compared with FBP images of standard dose chest CT (n= 6*35=210 series). Three board certified abdominal radiologists performed independent and blinded comparison for lesion detection, lesion margin, visibility of small structures and diagnostic acceptability. Objective measurements, noise spectral density was obtained.

CONCLUSION
SubmSv abdominal CT examinations when reconstructed with pIRT improves the visualization of lesion margins and normal abdominal structures and are associated with lower image noise as compared to hIRT and FBP, without any significant image artifacts affecting diagnostic interpretation.

CLINICAL RELEVANCE/APPLICATION
Pure iterative reconstruction technique can allow use of submSv radiation dose for routine abdominal CT with retained diagnostic confidence.

SSA06-07 • Comparison of Dose from Single Energy and Dual Energy Multi-detector Computed Tomography Examinations in the Same Patient Screened for Hepatocellular Carcinoma

Andrei S Puryshko MD (Presenter); Mark E Baker MD *; Andrew Primak PhD *; Erick M Remer MD; Nancy A Obuchowski PhD; Binx John MD, MPH; Federico Aucejo; Brian H Herts MD *

PURPOSE
To compare the dose and noise level between single energy (SE) and dual energy (DE) multi-detector computed tomography (MDCT) examinations in patients undergoing screening for Hepatocellular Carcinoma (HCC).

METHOD AND MATERIALS
IRB-approved, HIPPA-compliant prospective study of 59 adult subjects (mean age 59.5yrs) undergoing HCC screening with 3-phase CT (unenhanced, arterial and portal-venous phases), who were each examined on both SE (Sensation 64, Siemens Healthcare) and DE CT scanners (Flash, Siemens Healthcare) on different dates. SE scans were performed using 120kVp and weight-based mAs (mAs=patient’s weight), and DE scans at 100kVP and 140kVp, with mAs adjusted to match the estimated CTDIvol of a weight-based mAs SE scan. The CTDIvol and DLP of each phase were recorded. Maximum anteroposterior and transverse dimensions measured from CT radiographs were used to calculate the effective diameter (ED) and size-specific dose estimate (SSDE). Regions of interest (ROI) were drawn in liver, retroperitoneal (RP) fat, IVC, and aorta and Hounsfield unit values with Standard Deviation (SD) recorded. Paired t-tests were used to compare BMI, weight, and ED at the time of the two imaging studies. Distributions of outcome variables (dose and noise) were examined using Q-Q plots and Shapiro tests.

RESULTS
BMI and weight of the subjects were highly correlated with the ED (r=0.75 and 0.87) and did not differ significantly between the two scans. CTDIvol and SSDE were significantly lower for all the phases on DE scans compared to SE scans (p<values

CONCLUSION
Dose with the MDCT DE scanning protocol was significantly lower when compared to SE examinations, with either similar or lower noise levels.
SSA06-08 • Ultra Low-Dose CT for Patients with Clinically Suspected Acute Appendicitis: Optimal Strength of Sinogram Affirmed Iterative Reconstruction for Image Quality and Diagnostic Performance

Seung Ho Kim MD (Presenter); Janghee Lee MD; Kyeong Hwa Ryu MD; Een Young Cho MD; Jung Hee Yoon MD; Yun-Jung Lim; Choong K Eun MD

PURPOSE
To evaluate the optimal strength of Sinogram Affirmed Iterative Reconstruction (SAFIRE) to obtain the best image quality on ultralow-dose CT (ULDCT) and to compare its diagnostic performance with that of the half-dose CT (HDCT) for the diagnosis of acute appendicitis.

METHOD AND MATERIALS
This prospective study was IRB approved, and informed consent was obtained from all patients. A total of 102 consecutive patients (47 men, 55 women; mean age, 41.2 years; range, 15-82 years) with right lower quadrant pain underwent low dose CT, which consisted of enteric phase HDCT (120 kVp, 100 mAs, effective dose=3.6 mSv) and portal phase ULDCT (120 kVp, 30 mAs, 1.5 mSv). ULDCT images were reconstructed separately with five levels of strength levels (S1-S5). Two blinded radiologists recorded scores for the subjective image quality and diagnostic performance of the ULDCT data set (S1-S5 and S0 filtered back projection) according to the European guidelines on quality criteria for CT, as well as confidence scores for the diagnosis of acute appendicitis on each set and HDCT. Histopathological findings served as a reference standard for diagnostic performance. For the quantitative analysis, CT image noise was measured for each set. Subjective image quality data were analyzed with Wilcoxon rank test, measured noise data by repeated measures ANOVA, and diagnostic performance by pair-wise comparison of ROC curves.

RESULTS
The study population consisted of 58 positives and 44 negatives. There was no significant difference in diagnostic performance between HDCT and ULDCT with any strength for both readers (AUC for reader 1, S0-S5=0.968, HDCT=0.933, p>0.05; for reader 2, S0=0.963, S1-S5=0.966, HDCT=0.966, p>0.05). The measured noise decreased as the strength increased from S0 to S5 (mean, 19.1>17.3>15.1>13.0>10.9>8.8, S4>S5, p

CONCLUSION
Although measured noise declined as SAFIRE strength increased, S3 seems optimal for the best subjective image quality on ULDCT. The diagnostic performance of ULDCT with any strength is comparable to that of HDCT for the diagnosis of acute appendicitis.

CLINICAL RELEVANCE/APPLICATION
For reducing radiation dose and maintaining diagnostic performance in patients with clinically suspected acute appendicitis, ULDCT with S3 reconstruction can be recommended.

SSA06-09 • Imaging of Acute Appendicitis: Role of Low-Dose CT

Gopesh Mehrotra MBBS, MD (Presenter); Anupama Tandon MD, MBBS; Sanjay Gupta MD; Agarwal A Durgadas MD; Ajai K Srivastava

PURPOSE
The clinical diagnosis of acute appendicitis is not always accurate and twin objectives of imaging are to avoid negative appendicectomies and to diagnose alternate pathologies. There is controversy about optimal imaging techniques and accuracy of imaging modalities. This study compared the diagnostic accuracy of ultrasonography (USG), low dose CT and standard dose CT in diagnosis of acute appendicitis.

METHOD AND MATERIALS
Subjects were hundred patients of all age group and either sex with clinical suspicion of acute appendicitis. Informed consent and clearance from institutional ethical committee was taken. USG was conducted by two reviewers and Low dose CT images obtained at predefined protocols were presented to the two reviewers, who were blinded to clinical findings. Standard dose CT was done thereafter only if required (in 36 cases). Patients who refused consent, had contrast allergy, fulminant peritonitis or pregnancy were excluded from the study. A control group was 75 patients who had USG / CT done for non-GI complaints. The sensitivity, specificity, PPV, NPV of each modality and finding was calculated in comparison to operative findings.

RESULTS
The overall sensitivity, specificity, PPV, NPV and accuracy of USG was 98.6%, 96.2%, 96.2% and 97.4 and low dose CT was 95.9%-97.2%, 95.7%, 98.6% and 98.6% respectively. Standard dose CT had highest sensitivity and specificity of 100%. Overall detection rate of appendix was 88% on USG, 100% on standard dose CT and 85.6% to 87.6% on low dose CT. On USG statistically significant association was found between acute appendicitis and thickened wall of appendix (>2mm), fluid in lumen and periappendical fluid and on low dose CT between acute appendicitis and hyperdense wall, periappendical fluid and stranding. Mean radiation dose was 0.664mSv on low dose CT (eff mAs 20) and 4.286mSv on standard dose (eff mAs 120).

CONCLUSION
Overall diagnostic performance of USG and low dose CT was good and was almost similar. There were no false positives or negatives on imaging, using USG and low dose CT together and a diagnosis was possible in most cases. Alternative diagnoses were seen in 17% cases and could be detected in all cases.

CLINICAL RELEVANCE/APPLICATION
Low dose CT in association with sonography has the potential to be used as a less radiating alternative for standard dose CT for diagnosing acute appendicitis or alternative diagnosis.
terms of noise, signal to noise ratio and diagnostic acceptability.

Background

National Comprehensive Cancer Network (NCCN) and other guidelines recommend CT surveillance usually up to 5 years for patients with early stage testicular cancer. This is generally a young patient cohort and therefore considered an at-risk group for high cumulative lifetime dose of ionizing radiation. We report the early results of a prospective trial to examine the effectiveness of model-based iterative reconstruction (MBIR) to reduce effective dose (ED) due to CT in follow up of these patients.

Evaluation

Following ethical approval, 23 patients referred for follow up of testicular cancer (mean age 34 years, range 18-60) consented to undergo an additional simultaneous low-dose (LD) CT of chest, abdomen and pelvis at the time of routine surveillance CT. The conventional dose (CD) and LD images both at standard reconstruction (SR) with 40% adaptive-statistical iterative reconstruction (ASiR) and reconstruction with MBIR of the initial 5 patients of the cohort were independently reviewed by two radiologists who assessed for diagnostic acceptability and graded images using published image quality indices. The ED and size specific dose estimates (SSDE) for each study was calculated.

Discussion

The mean ED (and SSDE) for LD and CD CT were 3.5±1.6 mSv (6.1±2.9 mGy SSDE) and 10.3±3.7 mSv (17.7±4.5 mGy SSDE), a mean dose reduction of 66% (p<0.001).

SSA20-02 • Comparison of Hybrid (iDose) and Model-based (IMR) Reconstruction Techniques in Sub Milli-Sievert Chest and Abdominal CT

Ranish D Khawaja MBBS, MD (Presenter) ; Michael A Blake MBChb * ; Garry Choy MD, MS ; Matthew D Gilman MD ; Mannudeep K Kalra MD * ; Subha R Digumarthy MD ; Amita Sharma MBBS ; Avinash R Kambadakone MD, FRCR ; Sarabjeet Singh MD ; Atul Padole MD ; Sarvenaz Pourjabbar MD ; Diego A Lira MD ; Kevin M Brown MS * ; Mukta Joshi *

PURPOSE

To assess diagnostic quality of sub milli-Sievert (subSv) chest and abdominal CT reconstructed with iterative model reconstruction (IMR) and iDose4.

METHOD AND MATERIALS

In a prospective clinical study, 20 patients (BM12, chest, n=10 age range: 26-90; abdomen, n=10 age range: 30-80) gave written informed consent for the acquisitions of subSv additional images (0.9 mSv) on a 256-slice CT (ICT, Philips). In addition to their clinical standard-dose (SD) CT (chest: 2.95mSv; abdomen: 5.6mSv), subSv images were reconstructed with low-dose (LD) FBP, iDose4 and IMR. Lesion margins were better seen for 30% of detected chest lesions (mostly emphysematous air-pockets and nodules) with IMR compared to SD-FBP, LD-FBP and iDose4.

Lesion detectability was not compromised in chest and abdominal CT examinations acquired at sub-mSv radiation doses. IMR image reconstruction of sub-mSv CT data helps improve delineation of lesion margins when compared to low-dose and standard-dose FBP, and iDose4 techniques.

CLINICAL RELEVANCE/APPLICATION

Preliminary results from this ongoing prospective clinical trial show the potential of IMR for lesion evaluation in chest and abdomen CT examinations acquired at sub-millie-Sievert radiation doses.

SSA20-03 • Sub-mSv Cerebral CT Perfusion Using PICCS

Jie Tang PhD (Presenter) ; Guang-Hong Chen PhD * ; Patrick A Turski MD * ; Vivek Prabhakaran MD, PhD ; Kari A Pulfer ; Howard A Rowley MD *

PURPOSE

With increasing concern regarding ionizing radiation from CT examinations, the radiation dose should be kept as low as possible while maintaining sufficient diagnostic information. The purpose of this study is to evaluate whether the radiation dose from a cerebral CT perfusion (CTP) scan can be kept under 1 mSv while maintaining diagnostic perfusion maps.

METHOD AND MATERIALS

An IRB approved protocol was used to perform a reduced-dose (RD) CTP scan immediately following standard-dose (SD) clinical CTP scan for the same subject. The SD CTP protocol used a 16 slice axial Shuttle mode on a GE CT750HD scanner, with 80 kV, 500 mA, 0.4 s gantry speed (200 mAs) and 17 time frames which lasts 45 s, with effective dose = 3.74 mSv. RD CTP used 100 mA (40 mAs) with other parameters the same as SD, with effective dose = 0.75 mSv. 20 subjects were enrolled in this study. The SD scans were reconstructed using FBP (filtered back projection) and the RD scans were reconstructed using FBP, ASIR (with 100% setting) and an iterative reconstruction algorithm, PICCS (prior image constrained compressed sensing with iterative reconstruction). Perfusion maps (CBF, CBV and MTT) were then generated using GE Perfusion 4 software using the Perfusion 3 algorithms. All image series were randomized and each series was scored by 2 neuroradiologists using a 5-point scale (1: non-diagnostic; 2: poor; 3: fair; 4: good; 5: excellent). Clinical findings were recorded for each series.

RESULTS

The mean scores for the SD FBP series are 3.9±0.5, 3.9±0.5 and 3.9±0.5 for CBF, CBV and MTT maps respectively; corresponding scores were 2.2±0.4, 2.1±0.4 and 2.3±0.5 for the RD FBP series; 2.7±0.5, 2.6±0.5 and 2.7±0.5 for RD ASIR series, and 3.4±0.6, 3.4±0.5 and 3.5±0.5 for RD PICCS series. Subjective scores of the RD PICCS image series are higher than RD FBP series (p<0.001). Prior image constrained compressed sensing with iterative reconstruction (PICCS) provides diagnostic quality perfusion maps with 20% of the radiation dose compared to current clinical protocols.

CLINICAL RELEVANCE/APPLICATION

Diagnostic quality sub-mSv cerebral CT perfusion imaging can be achieved using PICCS reconstruction.

SSA20-04 • Adaptive Statistical Iterative Reconstruction for Low Dose Quantitative Myocardial CT Perfusion: A Microspheres Validation Study

Aaron So PhD (Presenter) ; Jhang Hsieh PhD * ; Jean-Baptiste Thibault * ; Kelley Branch MD * ; Ting-Yim Lee MSc, PhD *

PURPOSE

We validated the effectiveness of adaptive statistical iterative reconstruction (ASIR, GE Healthcare (GE)) for minimizing image noise in low dose quantitative myocardial perfusion (MP) imaging against microspheres MP measurement.

METHOD AND MATERIALS

Iodinated contrast (Isovue 370, 0.7 ml/g/kg) was injected at 3 to 4 ml/s into 68±25 kg normal pigs via an ear vein and the heart was
scanned using a GE Discovery 750HD scanner with a prospectively ECG triggered dynamic protocol (Snapshot Pulse (SSP), GE): axial scan every 1-2 heartbeats for 22 scans using 140 kV, 0.35 s gantry period and 80 mA (normal dose). MP measurement was repeated with the x-ray tube current reduced to 20 mA (low dose). The normal- and low-dose SSP images were reconstructed using filtered backprojection (FBP) (SSP80) and both FBP (SSP20 FBP) and ASIR (SSP20 ASIR) respectively. All images were corrected for beam hardening from which MP maps were generated using CT Perfusion (GE). After the CT perfusion studies, fluorescent microspheres were injected into the left atrial appendage of the heart to measure MP. Mean MP measured with microspheres and the three CT Image sets in 45 segments from the lateral, apical and septal wall in 15 slices from three pigs were compared using linear regression and Bland-Altman analysis. Effective dose (ED) of each SSP protocol was estimated from the dose-length product provided by the scanner.

RESULTS
SSP80 images exhibited the highest correlation with microspheres (R=0.69) compared to SSP20 ASIR (R=0.60) and SSP20 FBP (R=0.57). SSP80 images also showed the smallest difference in mean MP from microspheres and narrowest limits of agreement with microspheres (7.0 and -46.8 ml/min/100g (80)) compared to SSP20 ASIR (11.3 and -35.3 to 57.8 (93)) and SSP20 FBP (15.7 and -32.8 to 64.1 (97)). The ED of the SSP80 and SSP20 protocols were 4.5 and 1.1 mSv respectively.

CONCLUSION
Noise in low dose SSP images reconstructed with FBP was excessive which led to less accurate and reproducible MP estimation with CT Perfusion but such errors could be reduced with ASIR.

CLINICAL RELEVANCE/APPLICATION
With the proposed image acquisition and reconstruction approaches, MP measurement with low dose CT Perfusion is a feasible alternative to MRI and SPECT for studying ischemic heart disease.

SSA20-05 • Low-dose Pelvic CT Using Adaptive Iterative Dose Reduction 3D: A Phantom Study

Remko Kockekloren (Presenter) ; Hiromitsu Onishi MD ; Tonsok Kim MD ; Masatoshi Hori MD ; Atsushi Nakamoto MD ; Noriyuki Tomiyama MD, PhD ; Makoto Sakane MD ; Mitsuaki Tatsumi MD, PhD

PURPOSE
To evaluate the image quality and radiation dose reduction in pelvic CT reconstructed using an adaptive iterative dose reduction 3D (AIDR 3D) technique with a phantom model.

METHOD AND MATERIALS
An anthropomorphic phantom (CTU-41; Kyoto Kagaku, Kyoto, Japan) and a Catphan phantom containing low-contrast objects (Catphan 500; Phantom Laboratory, Salem, NY) were scanned with a 320× detector row CT scanner (Aquilion ONE; Toshiba Medical Systems, Otawara, Japan) in eight tube current levels (ranged from 25 mA to 500 mA) at 80 kV and 120 kV, respectively. The rotation period was 0.5 second and the helical pitch was 0.828 (53/64). Standard filtered back projection (FBP) images and AIDR 3D images were reconstructed for each setting and were compared. For the quantitative evaluation, image noise (standard deviation of CT number) and contrast to noise ratio (CNR) between the model bladder and the surrounding area of the anthropomorphic phantom were calculated. For the qualitative evaluation, image noise, image artifacts, delineation of the organs and overall image quality in the anthropomorphic phantom were assessed by three radiologists. The detectability of the low-contrast objects of the Catphan phantom were also evaluated using a receiver operator characteristic analysis. Sensitivities and specificities were compared by using McNemar's chi-square test.

RESULTS
In the quantitative evaluation, AIDR 3D resulted in a substantial noise reduction compared to FBP and revealed higher CNRs than FBP. In the subjective evaluation, the image noise, image artifact such as photon starvation, and overall image quality improved with AIDR 3D. In the detectability evaluation, at 120 kVp, the sensitivities, the specificities, and the Az values were 16.7%, 100%, 0.78 for image at 100 mA (50 mAs) with AIDR 3D, 33.3%, 100%, 0.75 for images at 150 mA (75 mAs) with AIDR 3D, and 33.3%, 100%, 0.81 for those at 200 mA (100 mAs) with FBP. There were no statistically significant differences.

CONCLUSION
Our results in a phantom study shows that AIDR 3D technique may allow approximately 25-50% radiation dose reduction compared to FBP technique in pelvic CT examinations maintaining the image quality and the diagnostic performance.

CLINICAL RELEVANCE/APPLICATION
Radiation at the pelvic region is of special importance particularly for the young patients because of the genetic risk and AIDR 3D technique may allow the radiation dose reduction in pelvic CT.

SSA20-06 • Synergistic Radiation Dose Reduction by Combining Automatic Tube Voltage Selection and Iterative Reconstruction

Jeremy R Wortman MD (Presenter) ; Alexander J Adduci MD, PhD ; Tim O’Connell MD, MEng * ; Aaron D Sodickson MD, PhD

PURPOSE
To evaluate radiation dose and image quality in CT pulmonary angiography (CTPA) exams with automated tube voltage selection (CarekV) before and after implementation of sinogram affirmed iterative reconstruction (Safire).

METHOD AND MATERIALS
The cohort included: 1) 50 consecutive CTPAs performed on a Siemens AS+ scanner from 5/7/12 5/31/12 using CarekV (vascular image quality selection, reference kVp 120, reference mAs 180), and 2) 59 consecutive CTPAs performed from 7/1/12 7/18/12 using CarekV with reference mAs reduced to 120 and images reconstructed using Safire at strength of 3. All scans were performed with longitudinal and in-plane tube current modulation (CareDose 4D). CarekV on a vascular setting uses the topogram x-ray attenuation to select the scan kVp expected to produce the lowest achievable CTDIvol while maintaining the desired iodine contrast to noise ratio and respecting the maximum x-ray tube current limits. We measured patient size (effective diameter = sqrt(AP X Lat)), signal (mean CT density) and noise (standard deviation), and recorded local CTDIvol at the level of the main pulmonary artery. Linear regression models were created for the dependent variables ln(CTDIvol), signal, noise, and signal to noise ratio (SNR) as a function of independent variables size, age, gender, and reconstruction technique.

RESULTS
The 33% reduction in reference mAs in the Safire group allowed CarekV to select reduced kVp in larger patients than in the FBP group, with an overall reduction in 120 kVp scans from 42.9% to 0% and an associated increase in 100 kVp scans from 53.6% to 62.0% and 80 kVp scans from 3.5% to 38.0%. When controlling for size, the combination of Safire and CarekV yielded an overall CTDIvol reduction of 44.5% (p < .0001), a signal increase of 96 HU (p = .002), and an increase in image noise (p = .004) with no significant change in SNR (p = .70).

CONCLUSION
The combination of CarekV and Safire resulted in a 44.5% dose reduction, substantially greater than the 33% reduction that would be achieved by reducing the reference mAs alone. This is accomplished with preserved image quality as the reduced reference mAs allows CarekV to scan larger patients at reduced kVp.

CLINICAL RELEVANCE/APPLICATION
Synergistic dose reduction can be achieved by combining automatic kVp selection with global mAs reduction (as used in concert with iterative reconstruction) with no negative impact on image quality.

SSA20-07 • Systematic Dose Evaluation of Iterative Reconstructed Computed Tomography in a Contrast Enhanced Cadaveric Model

Tobias Penzkofer MD (Presenter) * ; Jonas C Apitzsch MD ; Yunus Alparslan ; Hong-Sik Na MD ; Timm Dirrichs ; Philipp...
The results demonstrated that the proposed algorithm can improve image quality for current dedicated breast CT.

CLINICAL RELEVANCE/APPLICATION
The image quality improvement for the dedicated, cone-beam breast CT scanner may have impacts for breast cancer screening or diagnosis.

**Patient Radiation Dose: Reduction and Recording (An Interactive Session)**

**Sunday, 11:45 AM - 12:45 PM • S402AB**

QA NW HP  
MSRA12 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1  
Douglas E Pfeiffer, MD

**LEARNING OBJECTIVES**
This session will include a discussion of current methods and trends toward reducing patient radiation dose with highlights of areas where there is particular concern or new data. The remainder of the session will include the ethical, legal, and policy-driven practices related to recording patient radiation dose.

**Abdominal Imaging Clinical Pathways (An Interactive Session)**

**Sunday, 02:00 PM - 03:00 PM • S402AB**

QA NW  
MSRA13 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1  
Julia R Fielding, MD

**LEARNING OBJECTIVES**
With the growing concerns related to radiation safety and cost containment, the need for accurate imaging procedure selection to best fit the patient and the clinical presentation is more and more critical. This session will provide clinical scenarios with patient presentation information and a discussion of the choices of imaging pertinent to that clinical presentation. Where there are multiple imaging pathways, the decision will be discussed in light of radiation safety and cost containment guidelines.

**Quality and Safety 2013: Best Practices, Radiation and Contrast Media**

**Sunday, 02:00 PM - 03:30 PM • N226**

QA NW  
RC107 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5  
Coordinator  
Giles W Boland, MD  
Walter Huda, PhD  
Richard H Cohan, MD

**LEARNING OBJECTIVES**
1) Understand the background and current status of best practice clinical and workflow management and its imperative for improving patient outcomes. 2) To review indications for premedication prior to contrast material administration. To summarize the current understanding of iodinated contrast media nephrotoxicity. To describe common errors made in treating contrast reactions. 3) To understand the requirement to match radiation dose according to the individual patient, clinical question and modality used. To outline meaningful radiation metrics including organ dosages and the overall radiation absorbed to estimate patient risk.

**ABSTRACT**
BEST PRACTICES: Increasingly medicine is being defined and evaluated based on patient outcomes rather than procedural events. While best practices are evolving and sometimes incomplete, many do exist, yet there is marked departmental variation from one organization to another. This session will outline why and how best practice implementation, particularly as it relates to IV contrast use and radiation dose, is essential to achieve better patient outcomes. This will require evaluation of current practices and comparison to nationally driven guidelines, with subsequent compliance to guidelines where they exist. CONTRAST SAFETY: Some patients have contrast reactions despite premedication. Patients who have repeated reactions in this setting tend to have reactions of similar severity. Studies performed with control groups suggest that there is minimal to no increased risk of contrast-induced renal failure in patients who receive iodinated contrast material; however, the control groups likely included patients at increased risk of acute kidney injury. Some errors treating contrast reactions relate to failure to administer epinephrine or using the wrong dose / wrong route. The act of administering this drug can also be problematic.

RADIATION DOSE: In all radiological examinations that utilize x-rays, there are always three important issues that must be taken into consideration. The first relates to the appropriate amount of radiation to be used, which must always explicitly take into account the imaging task at hand as well as the physical characteristics of the patient undergoing the CT examination. The second issue is how to transform the radiation incident on the patient into the organ doses received which are essential to understanding (any) patient risks. The final consideration is to understand the radiological significance of the radiation absorbed by the patient, and to estimate (any) radiological risks, as well as the corresponding uncertainties.

**Health IT Tools to Improve Quality and Safety in Radiology (An Interactive Session)**

**Sunday, 02:00 PM - 03:30 PM • S103AB**

QA NW  
RC126 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5  
Moderator  
Kevin W McEnery, MD

RC126A • Measuring Quality in Radiology, a Practical Framework  
Ramin Khorasani MD (Presenter)

**LEARNING OBJECTIVES**
1) Describe some of the reasons and the urgency for measuring quality in radiology. 2) Describe a simple and practical framework for establishing radiology quality metrics in your practice. 3) Use a case example to illustrate how quality metrics can be implemented in your practice.

**ABSTRACT**
Making continuous improvements is a hallmark of successful organizations. Such improvements can impact every aspect of your radiology practice including quality, safety, efficiency (including financial performance), and quality of work-life. By focusing on few important and relevant metrics to your performance gaps and quality improvement initiatives, one can communicate current state and clearly identify
the goals on key improvement initiatives. In this session, we will demonstrate how using a practical framework, such as Institute of Medicine’s attributes (IOM) for high quality of care or the National Quality Forum (NQF) framework for creating quality metrics, a radiology practice can create and adopt quality metrics to help drive performance improvement. We will use case examples to demonstrate how measuring quality can help improve performance within the radiology department and the healthcare enterprise. The panel discussion will focus on how you can take practical steps in measuring quality and how to use quality metrics for performance improvement.

RC126B • Using Quality Metrics to Drive Change and Improve Quality within a Radiology Department

Paul G Nagy PhD (Presenter)

LEARNING OBJECTIVES
1) Discuss the National Quality Forum model for evaluating quality metrics based upon Importance, Repeatability, Feasability, and Usability. 2) Identify informatics mechanisms to assist in the capture, collection, analysis, and communication of quality metrics within Radiology. 3) Talk about actionable information and how to use quality metrics to drive change and enable effective management oversight.

RC126C • Using Quality Metrics to Drive Change and Improve Quality Across the Enterprise

Kevin W McEnery MD (Presenter) *

LEARNING OBJECTIVES
1) Understand potential to leverage the Electronic Medical Record to drive changes within radiology departments. 2) Learn about the benefits of extending radiology workflow into the enterprise to enhance workflow processes within radiology departments. 3) Appreciate capabilities of coordinating patient schedule activities to improve radiology performance and clinical interactions with clinicians in the Emergency Center and In-patient setting.

ABSTRACT

Vignette-based 'Disclosure of Medical Error in Radiology' (Sponsored by the RSNA Professionalism Committee) (An Interactive Session)

Monday, 08:30 AM - 10:00 AM • E450B

RC216 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5

Director
Stephen D Brown , MD
Constance D Lehman, MD, PhD *
Thomas H Gallagher , MD
Elaine C Meyer , PhD, RN

LEARNING OBJECTIVES
1) Understand error disclosure as an essential tenet of patient care and medical professionalism. 2) Identify barriers to effective error disclosure. 3) Develop strategies for effective disclosure of radiological errors to referring physicians, patients and families.

ABSTRACT

Disclosure of medical error is a daunting communication challenge for all physicians. Like many physicians, radiologists are unlikely to demonstrate full transparency and honesty when a medical error occurs. No educational programs have been developed specifically to help radiologists overcome barriers to disclosure of clinical errors, and learn how to approach communication about disclosure optimally. The objective of this Refresher Course is to enhance radiologists’ understanding of and comfort with disclosure of radiological errors to referring physicians and patients. The 90-minute Course will include didactic presentations by clinician scholars in the field of medical error disclosure, and live enactments between trained personnel/actors and Course participants. Didactic material will discuss background information, risks, benefits, and barriers to disclosure, and introduce strategies toward discussing medical errors with patients and treating physicians. Enactments will entail conversations between volunteer Course participants and trained personnel who will portray physicians and patients to whom the Radiologist/participant must disclose an error. The enactments will be followed by debriefings and group discussions.

Minicourse: Current Topics in Medical Physics-Practice Quality Improvement: Basics and Issues for Medical Physicists

Monday, 08:30 AM - 10:00 AM • S403B

RC223 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
G. Donald Frey , PhD

RC223A • Introduction

Richard L Morin PhD (Presenter)

LEARNING OBJECTIVES
1) The participant will have an overall orientation to the role of medical physics in nuclear cardiology.

RC223B • Practice Quality Control: The ABR Perspective

G. Donald Frey PhD (Presenter)

LEARNING OBJECTIVES
1) The participant will understand the role of PQI in the ABR MOC process.

ABSTRACT

This section is an overall introduction to the course and will place Practice Quality Improvement (PQI) into the perspective of the ABR Maintenance of Certification (MOC) process.

RC223C • Basics and Practical Projects

Paul G Nagy PhD (Presenter)

LEARNING OBJECTIVES
1) Learn why quality methodologies can be useful for physicists. 2) Discuss PQI projects a physicist can do in diagnostic radiology. 3) Learn the basics of quality techniques with a discussion around practical PQI projects. 4) Talk about how the physicist can be a real resource to physicians conducting PQI projects.
ABSTRACT

Should I Scan That Patient? A Very Interactive Session on MR Safety and Regulations (An Interactive Session)
Monday, 08:30 AM - 10:00 AM • S402AB

Learning Objectives
1) Recognize a spectrum of common MR safety issues and regulations. 2) Assess the benefits and limitations of ferromagnetic detector technology. 3) Formulate policies for contrast administration and MR imaging of pregnant patients. 4) Compare current approaches to MR scanning of patients with pacemakers and other implanted cardiac devices.

CT Dose Reduction: Diagnostic Information, Image Quality and CT Radiation Dose (How-to Workshop)
Monday, 08:30 AM - 10:00 AM • E261

Learning Objectives
1) Visual impression of general image quality parameters such as image noise, texture, sharpness and artifacts in CT. 2) Image guided tour on effects of radiation dose on general image quality parameters. 3) Image based display of effects of different scan parameters on general image quality metrics. 4) Image guided display of effects of radiation dose and different scan parameters on appearance of different lesion subtypes in adult and pediatric body CT examinations.

Gastrointestinal Series: Emerging Issues in Abdominal CT
Monday, 08:30 AM - 12:00 PM • N227

Learning Objectives
1) Understand the relative advantages and disadvantages of the use of positive oral contrast in abdominal CT imaging for a wide variety of clinical scenarios.

VSGI21-01 • Oral Contrast Issues
Perry J Pickhardt MD (Presenter) *

Learning Objectives
1) Understand the relative advantages and disadvantages of the use of positive oral contrast in abdominal CT imaging for a wide variety of clinical scenarios.

VSGI21-02 • Discontinuation of Positive Oral Contrast for Routine CT Scans Does Not Result in Substantial Repeat Scans
Wilbur Wang BA (Presenter) ; Nikita Shah ; Michael A Ohliger MD, PhD ; Yanjun Fu PhD ; Zhen J Wang MD ; Benjamin M Yeh MD *

Purpose
To evaluate the rate of repeat scans after an institution-wide policy to discontinue the routine administration of positive oral contrast in favor of oral tap water for routine abdominal CT examinations.

Method and Materials
From a total of 12,370 abdominal CT scans performed at our institution from March 9, 2009 to June 26, 2012, we identified all repeat abdominal CT scans occurring between 2 hours and 14 days after an initial abdominal CT scan. On March 9, 2009 our department discontinued the routine administration of positive oral (iodinated) contrast in favor of oral tap water for such scans. Readers recorded the presence of oral and IV contrast in both initial and repeat abdominal CT scans images. For scans in which positive oral contrast was given, the reason for administering oral contrast was given..
RESULTS
From a total of 12,370 abdominal CT examinations, 439 (3.5%) were repeat scans, and of these, 47 scans (10.7%) used oral contrast on the repeat CT scan but not the initial. The most common reasons for administration of oral contrast were for evaluation of abscesses (40.0%), evaluation for perforation (33.1%), and obstruction (13.1%). Only 11 out of the 439 repeat scans (2.5%) were explicitly performed due to a need for oral contrast in the repeat scan (0.09% of all scans). Significantly fewer repeat scans used oral contrast (either on the initial study or repeated study) in 2012 (5 of 60 scans, or 8.3%) compared with 2009 (76 of 215 scans, or 35.3%, \( P < .01 \)). Overall, the frequency of repeat abdominal CT scans significantly decreased from 4.7% in 2009 to 2.8% in 2012 (\( P < .001 \)).

CONCLUSION
The discontinuation of positive oral contrast from routine abdominal CT protocols at our institution led to a miniscule frequency of repeat examinations (0.09% of all scans) which diminished over 3 years. Our findings support the continuation of this policy, especially when weighed against the inconvenience, expense, and potential complications of administering oral contrast to every patient.

CLINICAL RELEVANCE/APPLICATION
Discontinuation of positive oral contrast from routine abdominal CT exams does not result in a substantial frequency of repeat examinations with oral contrast.

VSGI21-03 • Radiation Dose Reduction Techniques
Rendon C Nelson MD (Presenter) *

LEARNING OBJECTIVES
1) To understand the pros and cons of radiation dose reduction in CT. 2) To learn methods for radiation dose reduction that do not impact image quality. 3) To learn methods for radiation dose reduction that do impact image quality. 4) To understand the implications of using iterative reconstruction techniques for CT.

VSGI21-04 • Abdominal CT Radiation Doses (Conventional and Organ Doses) from Large Academic Institute with 3 Scan Vendors and Different Iterative Reconstruction Techniques
Sarvenaz Pourjabbar MD (Presenter) ; Sarabjeet Singh MD ; Mannudeep K Kalra MD * ; Atul Padole MD ; Ranish D Khawaja MBBS, MD ; Diego A Lira MD ; Sanjay Saini MD

PURPOSE
To assess and compare radiation doses for abdominal CT examinations performed with different scanning protocols, various scan manufacturers and models, with and without iterative reconstruction in routine clinical settings.

METHODOLOGY AND MATERIALS
This IRB-approved, HIPAA-compliant study included 8758 consecutive abdomen-pelvis CT exams (mean age: 59.3±16.6 years; M: F=4469:4288). Automatic dose monitoring software (Exposure, Bayer) was used to retrieve patient demographics, including date of birth, gender, weight, CT maximum skin to skin diameters, CT dose index (CTDIvol), DLP, effective doses, size specific dose estimates (SSDE), as well as organ doses. Selected scan protocols and scanner models with information on iterative reconstruction (IR) were also recorded. Analysis of variance was used to evaluate differences across above variables. \( P \)-value of 0.05 with 95% confidence interval was considered significant.

RESULTS
Distribution of CT examinations per scanner included 16-slice GE (n=3200), 64-slice GE (n=1730), 64-slice Philips (n=176), 128-Siemens (n=221) and 256-Phillips (n=724). Abdominal CT were performed with several clinical protocols, including routine abdominal CT (n=2463), stone/ hematia (n=570) and cancer follow up (n=1385). Stone protocols were performed more commonly on 64-GE with mean CTDIvol (n=344, 8.5±3.3 mGy), 6 GE (n=220, 10.5±3.8 mGy), and 256-Phillips (n=144, 8.4±5.5 mGy). Routine abdominal CT were stratified in 4 weight groups, less than 135lbs (n=683, 6.4±2 mGy), 136-200lbs (n=2257, 9±2.5 mGy), 200-300lbs (n=812, 13 ± 3.2 mGy) and more than 300lbs (n=51, 26±8 mGy). Estimated effective doses for iterative reconstruction scanners were 8±3 (n=764, Discovery750HD) 9±3 (n=133, Definition FLASH) and 7±3 (n=124, Brilliance ICT). Organ doses are summarized in a graphical manner in figure 1.

CONCLUSION
Clinical indication, CT scanner, and size based variations in abdominal CT protocols help in optimization of radiation doses. Although CT dose indexes provide good estimates for comparing across CT scanners, organ doses should be used for comparing patient doses.

CLINICAL RELEVANCE/APPLICATION
Abdominal CT examinations doses ranged from 6 to 26 mGy and hence it is important to optimize based on clinical indication, weight and iterative reconstruction technique.

VSGI21-05 • Observer Performance for Site-specific Detection and Correct Classification of Malignant Liver Lesions for an Image-based Denoising Method and Iterative Reconstruction
Joel G Fletcher MD (Presenter) ; Lifeng Yu PhD ; Zhoub Li ; Armando Manduca PhD * ; Daniel J Blzek PhD ; David M Hough MD ; Sudhakar K Venkatesh MD, FRCR ; Gregory C Brickner MD ; Joseph G Cernigliaro MD ; Amy K Harr MD * ; David Lake ; Maria Shiung ; David Lewis ; Shuai Leng PhD ; Kurt E Augustine MS ; Rickey Carter PhD ; David R Holmes PhD ; Cynthia H McCollough PhD *

PURPOSE
Noise reduction techniques may improve subjective image quality, but few studies have addressed impact on diagnostic performance. Our purpose was to determine if lower dose (LD) CT images reconstructed with image-based noise reduction (Noise Map; NM) or an IR technique (SAFIRE; Siemens Healthcare) resulted in reduced observer performance for detection of primary or secondary liver tumors (LTs), compared to routine dose filtered back projection (FBP) images.

METHOD AND MATERIALS
CT projection data from 60 CT exams were collected (30 abdomen at 16 mGy, 30 liver at 23 mGy; 31 with LTs). Presence of LTs was defined by progression/regression on CT/MR or pathology. Using a validated noise insertion tool, LD NM, LD FBP, and LD SAFIRE images were created corresponding to 12 mGy (ab) or 14 mGy (liver). In each reading session, 3 readers randomly evaluated either routine dose FBP, LD FBP, LD NM, or LD SAFIRE images. 3 mm CT images were reviewed on a dedicated computer workstation, with readers circling all liver lesions, then selecting a diagnosis (LT vs. individual benign diagnoses) and confidence score (0 100), and grading image quality. Reference detections were similarly marked, with automated matching of reference and reader lesions using an overlapping spheres method. JAFROC analysis was performed on a per lesion basis for LTs, with true positives correctly localized and classified. A limit of non-inferiority of -0.1 was defined as a priori.

RESULTS
There were 73 LTs with a median size of 1 +/- 1 cm. The JAFROC figure of merit (FOM) overlapped for routine dose FBP, LD FBP, and LD NM (FOM 95% CI±s= 0.84 ± 0.95, 0.79 ± 0.93, 0.82 ± 0.93, respectively for routine FBP, LD FBP, LD NM), with the estimated differences between routine FBP and LD FBP or NM being non-inferior. Similarly, JAFROC FOM±s were similar between routine dose FBP and each LD approach in the subset of 44 cases with SAFIRE (0.97 vs. 0.94, 0.93, 0.94), with LD approaches being non-inferior. Diagnostic image quality was greatest for LD images with noise reduction (\( P < .03 \) all readers).

CONCLUSION
Lower dose CT images reconstructed with FBP, NM and SAFIRE can be interpreted without loss of diagnostic performance despite the improved image quality of NM and SAFIRE.
Clinical relevance/application

Although perceived quality of LD images was improved with use of noise reduction methods, observer performance was not significantly different than for FBP even for challenging liver tumors.

VSG121-06 • Prospective Evaluation of Prior Image Constrained Compressed Sensing (PICCS) Algorithm in Abdominal CT: Preliminary Results Comparing Reduced Dose with Standard Dose Imaging

Meghan G Lubner MD (Presenter); David H Kim MD *; Jie Tang PhD; Perry J Pickhardt MD *; Alejandro Munoz Del Rio PhD;
Guang-Hong Chen PhD *

Purpose
To report preliminary prospective results of an ongoing CT dose reduction trial using Prior Image Constrained Compressed Sensing (PICCS).

Method and materials
50 patients (23 F, 27 M, mean age 57.7 years, mean BMI 28.6) were scanned in this HIPAA compliant, IRB approved study. Immediately following routine contrast-enhanced (n=26) or unenhanced (n=24) abdominal MDCT, a second reduced dose (RD), matched series scan was performed (target dose reduction 70-90%). DLP, CTDIvol and SSDE were compared between scans. Multiple reconstruction algorithms (standard filtered back projection (FBP), adaptive statistical iterative reconstruction (ASIR), and Prior Image Constrained Compressed Sensing (PICCS)) were applied to the RD series. Standard dose images (SD) were reconstructed with FBP (reference standard). Two blinded readers evaluated each series for subjective image quality and focal lesion detection. Objective noise and region of interest attenuation (HU) were measured at designated sites.

Results
Mean DLP, CTDIvol, effective diameter and SSDE for the RD series was 140.3 mGy*cm (median 79.4, range 15.9-526.6), 3.7 mGy (median 1.8, range 0.4-26.4), 30.1 cm (median 30, range 24.6-38.0), and 4.15 mGy (median 2.31 range 0.59-24.3) compared to 493.7 mGy*cm (median 345.6, range 57-1453.7), 12.9 mGy (median 7.9 mGy, range 1.43-79.8) and 14.6 mGy (median 10.1, range 2.1-73.4) for the SD series respectively. This is a mean SSDE reduction of 72%. RD PICCS image quality score was 2.8±0.5, improved over the RD FBP and RD ASIR scores (1.7±0.7 and 1.9±0.8 respectively), but less than the SD score of 3.5±0.5 (p < 0.05).

Conclusion
PICCS allows for marked dose reduction at abdominal CT at the expense of subjective image quality scores and diagnostic performance. Further study is needed to determine optimal dose reduction level to maintain acceptable diagnostic accuracy.

Clinical relevance/application
PICCS allows for substantial CT dose savings (70-90%), lowering the dose for some applications (urolithiasis, colon ca screening) into the sub-mSv range.

VSG121-08 • Dual Energy CT

Alec J Megibow MD, MPH (Presenter) *

Learning objectives
1) Understand basic physical principles that support Dual Energy CT applications for abdominal imaging. 2) Familiarize audience with radiation dose and image quality as they relate to Dual Energy CT. 3) Demonstrate the value of unique dual energy CT capabilities drawing on examples from abdominal imaging capabilities.

VSG121-09 • Can Multi-material Decomposition Algorithm Generated Virtual Unenhanced (VUE) Images from Single Source Dual-energy CT meet the Qualitative and Quantitative Expectations of True Unenhanced (TUE)?

Mukta D Agrawal MBBS, MD (Presenter) *; Jorge M Fuentes MD; Avinash R Kambadakone MD, FRCR; Yasir Andrabi MD, MPH; Shaheen Sombans MBBS; Jannareddy Namrata Reddy MBBS; Koichi Hayano MD; Dushyant V Sahani MD

Purpose
We investigated the performance of recent commercially available multi-material decomposition (MMD) algorithm rendered VUE images for image quality/texture improvements and attenuation (HU) measurements.

Method and Materials
In IRB approved prospective study, 33 consecutive patients had arterial and delayed phase ssDE-CTA (GE discovery CT750 HD) of the abdomen for AAA. The VUE images were generated using MMD algorithm. Each patient also had true unenhanced exam (TUE) for comparison. Three independent readers assessed the image quality and acceptance of VUE for TUE using a four-point scale. Visualization of incidental findings such as renal stones, vascular calcification, fatty liver, and cysts was evaluated. For quantitative measurement, attenuation values (HU) of liver, kidney, muscle and background fat were obtained on TUE and VUE. Pearson correlation coefficient was used for statistical analysis.

Results
The MMD-VUE images were rated acceptable in all 33 exams and actually preferred by all three readers over TUE (IQ score 3 vs 2.1). All renal stones (n=17), vascular calcification (n=32) and fatty liver infiltration (n=13) were accurately detected on MMD-VUE images. The mean HU of interest attenuation (HU) were measured at designated sites.

Conclusion
The MMD algorithm rendered VUE images meet the clinical expectations of quality and quantitative measurements and therefore a viable replacement of TUE.

Clinical relevance/application
Virtual unenhanced CT images that are quantitatively and qualitatively comparable to true unenhanced CT images are expected to bring workflow and radiation dose savings benefits.

VSG121-10 • The Clinical Impact of Retrospective Analysis in Spectral Detector Dual Energy Body CT

Michal H Gabbai MD (Presenter); Isaac Leichter PhD; Zimam Romman *; Amiaz Altman PhD *; Jacob Sosna MD *

Purpose
In existing tube-based dual-energy CT (DECT), dual-energy protocols must be prescribed in advance to select tube voltage or operate the two tubes at different kV. Spectral detector-based DECT enables retrospective reconstruction and analysis of data obtained from a single CT acquisition with no requirement to plan a dual-energy protocol in advance. The purpose of this study was to assess the potential added value of retrospective dual-energy reconstruction features.

Method and Materials
A total of 43 patients were scanned with a novel Spectral Detector CT (SDCT) prototype (Philips Healthcare, Cleveland, OH, USA). IRB approval and patient consent were obtained. The clinical indication for each case was evaluated, and indications were compared to the final diagnosis by two radiologists in consensus. The number of cases in which retrospective analysis of spectral data could potentially assist in the diagnosis while the indication on the request did not suggest in advance the use of dual-energy reconstruction was analyzed.

Results
SDCT data helped to achieve the diagnosis for 19 out of 43 patients (44%). In 8 of the 43 (18.6%), clinical history on the study request...
indicated potential advantage from use of a dual-energy protocol (4 suspected pulmonary emboli, 2 suspected kidney stones, 1 suspected insulinoma, 1 suspected hepato cellular carcinoma). In the remaining 35 patients, dual-energy reconstruction was not indicated based on the referral. In 11 of the 35 patients (31%) retrospective spectral detector reconstruction improved visualization of the following unexpected pathologies: 2 incidental adrenal adenomas (contrast enhanced CT, virtual non-enhanced images), 2 pelvic DVT cases (low KeV images), 3 pancreatic cysts (with low KeV, improved contrast-to-noise), 3 metal implants (reduced artifacts at higher KeV), and one abdominal aortic aneurysm (suboptimal CTA visualized at low KeV).

CONCLUSION
Retrospective spectral image reconstruction and analysis may frequently offer clinical advantage in cases where DECT is not indicated based on clinical history.

CLINICAL RELEVANCE/APPLICATION
Spectral detector-based dual-layer CT allows retrospective reconstruction and post-processing image analysis that may frequently be useful in clinical practice.

VSGI21-11 • CT Perfusion

Benjamin M Yeh MD (Presenter) *

LEARNING OBJECTIVES
1) Understand the potential benefits and drawbacks of imaging contrast material inflow and outflow for improving clinical diagnoses in the abdomen and pelvis, including for the evaluation and monitoring of tumors and fibrosis. 2) Review methods for quantifying different parameters associated with contrast material distribution into abdominopelvic tissues. 3) Show methods to improve consistency and radiation dose with CT perfusion imaging.

ABSTRACT
Use of intravenous contrast material is critical to the evaluation of a broad range of abdominopelvic diseases at CT. The rate of inflow and outflow of contrast material relative to arterial flow and intravascular concentrations, as well as distribution of contrast materials into tissues, reflects the underlying vascular and micro vessel physiology of tissues. On a simplistic level, subjective evaluation of enhancement relative to normal tissues is used routinely by radiologists to detect, characterize and monitor tumors and inflammatory processes. More advanced dynamic contrast enhanced imaging can be used to quantify such microvessel parameters as blood volume, blood flow, mean transit time, arterial fraction, extracellular fraction, and permeability surface, and has been studied in particular for monitoring treatment response in tumors. Simple equilibrium imaging can be used to assess relative washout and extracellular fraction, and appears to be a potentially valuable method to quantify and monitor a wide range of disease.

VSGI21-12 • Role of Perfusion CT in Characterization of Pancreatic Mass Lesions

Raju Sharma MD (Presenter) ; Ajay K Yadav MBBS ; Devasenathipathy Kandasamy ; Shivanand R Gamanagatti MBBS, MD ; Ashu Seth Bhalla MBBS, MD ; Peush Sahni MBBS, MS ; Arun K Gupta MBBS, MD

PURPOSE
Perfusion CT (PCT) provides quantitative information regarding blood flow and permeability in tissues in a noninvasive way. This prospective study was conducted to evaluate the utility of PCT findings in characterization of pancreatic mass lesions.

METHOD AND MATERIALS
PCT was done in 67 patients with histopathologically proven pancreatic mass. The spectrum of pancreatic pathology included adenocarcinoma (30), cystic neoplasm (21), neuroendocrine tumor (8), mass forming chronic pancreatitis (3), metastatic mass (3) and pancreatic tuberculosis (2). Perfusion parameters evaluated were blood flow (BF) and blood volume (BV). 25 controls with no pancreatic pathology were also studied.

RESULTS
No significant difference in perfusion parameters was noted in head, neck, body and tail of pancreas in control groups (BF 52-150 ml/100g/min and BV 22-50 ml/100g/ml) followed by adenocarcinoma (BF 2.8-36 ml/100g/min and BV 0.5-18 ml/100g/ml), metastatic and inflammatory pancreatic masses in increasing order. BF and BV were significantly reduced in the center of pancreatic adenocarcinoma and gradually increased from center to periphery of the lesion, as opposed to cystic tumors which showed homogeneous reduction.

CONCLUSION
Significant decrease in BF and BV values as compared to normal pancreas was seen in all pancreatic masses except neuroendocrine tumors. PCT may also help to differentiate pancreatic adenocarcinoma from inflammatory masses.

CLINICAL RELEVANCE/APPLICATION
Perfusion parameters can be an additional paradigm to characterize pancreatic mass lesions. This may in the future be useful to detect isodense pancreatic tumors which can be missed on conventional CECT.

VSGI21-13 • Perfusion CT in Patients with Hepatocellular Carcinoma: Comparison with Intravoxel Incoherent Motion Diffusion (IVIM)-Diffusion Weighted Imaging (DWI)

Mi Hye Yu MD (Presenter) ; Jeong-Min Lee MD * ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

PURPOSE
To determine the value of perfusion parameters from perfusion CT in patients with hepatocellular carcinoma (HCC) and analyze the correlation with those obtained from intravoxel incoherent motion diffusion (IVIM)-diffusion weighted imaging (DWI).

METHOD AND MATERIALS
A total of 30 patients (M:F=23:7; mean age, 58.7 ± 13.27; age range, 20-77) suspected having HCC were prospectively enrolled in this study. They underwent IVIM-DWI (10 b values, 1.5T) and liver perfusion CT (4D spiral mode, scan range 10 cm, 21 scans, cycle time 1.5 seconds) within 2 days before hepatic resection. Following perfusion parameters were calculated: blood flow (BF), blood volume (BV), permeability surface (PS), arterial perfusion (AP), portal perfusion (PP), total liver perfusion (TLP) and hepatic perfusion index (HPI) from perfusion CT; apparent diffusion coefficient (ADC), pseudodiffusion coefficient (D*), diffusion coefficient (D) and perfusion fraction (f) from IVIM-DWI. Those parameters statistically analyzed comparing HCC and liver parenchyma. Pearson correlation was also used to correlate perfusion CT and IVIM-DWI parameters.

RESULTS
Regarding the perfusion CT, BF, BV, AP, TLP and HPI were significantly higher, whereas PS and PP were significantly lower in HCC than in the liver parenchyma (BF: 39.46 ml/100g/min, BV: 11.80 ml/100g/min, AP: 41.86 ml/min/100g, TLP: 47.24 ml/min/100g, HPI: 87.88%, PS: 16.03 ml/100g/min, PP: 5.37 ml/min/100g, p < 0.05). Among the IVIM-DWI parameters, D* was significantly lower, whereas f was significantly higher in HCC than in the liver parenchyma (D* 4.95 vs. 9.71 10^-3/mm^2/s, f 20.17 vs. 16.37 %, p < 0.05). However, no significant correlation found between the perfusion CT and IVIM-DWI parameters.

CONCLUSION
Perfusion CT and IVIM-DWI can quantitatively assess the hepatic perfusion in patients with HCC, even though there was no significant correlation between the parameter of the two modalities.

CLINICAL RELEVANCE/APPLICATION
Global Health: Dose Reduction Is Our Business (Sponsored by the Associated Sciences Consortium) (An Interactive Session)

Monday, 10:30 AM - 12:00 PM • S105AB

Experimental Validation of Shaped Filter Design with Variable Source-to-Filter Distance for Breast CT with Respect to Image Quality and Dose

Ferdinand Lucke Dipl Phys *; Daniel Kolditz PhD (Presenter) *; Martin Hupfer PhD *; Willi A Kalender PhD *

PURPOSE
To validate the use of a single shaped filter with variable source-to-filter distance (SFD) for dedicated breast CT (bCT) and arbitrary breast sizes.

METHOD AND MATERIALS
The shaped filter was designed using simulations of a dedicated bCT system with the goal to achieve noise homogeneity and dose reduction for breast diameters of 80 to 180 mm. This was accomplished with a filter design method that aims to achieve a homogeneous detector noise and considering a correction factor for the filtered back projection process. According to the simulations, a single shaped filter designed for the largest breast diameter works for all breast diameters if SFD can be adjusted. To validate these results, the filter
was manufactured of an aluminum alloy. The measurements were performed on a bCT prototype with breast phantoms (80% adipose, 20% glandular tissue) of diameters from 80 to 180 mm. The filter was positioned at SFDs from 54 to 112 mm according to the phantom diameter. Image quality was evaluated for the reconstructed volume by assessing CT value accuracy, noise homogeneity and spatial resolution. Furthermore, scatter distribution was determined with the use of a beam-stop phantom with and without shaped filter. Dose reduction was measured using a calibrated ionization chamber in the center and in the periphery of the phantom.

RESULTS
The results with a single shaped filter at variable SFD resulted in improved noise homogeneity and dose reduction for all breast diameters: noise homogeneity was improved from 15% down to 5% and the overall dose was reduced by about 30 to 40% for all breast diameters. Furthermore, scatter reduction of about 60% was achieved, which reduced cupping artifacts and improved the CT value accuracy. Spatial resolution was not affected by the shaped filter.

CONCLUSION
By means of shaped filters designed for bCT, significant dose reduction can be achieved and image quality can be improved by reducing noise inhomogeneity as well as scatter-induced artifacts. A single shaped filter designed for the largest breast diameter used with variable SFD appears to be a good solution for bCT.

CLINICAL RELEVANCE/APPLICATION
The use of a shaped filter for bCT appears essential to keep patient dose as low as reasonably achievable.

SSC13-02 • An Automated Method to Estimate Organ Dose from Tube Current Modulated (TCM) CT Scans Using Software to Extract Regional Tube Current Values

Maryam Khatonabadi (Presenter) *; Tim O'Connell MD, MEng *; Aaron D Sodickson MD, PhD; Michael F McNitt-Gray PhD *

PURPOSE
Regional CTDIvol has proven to be a valuable metric for estimating dose from TCM CT scans; however, its practicality has not been established. The purpose of this study was to evaluate an automated landmark recognition software which can be used to extract basic landmarks within a CT exam to calculate both regional CTDIvol, and regional water equivalent diameter (WED) metrics to enable automated organ dose estimates.

METHOD AND MATERIALS
Image data and tube current modulation data were collected from 10 patients who underwent either an abdomen/pelvis (N=4) or thorax (N=6) exams. An automated software program was used to analyze each patient's image data and identify the type of exam and to extract image numbers corresponding to important landmarks of regional anatomy: for thorax, locations of the lung apices and the top of the diaphragm were extracted; for A/P, locations of the top of the diaphragm and iliac crests were extracted. The extracted image numbers were used to calculate a regional CTDIvol based on DICOM header-reported mAs values as well as the WED of each image. Regional CTDIvol and WED were used to estimate dose to lungs and breasts from thorax and dose to liver, kidneys, and spleen from abd/pel exams, using a predictive model capable of estimating organ dose using regional information. For these same patients, the image data was used to create voxelized models used in Monte Carlo simulations in which dose to each of the relevant organs was estimated. Estimated organ doses from automated method were compared with those obtained through simulations and a Root Mean Square error between methods was calculated.

RESULTS
Estimated doses using the automated method resulted in RMS error of 33%, whereas estimates using the manual approach resulted in lower RMS error of 15% across all organs.

CONCLUSION
This work has demonstrated that automated methods to estimate organ dose for CT scans performed with tube current modulation yield reasonable results in a small number of patients having either A/P or thorax exams. Further work is needed to improve automated extraction of regions, especially for extraction of regional data to estimate thoracic organ doses (particularly breast dose), where tighter organ-specific regions would be preferable.

CLINICAL RELEVANCE/APPLICATION
Automated body landmark recognition can facilitate the calculation of multiple regional CTDIvol values from a single TCM exam for use in organ dose estimation.

SSC13-03 • Phase Based Dose Modulation for Improved Dose Efficiency in Cardiac CT

Adam Budde MS (Presenter) *; Brian E Nett PhD *

PURPOSE
In cardiac half-scan reconstruction a smooth weighting function is typically used to weight the sinogram data. We assess if knowledge of this weighting function and the prescribed cardiac phase can be used to improve dose efficiency.

METHOD AND MATERIALS
In prospectively triggered cardiac CT, data is typically acquired such that a prescribed phase and some adjacent phases can be reconstructed (e.g. prescribed phase and nominal phase padding). During the reconstruction process of any given phase a smooth temporal weighting is applied to reduce motion artifacts. In this work a phase based mA modulation is proposed, such that less dose is delivered to the views which will receive a down weighting during the reconstruction process. The base protocol for comparison was a half scan acquisition with a gantry rotation period of 280ms with 50ms of phase padding on each side. A comparison, using numerical simulations of a 20cm water phantom, was performed between the standard and the phase based dose modulation, where the integral of the mA was conserved between the two acquisitions.

RESULTS
The image noise at the center of the phantom was assessed through region of interest measurements of the variance of voxel values, as this metric varies inversely with dose. Modulating the mA while keeping the total dose constant reduced the image variance by 12.2% at the center reconstructed phase, 12.0% at the reconstructed phase 25ms from center, and by 6.2% at the reconstructed phase 50ms away from the prescribed phase.

CONCLUSION
Prospective phase based dose modulation enables improved dose efficiency for cardiac CT scanning.

CLINICAL RELEVANCE/APPLICATION
Radiation dose reduction in cardiac CT can be achieved while maintaining the same level of image noise through phase based modulation.

SSC13-04 • Method to Achieve Specific Image Quality and Dose Targets over a Range of Patient Sizes by Optimizing CT Tube Current Modulation Parameters

David B Larson MD (Presenter) *; Daniel J Podberesky MD *

PURPOSE
Automated tube current modulation (ATCM) can reduce CT radiation dose by adjusting the tube current according to patient size. However, ATCM does not establish image quality or dose targets nor does it ensure that those targets are met. Our purpose was to develop a method for achieving specific image quality targets over a range of patient sizes by adjusting the ATCM parameters of standard deviation of noise ($\sigma_{SD}$) and minimum and maximum mA values.
A mathematical optimization model, based on a 320-detector row scanner (Aquilion ONE, Toshiba, Otawara, Japan), was developed to predict noise and size-specific dose estimates (SSDE) based on scanner settings, including ATCM parameters, which has been presented previously. The model was applied to a quantitative noise target curve as a function of patient size, which has also been presented previously. The three ATCM variables (SD and minimum and maximum mA) were adjusted in the model to enable explicit matching of predicted image noise with target image noise over a range of patient sizes. Mean deviation and mean absolute deviation (MAD) of the predicted from the target noise and SSDE were obtained for water-equivalent diameters corresponding to weight ranges of 0-15 kg, 16-30 kg, 31-45 kg, 46-70 kg, 71-100 kg, and 100+ kg. Values obtained using mA limits were compared to those not using mA limits.

RESULTS

The ATCM noise curve without mA limits resulted in excessive noise (insufficient dose) for smaller patient diameters and lower-than-necessary noise (excessive dose) for larger patient diameters (Fig. 1). MAD for noise and SSDE not using mA limits were 1.88 HU and 1.57 mGy, respectively. Values obtained using mA limits were 0.32 HU and 0.30 mGy, respectively. Use of mA limits decreased MAD for noise and SSDE by 83% and 81%, respectively.

CONCLUSION

Predicted CT image noise and SSDE can be closely matched to target noise and SSDE curves over a specified size range by adjusting the SD and minimum and maximum mA settings using a mathematical optimization model. Without setting minimum and maximum mA limits according to the model, the ATCM algorithm tends to use insufficient dose for smaller patients and excessive dose for larger patients.

CLINICAL RELEVANCE/APPLICATION

Using the model, ATCM parameters can achieve target noise and SSDE over a range of patient sizes, enabling reliable image quality and dose based on imprecise patient size estimates such as weight.

SSC13-06 • Monte Carlo Patient Dosimetry for Computed Tomography Examinations with Automatic Tube Current Modulation Using Precalculated Organ Dose Databases

Daniel J Long PhD (Presenter) ; Elliott J Stepusin BS ; Lindsay Sinclair PhD ; Wesley E Bolch PhD

PURPOSE

The demand for accurate, easily-accessible patient dosimetry for computed tomography examinations has been on the rise in recent years. Programs utilizing precalculated organ dose databases such as CTDosimetry and CT-Expo have seen widespread use for their ease-of-use; however, they fail to inherently account for modern examinations which use automatic tube current modulation (ATCM). This work seeks to develop a methodology by which to account for ATCM in patient dosimetry within the framework of a precalculated organ dose database program.

METHOD AND MATERIALS

Organ dose measurements using OSL detectors were made at Shands Hospital at the University of Florida on three female cadavers of varying BMI (17.4, 35.2, and 43.9) for four standardized CT protocols (CAP, chest, abdomen, and pelvis) utilizing ATCM. Voxel phantoms were then created for each cadaver by segmenting anatomy from the CAP exam image sets, and slice-by-slice organ dose databases were created for each through the use of a Monte Carlo model of a Toshiba Aquilion ONE CT scanner. In addition to doses, average photon attenuation was calculated for each slice of anatomy in the databases, which was then used to create weighting factors by which the doses for each slice in the desired exam range were scaled. By using the reported average effective mAs delivered for each exam, simulated in-field organ doses for each cadaver were calculated and compared to those experimentally measured.

RESULTS

Simulated and measured in-field average organ doses for each cadaver and CT exam type were compared by percent difference calculations using the measured doses as the accepted standard. Average magnitudes of percent differences over all exam types were 10.6 ± 2.5%, 9.2 ± 4.0%, and 11.5 ± 2.7% for the cadavers of BMI 17.4, 35.2, and 43.9, respectively.

CONCLUSION

This work establishes the feasibility of a methodology by which to account for automatic tube current modulation in Toshiba patient CT examination dosimetry within the bounds of a precalculated organ dose database program. This study lays the foundation for additional work to create a more robust methodology spanning various CT makes and models.

CLINICAL RELEVANCE/APPLICATION

The tools and methodology outlined in this work are a step closer to providing accurate and clinically-feasible patient organ doses in computed tomography exams with automatic tube current modulation.
Modulation

Da Zhang PhD (Presenter) ; Xinhua Li PhD ; Wenli Cai PhD ; Bob Liu PhD

CONCLUSION
Direct dose measurements inside the Abd/Pelvis region of an anthropomorphic phantom provided realistic dose distributions, and demonstrated the significant difference between scans with fixed mA and with mA modulation.

Background
Helical CT scans with automatic tube current modulation are widely utilized clinically. However, in the regions where the preset maximum mA is reached, the scan is conducted with constant mA. Due to the complex nature of scanning motion, mA modulation, and patient shape and composition, the dose distribution inside the scanned volume is not well understood. We want to investigate and compare the dose distribution under a scan with fixed mA and a scan with both z-directional and angular mA modulation.

Evaluation
We sampled the doses experimentally inside an anthropomorphic phantom (CIRS 701 ATOM) by embedding an array of optically stimulated luminescence dosimeters in it. We scanned the abdominal/pelvis region of the phantom at a GE LS 16 Pro scanner, using the routine protocol of our institution for this region (at 120 kVp, 0.5s rotation time, 16x1.25 mm beam collimation, and pitch of 1.375). The first scan employed Auto-mA and Smart-mA with a noise index of 15 and the widest available mA range, and the second scan was with a fixed 170 mA. For each scan, we acquired 16 readings along the central z-axis of the phantom, 13 readings along the peripheral z-axis near the anterior surface, and 22 readings on each of the two selected axial planes where many radio-sensitive organs are located.

Discussion
With both fixed mA and mA modulation, large fluctuations were observed on the peripheral doses along the z-direction, which was attributed to the ripple effect resulting from x-ray attenuation and beam divergence. With fixed mA, the central doses of all slices showed small fluctuation around about 85% of the reported CTDIvol. The central dose changed significantly when Auto-mA is used for compensating the change of cross-sectional shape and size of the subject. The doses on the same axial plane in both scans ranged from 70% to 160% of the reported CTDIvol, and were asymmetrically distributed.

SSC13-08 • Evaluating the Complex Relationship of Automated Tube Current Modulation, Noise Index, Image Noise and Phantom Size

Xiujiang J Rong PhD (Presenter) ; Eric P Tamm MD ; Vesna Gershan PhD ; Dianna D Cody PhD * ; Xinning Liu PhD ; Erik K Paulson MD ; Vikas Kundra MD, PhD *

PURPOSE
To determine the influence of phantom size on automated tube current modulation (ATCM) performance.

METHOD AND MATERIALS
Four tissue equivalent abdominal CT dose phantoms (CIRS 007TE) were scanned using a GE HD750 scanner. To simulate an extra-large size patient, a 5th phantom was created by wrapping a fat-ring around the Large Adult phantom. Abdominal CT protocol: 120kVp, 0.8s rotation time, 40mm beam width, 0.984 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 10 consecutive images of the central portion of the phantom were performed. The relationship of average noise versus NI was plotted for each phantom size.

RESULTS
For each phantom size, noise increased linearly as NI value increased ($R^2 = 0.9898-0.9996$). However, the slopes (ranged 0.47-1.26) differed among phantom of different sizes. Using a constant NI value, and hence the same scan protocol, noise levels decreased with phantom size. For the 15 year old to medium phantom sizes (circumference of 71, 86, and 96cm), the differences in slopes (1.26, 1.21, and 1.11) were relatively minor, indicating that the measured noise values were similar as a function of NI value. The slopes (0.68 and 0.47) of the large and extra-large phantoms (circumference of 116 and 136cm) were substantially less compared to the small-medium size phantoms, and also quite different from each other, resulting in three distinct sets of lines on the noise vs NI plot. Accordingly, for large and extra-large phantoms at a given NI, image noise is less than anticipated. Counter intuitively, this suggests that for large and very large phantoms, a higher NI could be used for maintaining adequate image quality while achieving lower radiation dose.

CONCLUSION
ATCM was limited in obtaining the same noise across phantoms of different size when using the same NI. Utilization of ATCM requires NI value be optimized based on patient size for optimal performance.

CLINICAL RELEVANCE/APPLICATION
Using a fixed NI across the entire range of patient sizes will likely result in great variability in image noise. Choice of an appropriate NI therefore must take into account patient size.

SSC13-09 • Dose to Radio-sensitive Organs during Routine Chest CT: Effects of Standard and Organ-based Tube Current Modulation

Federica Zanca PhD (Presenter) ; Xochitl Lopez-Rendon MSc ; Walter Coudyzer ; Raymond H Oyen MD, PhD

PURPOSE
To quantify the effect of standard and organ-based tube current modulation (TCM) on dose to radio-sensitive organs (breasts, lungs, heart, thyroid gland) and on image quality in adult female patients of various sizes undergoing chest CT examinations.

METHOD AND MATERIALS
Four (underweight, normal, overweight and obese BMI index) female cadavers ( phantom size differed among phantom of different sizes. Using a constant NI value, and hence the same scan protocol, noise levels decreased with phantom size. For the 15 year old to medium phantom sizes (circumference of 71, 86, and 96cm), the differences in slopes (1.26, 1.21, and 1.11) were relatively minor, indicating that the measured noise values were similar as a function of NI value. The slopes (0.68 and 0.47) of the large and extra-large phantoms (circumference of 116 and 136cm) were substantially less compared to the small-medium size phantoms, and also quite different from each other, resulting in three distinct sets of lines on the noise vs NI plot. Accordingly, for large and extra-large phantoms at a given NI, image noise is less than anticipated. Counter intuitively, this suggests that for large and very large phantoms, a higher NI could be used for maintaining adequate image quality while achieving lower radiation dose.

RESULTS
For each phantom size, noise increased linearly as NI value increased ($R^2 = 0.9898-0.9996$). However, the slopes (ranged 0.47-1.26) differed among phantom of different sizes. Using a constant NI value, and hence the same scan protocol, noise levels decreased with phantom size. For the 15 year old to medium phantom sizes (circumference of 71, 86, and 96cm), the differences in slopes (1.26, 1.21, and 1.11) were relatively minor, indicating that the measured noise values were similar as a function of NI value. The slopes (0.68 and 0.47) of the large and extra-large phantoms (circumference of 116 and 136cm) were substantially less compared to the small-medium size phantoms, and also quite different from each other, resulting in three distinct sets of lines on the noise vs NI plot. Accordingly, for large and extra-large phantoms at a given NI, image noise is less than anticipated. Counter intuitively, this suggests that for large and very large phantoms, a higher NI could be used for maintaining adequate image quality while achieving lower radiation dose.

CONCLUSION
ATCM was limited in obtaining the same noise across phantoms of different size when using the same NI. Utilization of ATCM requires NI value be optimized based on patient size for optimal performance.

CLINICAL RELEVANCE/APPLICATION
Using a fixed NI across the entire range of patient sizes will likely result in great variability in image noise. Choice of an appropriate NI therefore must take into account patient size.
LEARNING OBJECTIVES
1) Understand how to develop a process for radiation dose and image quality optimization. 2) Briefly review common techniques for reducing CT radiation dose including. 3) Learn ways to monitor quality and dose. 4) Discuss ways to improve compliance with imaging protocols.

ABSTRACT
As radiation dose in CT continues to be a concern, many radiology practices are in the process of revising their CT protocols to optimize radiation dose and quality. Optimizing CT radiation dose and quality is a challenging task requiring knowledge to implement complex technology and collaboration between radiologist and technologist. It is not enough to change imaging protocols alone; monitoring and training are necessary to ensure consistent quality. This course focuses on the development of processes for dose reduction and continuous quality improvement drawing on the experience of an academic healthcare system as a case study. Methodologies for evaluating current imaging protocols, reducing radiation dose, monitoring exam quality and dose, assessing changes in protocols, and improving protocol compliance will be discussed.

MSAS23B • A Case Study Using the American College of Radiology Dose Index Registry

Brent Little MD (Presenter)

LEARNING OBJECTIVES
1) The learner will become familiar with an approach to baseline CT radiation dose measurement and ongoing dose monitoring using the American College of Radiology Dose Index Registry. 2) The learner will be able to identify and avoid pitfalls in radiation dose tracking and analysis. 3) The learner will be able to identify common causes of dose outliers and develop a plan for standardizing and reducing doses based on a root cause analysis. 4) The learner will become familiar with practical considerations of dose reduction implementation using a variety of techniques.

ABSTRACT
Radiation dose reduction and standardization are essential components of quality assurance and quality improvement in CT imaging. This course will highlight a departmental initiative to decrease and standardize CT radiation dose at a large academic medical center. The practical aspects of measuring baseline doses, implementing dose reduction strategies, and measuring results will be emphasized. Our use of the American College of Radiology dose index registry to identify average dose and dose outliers will be described. Root cause analysis of variation in doses across sites, scanners, and exams will be discussed. An approach to planning, implementation, and continuous evaluation of dose reduction measures will be presented.

AAPM/RSNA Basic Physics Lecture for the Radiologic Technologist: Digital Imaging Exposure Indicators-Implications for Image Quality and Dose

Monday, 01:30 PM - 02:45 PM • S102D

LEARNING OBJECTIVES
1) Understand why exposure indicators are necessary for computed radiography and digital radiography. 2) Provide examples of how exposure indicators can be used for quality control of an imaging operation. 3) Explain the relationship between the amount of radiation used to perform the examination, the radiation dose to the patient, and the quality of the resulting image. 4) Discuss the importance of establishing and managing target values. 5) Appreciate the practical limitations of exposure indicators.

ABSTRACT
Digital imaging exposure indicators are widely used methods of risk analyses are Failure Modes and Effects Analysis (FMEA). This is a methodology for analyzing potential reliability problems early in the development cycle where it is easier to take actions to overcome these issues, thereby enhancing reliability through design. FMEA is used to identify potential failure modes, determine their effect on the operation of the product, and identify actions to mitigate the failures. From a manufacturer’s perspective, FMEA is a valuable method to systematically evaluate a device design’s potential for inducing use errors. User errors are defined as a pattern of predictable human errors that can be
attributable to inadequate or improper design. When these risk analyses are done early in the development cycle, potential faults and their resulting hazards are identifiable and much easier to mitigate with error-reducing designs. These risk management methods are excellent complements to other important user-centered design best practices. Risk analysis, or hazard analysis, is a structured tool for the evaluation of potential problems which could be encountered in connection the use of a device. The early and consistent use of FMEAs in the design process allows the engineers to design out failures and produce reliable and safe products. FMEAs also capture historical information for use in future product improvement. Such an approach should result in a QA/QM program in Radiation Oncology that has

URL

SPPH22B • QA/QM of the Reference Dosimetry
Larry A DeWerd PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

SPPH22C • QA/QM of the Treatment Planning Process
Jeffrey V Siebers PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

SPPH22D • QA/QM of the Treatment Delivery Process
Thomas R Mackie PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

SPPH22E • QA/QM of the Treatment Guidance Process
Lei Dong PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

Gastrointestinal (CT Dose Reduction II)

Monday, 03:00 PM - 04:00 PM • E353A

SSE07-01 • Factors Leading to High Dose CT Scans at a Tertiary Care Center: Can We Avoid Them?

Priyanka Prakash MD (Presenter) ; William W Boonn MD * ; Tessa S Cook MD, PhD

PURPOSE
To identify patients scanned with above acceptable radiation levels for CT abdomen and pelvis examinations (CTAP) and assess the reasons for high-dose scans.

METHOD AND MATERIALS
CTAP examinations between July 2012 and March 2013 on 64-slice (Sensation 64, Siemens) scanners were reviewed. All scans were acquired using automatic tube current modulation. Remaining scan parameters were held constant at pitch 1, slice thickness 5mm, collimation 10 and kVp 120 except for very large patients. The acquisition details (mean mAs, kVp, scan length, effective patient diameter) and dose details including CTDIvol, effective dose, size specific dose estimate (SSDE), dose length product (DLP), organ specific effective doses for these scans were extracted using a commercial software (eXposure, Version 1). The above acceptable radiation dose was defined as =2 standard deviations above the respective means. All patients who underwent the CT scan with = 2 standard deviations above the mean DLP, effective dose and SSDE were identified. These scans were reviewed on PACS to identify the reason for high doses.

RESULTS
1685 scans (995 females, 690 males) were included in the study. The mean DLP, effective dose and SSDE for these scans were 734.7±338.5mGy-cm, 13.2±6.4mGy-cm and 15.6±3.8mGy. The scans with doses greater than DLP of 1411.6 (35; 6M, 29F); effective dose of 25.9 (29; 12M, 17F); and SSDE of 23.1 (47; 7M, 40 F) were identified. The reasons for high effective dose were patient size (9/29), 140 kVp (3/29), scan length (3/29) and patient off centering (17/35). Similarly, patient size (9/29), 140 kVp scans for very large patients (5/35), longer scan length for coverage of perineum (2/35) and repeats because of patient motion, off centering, abdominal wall excluded from FOV (11/35). Similarly, patient size (9/29), 140 kVp (3/29), scan length (3/29) and repeats (12/29) accounted for high DLP. For high SSDE, patient size (19/47), 140 kVp (7/47), scanning with arms by side (24/47) and patient off centering (17/47) were the identifiable factors.

CONCLUSION
Patient size, 140 kVp, repeats, patient off centering and scanning with arms by side account for higher than acceptable radiation dose. Of these, the patient size may be avoidable in certain circumstances.

CLINICAL RELEVANCE/APPLICATION
Technologists can be given feedback/ in-service training reiterating the role of proper patient positioning, avoiding repeats and scanning with arms above head to avoid unnecessary radiation exposure.

SSE07-02 • Half Contrast Agent Dose and Low Radiation Dose Protocol for Abdominal Dynamic CT: Clinical Impact of the Iterative Model Reconstruction (IMR) for Low kVp Imaging

Takeshi Nakaura MD (Presenter) ; Shinichi Tokuyasu RT * ; Masafumi Kidoh ; Ryo Itatani ; Kazunori Harada ; Yasuyuki Yamashita MD * ; Shinichi Nakamura MD

PURPOSE
Low kilo-voltage (kVp) CT is well suited for low contrast and low radiation dose abdominal CT; however, increased image noise is a problem. The recent introduced iterative model reconstruction (IMR, Philips Healthcare) dramatically reduces the image noise and offers virtually noise free images. We evaluated the feasibility of a half contrast agent dose and low radiation dose protocol for abdominal dynamic CT using 80 kVp and the IMR technique.
METHOD AND MATERIALS
This prospective study received institutional review board approval; prior informed consent was obtained from all patients. We enrolled 30 patients who underwent abdominal dynamic CT using 80-kVp setting with a half contrast dose (300 mgI/kg) during 30 sec. We also enrolled 10 patients who were scanned with a standard 120-kVp protocol with filtered back projection (FBP) technique using the standard contrast dose of 600 mgI/kg during 30 sec as a control group. The 80-kVp images were reconstructed with FBP, hybrid-iterative reconstruction (iDose4) and IMR. We compared the effective dose (ED) of each protocol and evaluated image noise, CT numbers and the contrast to noise ratio (CNR) of 120 kVp and FBP-, iDose4-, IMR-reconstructed 80 kVp images at the abdominal aorta in hepatic arterial phase (HAP) and hepatic parenchyma in portal venous phase (PVP).

RESULTS
The total effective radiation dose was 42% lower with 80-kVp scan than with 120-kVp scan (9.0 mSv ± 1.3 vs 15.6 mSv ± 2.6). CT numbers with the half contrast dose 80 kVp protocol were significantly higher than with the 120 kVp protocol (abdominal aorta: 371.2 ± 65.1 vs 333.3 ± 46.9, p = 0.04; hepatic parenchyma: 121.1 ± 12.6 vs 107.7 ± 9.3, p < 0.01). IMR and iDose4 technique decreased mean image noise by 72% and 45% as compared with FBP technique at 80 kVp scan (IMR: 4.5 ± 0.7; iDose4: 8.8 ± 1.1; FBP: 15.8 ± 2.0; 120 kVp: 8.3 ± 1.6, respectively). The CNR of 80-kVp with IMR were significantly higher than 120-kVp protocols (abdominal aorta: 87.9 ± 19.8 vs 42.5 ± 10.8, p < 0.01; hepatic parenchyma: 26.3 ± 4.5 vs 13.2 ± 3.2, p < 0.01).

CONCLUSION
IMR is a promising technique to improve the image quality of the half contrast agent dose and low radiation dose protocol for abdominal dynamic CT with low kVp setting.

CLINICAL RELEVANCE/APPLICATION
The contrast dose for abdominal dynamic CT can be reduced by 50% by using a 80 kVp setting with IMR with improved image quality and reduced radiation dose.

SSE07-03 • How to Choose Spectral CT Imaging Protocol Individually: A Dose Study in Abdomen
Tan Guo MD (Presenter) ; Cheng Zhou MD ; Wen Chen ; Juan Chen MD, PhD
PURPOSE
Spectral CT scan is thought of high dose level, but different protocol combinations can ensure a relative low dose. The aim of this study is to discuss choosing spectral CT protocol individually for each patient in abdominal examinations.

METHOD AND MATERIALS
This was a retrospective study using the imaging data of another abdomen research. 44 patients underwent two phase enhancement abdomen scan. GSI mode scan with fixed tube current were used in artery phase and conventional 120 kVp scan with auto tube current were used in portal venous phase (GE discovery CT 750 HD, GE Healthcare). There were two protocol settings of GSI mode scan (protocol A with pitch 1.375 and protocol B with pitch 0.984), and 31 patients underwent protocol A while others underwent protocol B. The CTDI were fixed in protocol A (15.64 mGy) and protocol B (21.84 mGy) for fixed tube current. The 44 patients were divided into 3 groups according to BMI (low BMI: ≤ 26). The noises and CTDI were compared in different groups and protocols between GSI mode scan and conventional 120 kVp scan.

RESULTS
The CTDI of GSI mode scan with both protocol A or B were significant higher than conventional 120 kVp scan (7.95 mGy ) in low BMI group, the noises of GSI mode scans (6.3±0.8) were significant lower than conventional scan (11.36±2.1). In the medium BMI group, the CTDI of protocol A didn’t show significant difference in comparison with conventional scan (14.97 mGy), CTDI of protocol B was significant higher than conventional scan (16.88 mGy). The noises of protocol A (10.3±0.8) and B (8.9±0.8) didn’t show significant differences with conventional scan (24.46 mGy), CTDI of protocol B didn’t show significant difference compared with conventional scan (26.45 mGy). The noises of protocol A (8.6±1.3) were equal to the noises of conventional scan, and the noises of protocol B (7.7±1.0) were significant lower than conventional scan.

CONCLUSION
In low BMI group, spectral CT scan is not suggested for the relatively high dose level. In medium and large BMI group, protocol A is suggested for acquiring the same image quality without increasing dose.

CLINICAL RELEVANCE/APPLICATION
Spectral CT scan as a dual energy technique has been introduced in clinical applications and confirmed as useful in diagnosing. However, the dose of spectral CT imaging is still debated.

SSE07-04 • Radiation Dose Optimization in Abdominal Dual-source, Dual-energy CT: Assessment of Image Quality, Iodine Quantification and Low-contrast Detectability?
Matthias Benz (Presenter) ; Michele Pansini MD ; Kovacs Bolazs ; Robert Bolt ; Dorothee Harder ; Georg M Bongartz MD * ; Zsolt Szucs-Farkas MD, PhD ; Sebastian T Schindera MD *
PURPOSE
To assess the image quality, iodine quantification and low-contrast detectability in abdominal dual-source, dual-energy CT at different radiation dose levels in a phantom.

METHOD AND MATERIALS
A custom liver phantom with 43 hypodense tumors (diameters of 5, 10 and 15 mm; tumor-to-liver contrast of -10, -25, and -50 HU) and eight tubes containing solutions of varying iodine concentration (0-22 mg/ml) were placed in a cylindrical water container that mimicked an intermediate-sized patient. The phantoms were scanned with a dual-source CT scanner (Somatom Definition Flash, Siemens) using the abdominal dual-energy protocol recommended by the vendor (tube A, 100 kVp, 230 reference mAs; tube B, 140 kVp, 196 reference mAs) (protocol A). The phantoms were also scanned with three dose-optimized protocols in which the reference mAs setting of tube A was reduced by 40, 80 and 120 compared to protocol A (protocol B, C and D, respectively). The radiation dose was assessed with the volume CT dose index (CTDivo). The image noise was measured, and the contrast-to-noise ratio (CNR) of the tumors was calculated. Tumor detection was independently performed by three radiologists. Software provided by the vendor was used for iodine quantification. Kruskal-Wallis test was used to compare iodine measurements between protocols.

RESULTS
The CTDivo of protocol A, B, C and D measured 17.7, 14.6, 11.5 and 8.5 mGy, respectively. As the radiation dose decreased, the image noise increased (13.2, 14.4, 16.7 and 19.4 HU for protocol A, B, C and D, respectively) and the CNR decreased (4.4, 3.8, 3.1, and 2.7 for protocol A, B, C and D, respectively) (P < 0.05). The overall sensitivity for tumor detection measured 82.2%, 82.2%, 81.4% and 79.8% (P = 0.789). Quantitative iodine measurements showed no significant difference in the four protocols (P = 0.996).

CONCLUSION
The radiation dose of the abdominal dual-energy CT protocol that is provided by the vendor can be reduced by at least 50% while maintaining low-contrast detectability and accuracy in iodine quantification. Image noise and CNR is not an adequate surrogate for evaluating the potential for radiation dose reduction.

CLINICAL RELEVANCE/APPLICATION
The radiation dose-optimized abdominal dual-source, dual-energy CT protocol improves patient safety without degradation of diagnostic accuracy.

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LEARNING OBJECTIVES
1) To understand the use and value of dose index registries. 2) To understand what patients want to know about their radiation exposure from medical imaging examinations. 3) To explore how best to work with payers on radiation protection programs. 4) To identify issues related to state regulations and accreditation for the use of ionizing radiation with medical imaging.

SSE07-06 • Liver CT with Low Tube Voltage and Model-based Iterative Reconstruction (MBIR) Algorithm for Hepatic Vessel Evaluation in Living Liver Donor Candidates

Bo Yun Hur (Presenter) ; Jeong-Min Lee MD * ; Ijin Joo MD * ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

PURPOSE
To investigate the image quality and diagnostic confidence of Model-based Iterative Reconstruction (MBIR) algorithm for evaluation of hepatic vessels on low-tube-voltage (100-kVp) liver donor CT.

METHOD AND MATERIALS
Fifty-one consecutive low-tube-voltage liver CT for liver donor work-up were reconstructed using FBP, adaptive statistical iterative reconstruction (ASIR), and MBIR and were compared with each other and thirty high-tube-voltage (120-kVp) liver donor CT scans reconstructed using FBP. Weighted volume CT dose index and dose-length product, mean image noise, and contrast-to-noise ratios (CNRs) were assessed. Two radiologists evaluated the image quality and diagnostic confidence on the different image sets.

RESULTS
In low-tube-voltage CT, a significant dose reduction was obtained compared with that in high-tube-voltage CT (p=0.001). The image noise on MBIR images was significantly lower and CNRs on MBIR images were higher compared with those on FBP and ASIR images of low-tube-voltage CT (p = .001). Image quality and diagnostic confidence were significantly superior in group 2 for the liver and portal vein (P < .001) and hepatic vein (P < .001) in portal venous phase (PVP), and liver parenchyma in all phases (P < .001). In group 2, HLC (P = .004) and FOM (P = .001) obtained in equilibrium phase were significantly superior to those in other groups. Sensitivity, specificity, AUC for detection of HCC, and image quality were comparable among three groups. The effective dose during HAP was lower in group 1 (3.3 ± 1.2 mSv) than in group 2 (3.8 ± 1.6 mSv) and 3 (4.1 ± 1.5 mSv) (P = .025).

CONCLUSION
Low-tube-voltage liver CT using MBIR algorithm may increase the image quality and improve the diagnostic confidence for hepatic vessel evaluation at a reduced radiation dose compared with high-tube-voltage CT with FBP.

CLINICAL RELEVANCE/APPLICATION
Low-tube-voltage CT using MBIR could be recommended to liver donors for preoperative hepatic vessel evaluation because of improved image quality and diagnostic confidence with reduced radiation dose.

SPE07-05 • Reduction of Total Iodine Dose by Using Low Tube Voltage and High Tube Current Technique in Combination with Adaptive Statistical Iterative Reconstruction for Dynamic CT of the Liver

Yoshifumi Noda MD ; Satoshi Goshima MD, PhD ; Hiroshi Kawada MD ; Haruo Watanabe MD ; Hiroshi Kondo MD ; Masayuki Kanematsu MD ; Nobuyuki Kawai MD (Presenter) ; Yukichi Tanahashi MD ; Kyongtae T Bae MD, PhD *

PURPOSE
To prospectively compare a low tube voltage (80-kVp) with a conventional (120-kVp) CT protocol for contrast enhancement degree of vascular and liver parenchyma, image quality, and detectability of hepatocellular carcinomas (HCCs).

METHOD AND MATERIALS
Institutional review board approval and written informed consent was obtained. During a 9 months period, 170 patients (114 men, 56 women, age range 40-85 years, mean age 67.7 years) with suspected having liver disease were randomized into three groups according to the following iodine-dose per body-weight protocols: 600 mgI/kg (600 mg of iodine per kilogram) at 120-peak kilo voltage (kVp) (Group 1), 500 mgI/kg at 80-kVp (Group 2), and 400 mgI/kg at 80-kVp (Group 3). One way analysis of variance were conducted to evaluate differences in CT number, back ground noise, signal-to-noise ratio (SNR), DLP, effective dose (ED), HCC-to-liver contrast-to-noise ratio (HLC), and figure of merit (FOM). Receiver operating characteristic (ROC) curves were fitted to blinded observers' confidence ratings for the presence of HCCs. Sensitivity, specificity, and area under the ROC curve (AUC) were compared to assess the detectability of HCCs.

RESULTS
64 hypervascular HCCs (mean size, 16.8 mm; range, 6.0-88.0 mm) were identified in 35 patients (27 men, 8 women, mean 69.5 years, age range 51-85 years). Compared with group 1 and 3, group 2 demonstrated significantly higher contrast enhancement and SNR of the aorta in hepatic arterial phase (P < .001), portal vein (P < .001) and hepatic vein (P < .001) in portal venous phase (PVP), and liver parenchyma in all phases (P < .001). In group 2, HLC (P = .004) and FOM (P = .001) obtained in equilibrium phase were significantly superior to those in other groups. Sensitivity, specificity, AUC for detection of HCC, and image quality were comparable among three groups. The effective dose during HAP was lower in group 1 (3.3 ± 1.2 mSv) than in group 2 (3.8 ± 1.6 mSv) and 3 (4.1 ± 1.5 mSv) (P = .025).

CONCLUSION
Use of 400 mgI/kg at 80-kVp tube voltage demonstrated comparable image quality and detectability of HCC to conventional protocol of 600 mgI/kg at 120-kVp, while the use of 500 mgI/kg at 80-kVp showed better enhancement degree and HLC.

CLINICAL RELEVANCE/APPLICATION
Our study demonstrated the possibility of the iodine-dose reduction in 80-kVp CT imaging of the liver. This information is useful for designing clinical protocols for hepatic CT imaging.

SSE07-06 • Liver CT with Low Tube Voltage and Model-based Iterative Reconstruction (MBIR) Algorithm for Hepatic Vessel Evaluation in Living Liver Donor Candidates

Bo Yun Hur (Presenter) ; Jeong-Min Lee MD * ; Ijin Joo MD * ; Joon Koo Han MD ; Byung Ihn Choi MD, PhD *

PURPOSE
To investigate the image quality and diagnostic confidence of Model-based Iterative Reconstruction (MBIR) algorithm for evaluation of hepatic vessels on low-tube-voltage (100-kVp) liver donor CT.

METHOD AND MATERIALS
Fifty-one consecutive low-tube-voltage liver CT for liver donor work-up were reconstructed using FBP, adaptive statistical iterative reconstruction (ASIR), and MBIR and were compared with each other and thirty high-tube-voltage (120-kVp) liver donor CT scans reconstructed using FBP. Weighted volume CT dose index and dose-length product, mean image noise, and contrast-to-noise ratios (CNRs) were assessed. Two radiologists evaluated the image quality and diagnostic confidence on the different image sets.

RESULTS
In low-tube-voltage CT, a significant dose reduction was obtained compared with that in high-tube-voltage CT (p=0.001). The image noise on MBIR images was significantly lower and CNRs on MBIR images were higher compared with those on FBP and ASIR images of low-tube-voltage CT (p = .001). Image quality and diagnostic confidence were significantly superior in group 2 for the liver and portal vein (P < .001) and hepatic vein (P < .001) in portal venous phase (PVP), and liver parenchyma in all phases (P < .001). In group 2, HLC (P = .004) and FOM (P = .001) obtained in equilibrium phase were significantly superior to those in other groups. Sensitivity, specificity, AUC for detection of HCC, and image quality were comparable among three groups. The effective dose during HAP was lower in group 1 (3.3 ± 1.2 mSv) than in group 2 (3.8 ± 1.6 mSv) and 3 (4.1 ± 1.5 mSv) (P = .025).

CONCLUSION
Low-tube-voltage liver CT using MBIR algorithm may increase the image quality and improve the diagnostic confidence for hepatic vessel evaluation at a reduced radiation dose compared with high-tube-voltage CT with FBP.

CLINICAL RELEVANCE/APPLICATION
Low-tube-voltage CT using MBIR could be recommended to liver donors for preoperative hepatic vessel evaluation because of improved image quality and diagnostic confidence with reduced radiation dose.
LEARNING OBJECTIVES
View learning objectives under main course title.

LEARNING OBJECTIVES
View learning objectives under main course title.

LEARNING OBJECTIVES
View learning objectives under main course title.

LEARNING OBJECTIVES
1) To understand the importance of a non-punitive approach to peer review. 2) To understand elements required to create a non-punitive environment. 3) To understand the limitations of using peer review for individual performance measurement. 4) To be able to implement a non-punitive peer review program locally.

LEARNING OBJECTIVES
1) To understand the status of the SIR Quality Registry. 2) To be able to design an IR peer review system using the SIR Quality Registry. 3) To learn how to drive quality improvement using regular feedback from a national quality registry.

LEARNING OBJECTIVES
1) To be familiar with the elements of a PQI project. 2) To identify peer review data suitable for a PQI project. 3) To perform a gap analysis of one's own peer review data. 4) To formulate a practical plan to achieve performance improvement. 5) To monitor improvement.

ABSTRACT
In this course we will discuss the PQI process, including necessary elements of a PQI project. We will start by identifying peer review data that is suitable for a project. A classification system for errors will be introduced that allows us to group errors, streamline our analysis and develop performance improvement measures. We will focus on individual and group projects, outline the differences in how these projects are performed and help the radiologist decide which type of project is best suited to her/his practice. We will define how an improvement plan can be put in place and how improvement can be measured. We will demonstrate the timeline and necessary documentation.

ABSTRACT
Ever increasing attention has been placed on safety in radiology departments with increasing expectations by the public, certifying organizations, licensing organizations, and payers. Areas of attention include both specific areas such as radiation safety and MRI safety as well as error reduction in general. Several aspects of safety in the radiology department will be addressed in this forum including the importance of creating a well-functioning daily management system to rapidly identify abnormal states and apply countermeasures, staff safety, and risk management. Understanding these areas will potentially help attendees improve safety in their institutions.
LEARNING OBJECTIVES
1) To understand the importance of a Daily Management System to optimize rapid identification of issues and implementation of solutions to improve patient safety.

ABSTRACT
Have an effective Daily Management System (DMS) is seen as an important component of achieving a patient safety and continuous improvement culture. Many would argue that culture is the result of the management system in place. Effective DMS enables front line associates to be empowered to fix problems and helps identify and escalate issues rapidly when more resources are needed. An effective DMS typically has a number of components: tiered huddles, leadership standard work, and effective visual boards. This portion of the presentation will review the concepts and examples of success related to effective DMS.

MSQI318 • Staff Safety in the Radiology Department - What Dangers Lurk?
Olga R Brook MD (Presenter) *

LEARNING OBJECTIVES
1) Identify common staff safety risk sources in radiology department. 2) Apply and implement strategies and use tools to mitigate and prevent such risks. 3) Demonstrate understanding of policies and guidelines on staff and environmental safety.

ABSTRACT
Employees in a radiology department are exposed to multiple risks, including injuries due to radiation exposure, poor ergonomics, or repetitive stress; those caused by wearing lead aprons or moving heavy equipment for portable studies; and needle stick injuries. A comprehensive staff safety program was developed for a clinical radiology department to provide a framework for staff injury prevention. The important parts of a staff safety program are observational safety audits and walkabouts and a safety reporting tool for employees. Faculty education about workplace environmental risks and their consequences, compliance with policies and guidelines on environmental safety, and development of a culture that encourages surveillance, reporting, and prompt action will go a long way toward improving overall safety for all workers in a radiology department.

MSQI31C • Risk Management 101 for Radiologists
Ronald L Eisenberg MD, JD (Presenter)

LEARNING OBJECTIVES
1) To master the basic elements of risk management in order to protect patients and yourself.

ABSTRACT
Risk management has been defined as encompassing ‘clinical and administrative activities that [health care organizations] undertake to identify, evaluate, and reduce the risk of injury and loss to patients, personnel, visitors, and [the organization] itself.’ A successful risk management must be both reactive (to incidents that have already occurred) and proactive (to prevent future occurrences). In essence, risk management deals with ‘identification if legal risk, prioritization of identified risk, determination of proper organizational response to risk, management of recognized risk causes with the goal of minimizing risk (risk control), establishment of effective risk prevention, and maintenance of adequate risk financing.’ This segment will discuss the various aspects of risk management so that you are better prepared to protect your patients, your imaging department, and yourself.

Minicourse: Current Topics in Medical Physics-Radiation Dose Reduction in Medical Imaging

Tuesday, 08:30 AM - 10:00 AM • S404AB

RC323 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Mahadevappa Mahesh , MS, PhD *

ABSTRACT
This mini-course will include discussions on how to reduce radiation dose and clinical management in the areas of CT, Fluoroscopy and Radiography (CR and DR). Discussion will include dose-reducing strategies applicable due to technological advances, and also include practical steps on how to manage patient and staff safety clinically.

RC323A • CT Dose Reduction and Clinical Management
Mahadevappa Mahesh MS, PhD (Presenter) *

LEARNING OBJECTIVES
1) To identify various radiation dose reduction strategies in CT. 2) To assess impact of technological advances on reducing CT dose. 3) To describe ways to optimize radiation dose in CT.

ABSTRACT
There are two basic schools of fluoroscopy operation logic design (FOLD). Discussion of FOLD enables us to understand how the modern fluoroscopy systems are able to (1) lower radiation dose to the patient, (2) maintain the image quality required and (3) provide a wider dynamic range of patient thickness. While equipment based reduction of patient dose is effective, there is a need to monitor the overall radiation dose as the patient receives various types of radiological examinations. A hospital wide radiation monitoring (HWRM) is ever increasing as public-at-large becomes aware of potential radiation injuries from some of the radiological examinations. A sample monitoring system that is designed to monitor various patient dose data generated from CT and RF equipment will be discussed.

RC323B • Fluoroscopy dose reduction and Clinical Management
Pei-Jan P Lin PhD (Presenter)

LEARNING OBJECTIVES
1) To identify that there are two basic schools of fluoroscopy operation logic design (FOLD). Discussion of FOLD enables us to understand how the modern fluoroscopy systems are able to (1) lower radiation dose to the patient, (2) maintain the image quality required and (3) provide a wider dynamic range of patient thickness. While equipment based reduction of patient dose is effective, there is a need to monitor the overall radiation dose as the patient receives various types of radiological examinations. A hospital wide radiation monitoring (HWRM) is ever increasing as public-at-large becomes aware of potential radiation injuries from some of the radiological examinations. A sample monitoring system that is designed to monitor various patient dose data generated from CT and RF equipment will be discussed.

RC323C • CR and DR Dose Reduction and Clinical Management

ABSTRACT
...
LEARNING OBJECTIVES
1) Appreciate why dose reduction efforts are necessary in projection radiography using CR and DR. 2) Identify the meaning of vendor-specific receptor exposure indicators and the new standardized receptor exposure indicators, and their indirect relationship to patient dose. 3) Assess the role of output indicators, DAP, KAP, and EAP, in estimating patient dose. 4) List simple operational methods for managing radiation doses in clinical radiography.

ABSTRACT
Computed Radiography (CR) and Digital Radiography (DR) are key technologies that enable the electronic practice of radiology. Both CR and DR are capable of producing acceptable diagnostic quality images over a wide range of exposures. A combination of traditional and new methods is necessary to manage the concomitant radiation dose to patients undergoing projection radiography examinations.
LEARNING OBJECTIVES
1) Understand the role of the root cause analysis in process improvement. 2) Learn techniques to improve patient safety.

MSQI33A • Root Cause Analysis - Getting to the Root(s) of Your Problem
   Sumir S Patel MD (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

MSQI33B • A Mock Root Cause Analysis
   James V Rawson MD (Presenter) ; Sumir S Patel MD (Presenter) ; Norman B Thomson MD (Presenter) ; Layne Mitchell RT (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

MSQI33C • Using Lessons Learned to Improve Patient Safety
   Norman B Thomson MD (Presenter) ; Layne Mitchell RT (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

Physics (Population-Dose Survey)
Tuesday, 03:00 PM - 04:00 PM • S403A

SSJ22-01 • ACRIN PA 4006: Characterization of Mean Glandular Dose Adjusted to Volumetric Breast Density in a Prospective Digital Breast Tomosynthesis Screening Trial
   Mathew Thomas BS (Presenter) ; Yohei Matsutani ; Jae Y Choi DPhil ; Despina Kontos PhD ; Emily F Conant MD * ; Andrew D Maidment PhD *

PURPOSE
To characterize the effect of breast density and thickness on mean glandular dose (MGD) in digital mammography (DM) and digital breast tomosynthesis (DBT).

METHOD AND MATERIALS
Participants in this prospective screening trial were imaged with 2-view DM and 2-view combined DM/DBT obtained at 15% reduced dose. The MGD was calculated from exposure parameters for the combination-DM/DBT. Area (PD) and volumetric (VD) percent breast density was estimated using fully-automated, FDA-cleared software (Hologic R2 Quantra). PD and VD in each image was averaged for each breast. MGD unadjusted for glandularity was calculated from exposure factors in the DICOM header on a per-acquisition basis. MGD was adjusted for patient glandularity by Dance coefficient conversions. Statistical comparisons were made by paired t-test and regression analysis.

RESULTS
Data was available for analysis on 330 patients with 1320 images. Compressed breast thickness was 54.6 mm and 56.0 mm for CC and MLO, respectively. VD was 11.9% and 12.5% for LCC and RCC, respectively; PD was 23.4% and 21.6%, respectively. Volumetric density was 45.7% lower than area density (p

CONCLUSION
MGD for mammography is dependent upon thickness and glandularity, while MGD in tomosynthesis is predominantly thickness-dependent. The VD was lower than the PD, and both were substantially below 50% in all images. Reporting MGD without adjusting for glandularity underestimates actual dose delivered to the breast tissue per acquisition.

CLINICAL RELEVANCE/APPLICATION
This work characterizes key factors affecting MGD in combination-DM/DBT screening and provides more accurate estimates of MGD for prospective screening.

SSJ22-02 • Fetal Radiation Doses in Computed Tomography Examinations of Pregnant Patients: A Comparison between Whole-body and Individual Organ Doses at Three Different Gestational Ages
   Nelia Long MS (Presenter) ; Matthew Maynard MS ; Roger Y Shifrin MD ; Nash S Moawad MD, MS ; Wesley E Bolch PhD

PURPOSE
The purpose of this study was to compare values of whole fetal averaged absorbed dose to that for individual fetal organs following CT examination of the adult pregnant female. These differences were compared across three gestational ages and with variations in maternal perimeter at a given gestational age.

METHOD AND MATERIALS
In this study, the University of Florida (UF) series of anatomic computational models of the adult pregnant female were employed which
RESULTS
Calculated CT doses for abdomen-pelvis CT exams for soft-tissue organs differed by up to 26% from whole body averaged fetal doses. However, skeletal tissue doses were at most 110% larger than whole-body doses within the 25- and 38-week models. Skeletal doses were as high as 25 mGy per 100 mAs per rotation. Skeletal doses within the 10-week model were no more than 30% larger than the calculated whole-body dose. At greater gestational ages, the significant differences in results between the average whole-body dose and the skeletal dose during abdomen-pelvis CT exams should be considered when prospectively assessing stochastic risks to these tissues.

CONCLUSION
Although whole-body fetal dose is often the only quantity quoted in CT dosimetry, the imaging community should be aware that although soft-tissue organ doses are very similar to this number, the skeletal dose can be more than twice as large as the whole-body dose. These differences should be taken into consideration when making projections of stochastic risks resulting from exposures to the fetal skeletal tissues.

CLINICAL RELEVANCE/APPLICATION
Stochastic risk estimates to the skeletal tissues following in utero exposures during CT imaging of pregnant patients may be under reported if approximated using estimates of whole-body fetal dose.

SSJ22-03 • Radiation Dose from 3D Rotational Neurovascular Studies vs. Conventional 2D DSA

Elena Tonkopi MS (Presenter) ; Ahmed H Al-Habsi MD ; Jai Shankar

PURPOSE
To compare patient effective dose resulting from two alternative imaging methods for pre-intervention assessment of intracranial aneurysms: a series of Digital Subtraction Angiography (DSA) runs taken at different positions, and a 3D RA technique.

METHOD AND MATERIALS
In a retrospective analysis, we investigated the planning studies of 44 patients who underwent endovascular coiling in our institution between January and October, 2012. Images were acquired on a bi-plane II-based system (Siemens Axiom Artis) not equipped with a DAP meter. Conventional 2D projection DSA images were simulated with an anthropomorphic head phantom using 12 s runs with a rate of 2 f/s. Entrance skin exposure was measured with a 60 cc ionization chamber (Radcal, Accu-Pro) for AP, LAT, and Oblique projections. A commercially available Monte Carlo simulation program PCXMC was used to calculate patient effective dose. The second technique involved acquisition of 128 images during a 200° rotation of the C-arm around the patient’s head resulting in the 3D reconstruction. A 16 cm CT dosimetry phantom and a 100 mm pencil ion chamber were used to measure the CT dose index resulting from the RA. The ImPACT patient dosimetry software was employed for patient effective dose calculations. Scatter radiation was measured at 152 cm from the head phantom during both acquisitions. An unpaired two-tailed t-test was used to determine the significance of differences between patient doses in each group.

RESULTS
The sixteen patients underwent 2D projection DSA with a mean number of cine runs of 5.1 (minimum 4, maximum 8). Twenty eight patients were assessed using the 3D RA protocol, which included an AP/LAT run and one rotational spin. In the 2D DSA group the mean effective dose was 2.11 mSv (range 1.69–3.43 mSv), and in the 3D RA group effective dose was 1.29 mSv (p=0.00028). Scatter to the staff was 2.2 times higher during the cine run than from the one spin RA (p=0.00016).

CONCLUSION
Our study demonstrated that the patient effective dose and scatter radiation to the staff were significantly lower from the 3D RA than that from the 2D projection DSA runs used in the planning of cerebral aneurysm coiling.

CLINICAL RELEVANCE/APPLICATION
3D rotational angiography (RA) has the potential to decrease radiation dose and to improve the efficiency of the procedure.

SSJ22-04 • Predictive Models for Estimating Organ Dose from Fixed and Tube Current Modulated CT Scans Using Regional CTDIvol and Water Equivalent Diameter

Maryam Khatonabadi (Presenter) * ; Grace Kim MD ; Dianna D Cody PhD * ; Gary Arbique PhD * ; S. Bruce Greenberg MD ; Christopher H Cagnon PhD ; John J Demarco PhD ; Michael F McNitt-Gray PhD *

PURPOSE
To create predictive models that estimate organ doses from fixed mA or tube current modulated CT scans and that were applicable to both chest and abdomen exams. These models employ water equivalent diameter (WED) to describe patient size and a regional descriptor of scanner output, regional-CTDIvol.

METHOD AND MATERIALS
A total of 334 CT exams (188 chest and 146 abdomen/pelvis) of adult females, adult males and pediatric patients, were collected from 64-slice CT scanners from three different manufacturers (Siemens Healthcare, GE Healthcare and Toshiba Medical); all scans were performed with TCM. Voxelized patient models were created from image data from each exam and organs were identified by semi-automated segmentation to obtain: liver, spleen, and kidneys for abd/pel exams and lungs and glandular breasts tissue for chest exams. For patient size, WED was calculated for each image. For all patients, regional landmarks were manually identified and used to calculate regional CTDIvol. A validated Monte Carlo based CT dosimetry simulation package was used to estimate dose to all segmented organs, once using TCM data and once simulating fixed mA scans. Predictive models based on WED and regional CTDIvol values were developed to estimate organ dose using 60% of cases as a training set. The model was evaluated using the remaining 40% of cases as a test set and compared the predicted values to detailed simulated results for each case. RMS of absolute percent errors between simulated and estimated organ doses were reported across all organs, scanners and scan types as well as for individual organs.

RESULTS
The overall RMS of absolute percent error was 6.7% for fixed mA and 13.9% for TCM simulations. RMS errors were less than 10% for all organs in fixed mA simulations and range from 11-14.8%, for TCM CT scans. Smaller sized patients tended to have larger percent errors.

CONCLUSION
Predictive models were generated based on regional information of the scanner output and size and agreed with detailed simulations to within 7% for fixed and 14% for TCM across all scanners, organs, and exam types. The TCM predictive model could possibly be further improved by tailoring it to smaller patients.

CLINICAL RELEVANCE/APPLICATION
Organ doses can be estimated in a robust fashion for patients undergoing CT exams using predictive models based on regional descriptors of scanner output and patient size.

SSJ22-05 • Decreased Radiation Dose and Preserved Diagnostic Accuracy with Iterative Reconstruction at Coronary Computed Tomography Angiography: Intra-Individual Comparisons

Wei-Hua Yin (Presenter) ; Bin Lu MD ; U. Joseph Schoepf MD * ; Zhi-Hui Hou MD ; Run-Ze Wu ; Nan Li ; Lei Han ; Yang Gao ; Fang-Fang Yu

provided detailed anatomical modeling of the developing fetus at 10, 25, and 38 weeks gestation to determine the fetal size range at which the average whole-body fetal dose would be sufficient to approximate the dose to specific fetal organs. Monte Carlo simulations were used to calculate individual fetal organ doses as well as whole-body doses for a Toshiba Aquilion ONE scanner at 100 mAs per rotation. Variations in radiation dose to the fetus with changes in maternal size as given by the maternal abdominal perimeter were also explored.

RESULTS
Calculated CT doses for abdomen-pelvis CT exams for soft-tissue organs differed by up to 26% from whole body averaged fetal doses. However, skeletal tissue doses were at most 110% larger than whole-body doses within the 25- and 38-week models. Skeletal doses were as high as 25 mGy per 100 mAs per rotation. Skeletal doses within the 10-week model were no more than 30% larger than the calculated whole-body dose. At greater gestational ages, the significant differences in results between the average whole-body dose and the skeletal dose during abdomen-pelvis CT exams should be considered when prospectively assessing stochastic risks to these tissues.

CONCLUSION
Although whole-body fetal dose is often the only quantity quoted in CT dosimetry, the imaging community should be aware that although soft-tissue organ doses are very similar to this number, the skeletal dose can be more than twice as large as the whole-body dose. These differences should be taken into consideration when making projections of stochastic risks resulting from exposures to the fetal skeletal tissues.

CLINICAL RELEVANCE/APPLICATION
Stochastic risk estimates to the skeletal tissues following in utero exposures during CT imaging of pregnant patients may be under reported if approximated using estimates of whole-body fetal dose.
Purpose
Iterative reconstruction techniques show promise to decrease radiation requirements at coronary CT angiography (CCTA). No study performed a direct head-to-head, intra-individual comparison of iterative reconstruction algorithms with traditional filtered back projection (FBP) vis-à-vis diagnostic accuracy and radiation dose at CCTA.

Method and Materials

Results
Sensitivity and specificity for diagnosing ≥50% coronary artery stenosis on a per-segment level were 88.5% and 92.1% with FBP and 84.2% and 93.4% with iterative reconstruction (p>0.05). The area under the receiver-operating characteristic curve on a per-segment level was 0.903 (95% confidence interval [CI], 0.875-0.932) and 0.888 (95% CI, 0.856-0.920) with FBP and iterative reconstruction, respectively (p = 0.290). Compared with FBP, iterative series showed no significant (p<0.05) differences in image quality analyses. Median effective radiation dose was 52% lower for the iterative reconstruction protocol compared with FBP (0.73 mSv [interquartile range, 0.55-1.18] vs. 1.53 mSv [1.15-2.42]), p < 0.001

Conclusion
Compared with a routine radiation dose FBP protocol, 50% reduced dose acquisition using iterative reconstruction preserves image quality and diagnostic accuracy at CCTA.

Clinical Relevance/Application
Iterative CT image reconstruction techniques have potential to further reduce already low radiation requirements associated with CCTA.

SSJ22-06 • Quantifying the Spread in Deviation Index (DI) - An Initial Experience for a Tertiary Health Care Center and Its Affiliated Community Hospital

Jaydev K Dave PhD, MS (Presenter); Eric L Gingold PhD (Moderator)

Conclusion
Only 15%-18% of DI values fall within the target range of -0.5 to 0.5, and the SD ranged from 1.8 to 2.7. Thus, the range recommended in AAPM Report 116 is not being achieved in the current practice. This audit of DI values indicates the need for quality improvement projects and perhaps a re-evaluation of target values.

Discussion
The mean ± standard deviation (SD) for all DI values (n=283141) was 1.4±2.7. For neonatal (n=1877) and adult (n=32785) radiographs with mobile equipment and manual exposure parameters the mean±SD for the DI were -1.1±2.4, and 0.3±2.4, respectively. The most common radiographic exposure using manual technique was anterior-posterior chest for the neonatal (45%) and adult (60%) populations with mean±SD for the DI to be -1.2±2.2, and 0.1±1.8, respectively. For radiographs obtained with automatic exposure control (n=90272) the mean±SD for the DI were 0.7±2.2; amongst these, radiographs of the chest were most frequent with a mean±SD for the DI of 0.4±2.2. The mean±SD of the DI for radiographs acquired with the flat-panel digital radiography system were 1.5±2.3. Only 15% to 18% of the cases were in the target exposure range for the entire data set and the subsets considered. Overall, 23% radiographs were in the underexposed category (5%: DI<-3.0 and 18%: DI from -3.0 to -0.6) and 62% radiographs were in the overexposed category (37%: DI from 0.6 to 3.0 and 25%: DI>3.0). The DI values followed a gaussian distribution for the subsets considered in this study.

SSJ27 • AMA PRA Category 1 Credit™:1 • ARRT Category A+ Credit:1

SSJ27-01 • The Combination of Spectral CT Imaging and Low Concentration of Contrast Media (Iodixanol 270mgI/ml) Used in Abdominal CTA

Dandan Shao (Presenter); Xuexue Wang; Ying Yu; Xu Xu; Lun Lu; Ping Yang; Yongbo Yang; Xingan Long; Dong Chen; Na Gao; Hong-Yan Cheng

Purpose
To evaluate the image quality and diagnostic value of using spectral CT imaging and iodixanol 270mgI/ml in abdominal CTA.

Method and Materials
Thirty eight patients (BMI=25) with hepatic tumors, all of which intended to take surgical operation in our hospital, underwent bi-phase hepatic CT scan (Discovery CT750 HD,GE Healthcare). This study was approved by our institutional ethics committee. Half patients underwent spectral imaging and the other half underwent conventional CT scan. By GSI viewer software, optimal keV images were obtained directly. The CTA scan was triggered by SmartPrep software at the threshold of 100HU. Two CTA protocols (group A: n=19, 80/140kVp fast switching, 60%FBP+40%ASiR, injection volume of 1.2ml/kg, injection speed of 3.5ml/s, iodixanol 270mgI/ml; group B: n=19, 120 kVp, FBP, injection volume of 1.2ml/kg, injection speed of 3.5ml/s, Iohexol 350mgI/ml) were compared. The image quality parameters [the density of vessels, more distal branches; CT value, contrast-to-noise ratio (CNR) and signal-to-noise ratio (SNR) for common hepatic artery, proper hepatic artery and gastroduodenal artery] and radiation dose [the volume CT dose index (CTDI vol)] were evaluated. Use 5-points scale to evaluate the image quality by 2 experienced radiologists individually and blinded (5 for the best, 1 for the worst, =3 for acceptable image quality).

Results
There was no statistical difference for subjective scores, mean SNR and mean CNR in the abdominal arteries between the two groups (4.05±0.52, 34.54±5.33, 23.06±4.52 for group A and 4.11±0.46, 33.64±4.89, 23.89±3.85for group B, respectively),(p>0.05). Higher mean CT values were obtained in group B(284.11±37.81HU) than in group A(242.41±50.86HU),(p<0.05). Higher mean CNR were significantly lower than those in group B (28.25mGy and 0.24mSv) were significantly lower than those in group B (28.5mGy and 0.42mSv), (both p<0.05).

Conclusion
The use of low concentration of contrast media (iodixanol 270mgI/ml) combined with spectral CT imaging in abdominal CTA provided both iodine dose and radiation dose reduction with similar image quality in comparison with the conventional protocol, for individuals with
CLINICAL RELEVANCE/APPLICATION
The use of low iodine dose scan with spectral CT imaging decreased the patient’s renal toxicity and radiation injury in CT imaging.

SSJ27-02 • Injecting Contrast Media with Reduced Iodine Concentration at Higher Speed Results in Improved and Prolonged Arterial Enhancement in CT Angiography

Toon Van Cauteren MSc (Presenter); Gert Van Gompel PhD; Nico Buls DSc, PhD *; Koenraad H Nieboer MD *; Inneke Willekens MD; Guy Verfaillie PhD, MD; Daniel Jacobs Tulleneers Thevissen MD; Johan De Mey *

PURPOSE
To assess the impact of contrast media concentration on the height and length of arterial enhancement at constant iodine dose delivery rate (IDR) and total iodine dose (TID).

METHOD AND MATERIALS

RESULTS
Iodine concentration had a significant effect: the injection of lower concentrations at higher speed was associated with increased enhancement. Compared to 370 mg I/ml, all concentrations equal and below to 270 mg I/ml resulted in both a broader and higher arterial peak (all p values < 0.02). Tmax increased from 7.3 ± 4.0 s at 370 mg I/ml up to 15.8 ± 4.0 s at 120 mg I/ml, whereas Cmax increased from 237 ± 33 HU to 271 ± 20 HU, respectively. Despite higher injection speed, only a marginal increase in injection pressure was observed for lower iodine concentrations due to their reduced viscosity.

CONCLUSION
Despite constant IDR and TID, injecting a reduced contrast media concentration at higher speed results in a higher arterial peak enhancement and improved time window above 200 HU compared to the administration of a high contrast media concentration at lower speed.

CLINICAL RELEVANCE/APPLICATION
At equal iodine burden, reduced contrast media concentration improves image quality and relaxes the timing of the acquisition in CT angiography studies.

SSJ27-03 • Image Quality of Whole Aortic Angiography with Low Contrast Flow Rate and Dual-energy CT Non-linear Blending Technique

Jie Liu (Presenter); Jianbo Gao MD

PURPOSE
To investigate the image quality of thoracoabdominal aortic angiography with a low contrast medium flow rate and DECT non-linear blending technique

METHOD AND MATERIALS
Twenty patients with suspected aortic dissection were referred to whole aortic angiography. All patients underwent DECT angiography on a 128-slice dual-source CT with 64 * 0.6 mm collimation, pitch 1.2, 80/Sn140 kVp tube potential. The contrast medium was adapted by patient weight (0.5 ml 370 mg I/ml contrast per kg of body weight) and the flow rate was calculated by the contrast volume divided by the sum of delay and scan duration. The resulting high and low kVp images were transferred to a commercial non-linear blending software package to optimize the image contrast and noise. The linear mixed image was used as reference image which was considered as simulated 120 kVp image. The region-of-interest was placed on ascending aorta (AA), descending aorta (DA) and bifurcation (AB). The noise, signal-to-noise ratio (SNR) and CT attenuation were recorded. The ROI was also placed on the muscle to calculate contrast-to-noise ratio (CNR).

RESULTS
The patient weight was 72.5 ± 12.6 kg. The contrast volume was 36.5 ± 6.3 ml. The flow rate was 3.2 ± 0.4 ml/s. The CT attenuation was significant higher in optimal contrast than simulated 120 kVp group (AA: 12.4 ± 1.8 vs. 7.0 ± 1.5, p < 0.001; DA: 11.1 ± 2.1 vs. 6.5 ± 1.3, p < 0.001; AB: 12.0 ± 2.0 vs. 6.8 ± 1.5, p < 0.001). The volume CT dose index and dose-length-product were 7.7 ± 1.6 mGy and 526.2 ± 125.7 mGy*cm.

CONCLUSION
DECT non-linear blending technique can improve the image quality of whole aortic angiography and permit a low contrast medium volume and flow rate injection protocol.

CLINICAL RELEVANCE/APPLICATION
DECT permitted low contrast medium volume and flow rate which improve the patient care and maintain diagnostic image quality.

SSJ27-04 • Validation of a Low Dose Simulation Method for Evaluation of Sub-mSv Computed Tomography

Daniela Muenzel MD (Presenter); Thomas Koehler PhD *; Kevin M Brown MS *; Stanislav Zabic PhD *; Alexander A Fingerle MD; Simone Waldt MD; Edgar Bendik; Tina Zahel; Ernst J Rummeny MD; Martin Dobritz MD; Peter B Noel PhD

PURPOSE
Evaluation of a new software tool for generation of simulated low-dose computed tomography (CT) images from an original higher dose scan.

METHOD AND MATERIALS
Original contrast-enhanced and non-enhanced CT examinations (120 kVp; 100 mAs, 80 mAs, 60 mAs, 40 mAs, 20 mAs, and 10 mAs) of a swine were acquired. Simulations of CT images with a lower radiation exposure (range 10-80 mAs) were calculated using a low-dose simulation algorithm that simulates accurately both photon noise and electronic noise that would be present in a scan at lower dose. Simulated non-enhanced images were compared to the original non-enhanced CT data of the same radiation dose level regarding density values and image noise. Four radiologists assessed the visual appearance of the simulated contrast-enhanced CT data.

RESULTS
Image characteristics of simulated low-dose scans were similar to the original acquisitions. Mean overall discrepancy of image noise and CT values between original and simulated CT images was 0.2 % (range -0.6 % to 0.8 %) and -0.3 % (range -2.1 % to 0.8 %), respectively, p > 0.05. Subjective observer evaluation of image appearance showed no visually detectable difference.

CONCLUSION
Simulated low dose images showed excellent agreement with the original scan data concerning image noise, CT density values, and subjective assessment of the visual appearance of the simulated images.

CLINICAL RELEVANCE/APPLICATION
SSJ27-05  Reduced Iodine Dose Single Source Dual-energy CT Angiography of Abdomen for Assessment of Aorto-Illiac Diseases: Is This the Killer Application for Dual-energy CT?

Mukta D Agrawal MBBS, MD (Presenter) *; Surabhi Bajpai MBBS, DMRD; George R Oliveira MD; Sanjeeva P Kalva MD *; Jorge M Fuentes MD; Koichi Hayano MD; Yasir Andrabi MD, MPH; Dushyant V Sahani MD

PURPOSE
To investigate the performance of ssDE-CTA using reduced iodine dose for abdominal angiography in comparison to currently applied iodine dose conventional single energy CTA (SE-CTA) and to determine the energy level (keV) that provide optimal imaging for vascular and extravascular evaluation.

METHOD AND MATERIALS
In a IRB approved ongoing clinical trial, 64 consecutive patients with AAA and prior SE-CTA exam using standard dose of iodine were enrolled. Their follow up CTA exam was undertaken on ssDECT (GE Discovery CT750 HD) with reduced iodine dose (21-24gms instead of 33-55gms). Patients received iso-osmolar iodinated CM (Iodixanol, GE) of 270 mgI/mL (group A, n=32) or 320 mgI/mL (group B, n=32) concentration. The arterial phase DECT images were processed to generate virtual monochromatic images (VMC) of various energies (40 to 140 keV at an increment of 5 keV). Two-experienced radiologist independently evaluated VMC image sets for subjective image quality and noise. Image quality was determined the diagnostic keV range and the optimal keV for vascular and extravascular assessments. The contrast to noise ratio (CNR) was calculated on VMC images at various energies and SE-CTA images. A paired student t-test was used to determine statistical significance.

RESULTS
All DE-CTA exams were considered diagnostic with an IQ score 4.2. Both readers observed a broad range of diagnostic keV images from 40 to 75; and 40-45 keV images were considered best for vascular assessment, whereas 60-65 keV images were rated best for both vascular and extra-vascular assessment. In comparison to SE-CTA images, VMC images (40 ◅ 60 keV) provided significantly higher intravascular attenuation (200-20%) and CNR (40-20%) at 28% less iodine dose (P CONCLUSION
ssDE-CTA of abdomen at 28% less iodine dose provides a broad range of diagnostic keV, with 40-45 keV considered best for vascular evaluation and 60-65 keV for both vascular and extra-vascular assessment. This broad diagnostic keV range provides high latitude for image post processing.

CLINICAL RELEVANCE/APPLICATION
ssDECT enables substantial reduction in the iodine dose for CTA exam while yielding 200-20% higher intravascular enhancement thereby providing an opportunity to lower renal risks in older patients.

SSJ27-06  Whole-body 64-detector CT Angiography with Low-tube-Voltage (80 kVp) and Low-concentration (240 mg/mL) Contrast Material to Reduce Radiation Dose and Iodine Load

Masayuki Kanematsu MD; Satoshi Goshima MD, PhD; Yoshiharu Miyoshi RT; Hiroshi Kondo MD; Haruo Watanabe MD; Yukichi Tanahashi MD (Presenter); Yoshifumi Noda MD; Kyongtae T Bae MD, PhD *; Nobuyuki Kawai MD

PURPOSE
To prospectively evaluate contrast enhancement, vascular depiction, image quality, and radiation dose of low-tube-voltage whole-body computed tomographic angiograms (CTAs) with low-concentration iodinated contrast material (CM).

METHOD AND MATERIALS
This study was approved by our institutional review board and all patients provided informed consent. Whole-body CTAs were obtained in 109 patients (body weight range, 37-100 kg; mean, 61.2 kg) with a 64-detector CT (Discovery CT750 HD; GE Healthcare) using adaptive statistical iterative reconstruction algorithm (ASIR; GE Healthcare). Patients were randomized into three groups: CTA with 240 mg/mL CM at 80 kVp (240-80 group), 300 mg/mL at 80 kVp (300-80 group), and 370 mg/mL at 120 kVp (370-120 group). CM was intravenously injected at 4 mL/sec and bolus tracking was used in all patients. Signal-to-noise ratio (SNR), arterial depiction, image quality, and radiation dose were assessed separately for the thorax, abdomen, and pelvis. A figure of merit (FOM) was computed to normalize the SNR, estimated effective dose, and iodine weight administered, using the following equation: FOM = SNR/effective dose/iodine weight.

RESULTS
Mean iodine weight administered was 21.6, 26.8, and 34.0 g, respectively, for 240-80, 300-80, and 370-120 groups (P < .05). Mean vascular enhancement in the thoracic aorta, abdominal aorta, and iliac arteries ranged 508-521, 546-593, and 435-442 HU with 240-80, 300-80, and 370-120 groups, respectively (P < .05). The arterial depiction and image quality were comparable between 240-80 and 370-120 groups and were greater with 300-80 group than with the other two groups in selected arteries (P < .05). Mean effective dose was higher with 370-120 group (2.8-5.4 mSv) than with 240-80 group (2.3-4.3 mSv) for the abdomen and pelvis (P < .05). Mean FOMs were higher with 370-120 group (4.8-9.2) as compared to other two groups (2.8-5.4 mSv) for the abdomen and pelvis (P < .05) and tended to be greater for the thorax and pelvis than those with 370-120 group (4.8-9.2).

CONCLUSION
Use of 240 mg/mL CM at 80 kVp seems appropriate for a routine whole-body CTA and beneficial to the reduction of iodine load and radiation dose, whereas the use of 300 mg/mL CM may marginally improve the delineation of selected small arteries.

CLINICAL RELEVANCE/APPLICATION
Whole-body CTA with 240 mg/mL CM and 80-kVp tube voltage may replace conventional CTA with 350-400 mg/mL CM at 120-kVp tube voltage, contributing to a reduction of iodine load and radiation dose.

MRI Safety Update (An Interactive Session)

Tuesday, 04:30 PM - 06:00 PM • E353C

RC429  AMA PRA Category 1 Credit ™:1.5  • ARRT Category A+ Credit:1.5

RC429A  Implants and Devices

Frank G Shellock PhD (Presenter) *

LEARNING OBJECTIVES
1) To understand the MRI issues for implants and devices. 2) To comprehend the MRI labeling terminology for implants and devices. 3) To understand current information pertaining to patients that present with passive and active implants (e.g., neurostimulation systems, pacemakers, etc.). 4) To apply knowledge about implants and devices to ensure safety for patients undergoing MRI examinations.

ABSTRACT

RC429B  MRI Technologist Perspectives
William H Faulkner

**LEARNING OBJECTIVES**

1. To understand the steps required to research information relating to MR safety status of implants and/or devices.
2. To learn how to properly screen patients for MR procedures.
3. To understand the importance of being able to control access to Zones III and IV.
4. To learn how to manage patient warming and avoid patient burns.

**ABSTRACT**

RC429C • Standard and MR Conditional Cardiac Pacemakers

Patrick M Colletti MD (Presenter) *

**LEARNING OBJECTIVES**

1. Identify, schedule, prepare, examine with MRI, and confirm reprogramming for patients with MR conditional pacemaker systems.
2. Consider the risks and benefits for MR imaging in patients with non-conditional electrophysiology devices.
3. Optimize 3rd party coverage for MR services in patients with MR conditional pacemaker systems.

**ABSTRACT**

There are more than 1.5 million patients in the US with implanted cardiac devices. It is estimated that 750,000 to 1M may have indications for MRI. There have been more than 15 monitored cardiac device/MR trials involving over 1419 participants examined at 0.2T to 3T. At least 17 deaths with unmonitored MRI examinations have been reported. Until recently, most radiologists and MR centers have opted out of examining patients with cardiac devices. In 2008, Gimbel presented results of MR examination of patients with cardiac pacemakers at 3-Tesla with no restrictions placed on pacemaker dependency, region scanned, device type, or manufacturer, suggesting that monitored pre-programmed 3T MRI scans may be safely performed. There is currently one available FDA approved MR conditional system available for limited use. Protocol for MR conditional MR includes:

1. Confirm clinical requirement for MR.
2. Confirm functioning MR conditional device.
4. Program device to scan mode.
5. Monitor and scan patient at 1.5T.
6. Reprogram device, confirm, and discharge.

Controversy Session: MRI Contrast Use: Have Quality and Safety Collided?

Wednesday, 07:15 AM - 08:15 AM • E350

**LEARNING OBJECTIVES**

1) Be aware of the current issues relating to the use of gadolinium based contrast agents in patients with renal failure. 2) Be updated on factors relating to the relative and absolute risk of NSF in patients receiving gadolinium based contrast agents. 3) Be aware of current practical approaches to minimizing risk of NSF in patients with renal failure receiving gadolinium based contrast agents. 4) Be exposed to debate and discussion on the risk/benefit of using vs non using gadolinium based contrast agents in patients with renal failure. 5) Be better informed about management of the patient with renal failure requiring MRI with gadolinium based contrast agents.

**ABSTRACT**

Minicourse: Recording and Reporting Radiation Dose: National and International Perspectives and Activities

Wednesday, 08:30 AM - 10:00 AM • N226

**RC523 • The American College of Radiology Dose Index Registry**

Richard L Morin PhD (Presenter)

**LEARNING OBJECTIVES**

1) Understand how registries perform. 2) Understand the way in which registries have altered physician behavior and improve patient care. 3) Identify the parameters involved in optimizing radiation dose in clinical practice. 4) Apply this knowledge by participating in a dose index registry and utilizing these techniques in Maintenance of Certification.

**ABSTRACT**

There is no major debate regarding the validity of the computed tomography dose index (CTDI) in Europe because it is considered as a tool for scanner acceptance and constancy testing. Its use for that purpose is undisputed. Measures for patient dose have been a major topic for decades. There are no common regulations valid for all of Europe, but there are a number of initiatives and concepts in place already which originated here. Among these are primarily the generation of conversion coefficients k for estimating values of the effective dose E from the dose length product (DLP) by E = k×DLP and the concept of dose...
**RC554** • *AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**Tessa S Cook**, MD, PhD

**Adam H Kaye**, MD

**William W Boonn**, MD *

**LEARNING OBJECTIVES**

1) Download and install RADIANCE. 2) Configure RADIANCE for their facility. 3) Set up RADIANCE to query and retrieve dose sheets automatically from PACS or another archive. 4) Use the RADIANCE reporting tools to review their institutional dose data. 5) Export dose data from RADIANCE for custom analysis using a spreadsheet or database.

**ABSTRACT**

RADIANCE is a freely-available, open source software package designed to facilitate dose monitoring, dose reporting and quality assurance for computed tomography (CT) examinations. It uses optical character recognition (OCR) to extract structured data from the image-based dose sheets that have been and continue to be produced by CT scanners worldwide. The structured data is parsed and useful dose-related parameters are extracted, including the x-ray tube voltage (kV), x-ray tube current (mA), volumetric CT dose index (CTDIcon) and dose-length product (DLP). In addition, information about the patient, type of study, scanner and performing institution are obtained from the DICOM study header. This aggregate of dose and exam data is stored in a relational database which can be used to perform quality assurance measures. Using the RADIANCE dashboard and scorecards, facilities can closely monitor their dose data, generate monthly reports for individuals and administrators, identify and investigate outliers and evaluate dose reduction and protocol optimization measures. With the development of radiation dose structured reports (RDSRs or Dose SRs), which are generated by newer scanners, facilities can participate in the American College of Radiology's Dose Index Registry (DIR). However, sites without the newest scanners or latest firmware, or those whose scanners will not be updated, can use RADIANCE to generate an RDSR from legacy (i.e., image-based) dose sheets and automatically send it to the DIR. Participants in this hands-on course will learn how to install and configure RADIANCE for optimal use at their facilities.

URL's

http://www.radiancedose.com

**ICII41** • *AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

**LEARNING OBJECTIVES**

1) Broadly describe the role of IT in helping improve quality and safety for radiology. 2) Describe some of the next generation IT requirements for quality and safety improvement. 3) Use case examples to demonstrate the use of IT to improve access, appropriateness, report quality and results communication. Demonstrate how IT tools can help quantify measurable improvements in each function/process. 4) Use case examples to describe system integration requirements and strategies to enable quality and safety improvement.

**ABSTRACT**

Improving quality and safety in healthcare and reducing medical errors has become an important element of the national dialogue. A series of ground-breaking reports from the Institute of Medicine, including Crossing the Quality Chasm published in 2001 have helped frame the national debate. It has become apparent that working harder or smarter is not the answer. Broad system changes are sorely needed to enable the transformation of our healthcare system and creating a patient-centered, evidence-based care model. Information technology (IT) solutions are a critical element for this transformation.

In this session we will present some of the next generation IT requirements for improveing quality and safety in radiology. Our speakers will use case examples to demonstrate how information technology tools can be used to improve appropriateness, access, value' of the radiology report, and results communication. Where relevant, our speakers will describe how metrics (e.g. with the use of dashboards, scorecards, or analytics tools) can be used to measure the improvements enabled with IT described in each presentation. Speakers will address the importance of system integration and suggest strategies to use existing IT standards to enable quality and safety improvements in our practices.

**ICII41A** • *Using IT to Improve Appropriateness and Access*

**Keith D Hentel** MD, MS (Presenter)

**LEARNING OBJECTIVES**

View learning objectives under main course title.

**ABSTRACT**

**ICII41B** • *Using IT to Improve the 'Value' of Radiology Reports*

**Ramin Khorasani** MD (Presenter) *

**LEARNING OBJECTIVES**

1) Describe some of the key attributes of a 'high value' radiology report. 2) Describe some of the existing performance gaps for creation of an optimal radiology report. 3) Using case examples, illustrate how health IT tools could improve the 'value' of radiology reports.

**ICII41C** • *Using IT to Improve Results Communication, Including Critical Results*
HEPATIC STEATOsis IS A FREquent INCIDENTAL FINDING ON ABDOMINAL CT. THERE IS LIMITED DATA ON THE IMPACT OF DOCUMENTATION OF INCIDENTAL DETECTED HEPATIC STEATOSIS IN RADIOLOGY REPORTS ON PCP IDENTIFICATION AND THEIR DECISION-MAKING. THE PURPOSE OF THIS STUDY WAS TO EVALUATE THE IMPACT OF STRUCTURED REPORTING OF INCIDENTAL DETECTED HEPATIC STEATOSIS ON PCP DECISION-MAKING AND PATIENT MANAGEMENT.

METHOD AND MATERIALS
This retrospective study included patients who underwent abdominal CT scans for evaluation of hematuria or nephrolithiasis between January 2008 and October 2011. An independent reader evaluated the CT reports for documentation of hepatic steatosis, nature of reporting (body of report vs impression), presence of recommendations and physician contact at the time of reporting. The patient medical records were then reviewed for diagnosis of steatosis, alcohol use, medications, diagnosis of hypertension, hyperlipidemia, and diabetes. The laboratory values were also examined prior to and after CT scanning.

RESULTS
Out of a total of 12,000 CT scans, 356 patients had hepatic steatosis on CT reports. Out of these, 127 patients (M:F, mean age - , age range - ) were included in final analysis due to availability of follow up data. On evaluation of CT reports, hepatic steatosis was documented in the impression in 83/127 (65%) patients and in the body of report in 44/127 (35%) patients. HCV screening was performed in 6.3% of patients and 59% underwent insulin resistance screening and over 80% of patients underwent LFT and lipid screening. There was a significant difference in the rate of follow up when radiology reports commented on fatty liver in the impression vs the body (30.1% vs. 9.1%, p = 0.007). On follow up evaluation at 14 months, steatosis was commented in the PCP follow up notes in only 23% of patients. New cases of insulin resistance were identified in 36% of patients (12% diabetes, 24% pre-diabetes) who underwent screening within 14 months of imaging.

CONCLUSION
Structured radiology reporting practices for incidentally detected hepatic steatosis on CT scans significantly impacts PCP decision-making and patient care. Our data suggest that steatosis should be recorded in impression section of reports.

CLINICAL RELEVANCE/APPLICATION
Structured reporting of incidentally detected hepatic steatosis in CT scans will enable the treating physician to take decisive action allowing significant impact on patient care and management.

Hepatic steatosis is a frequent incidental finding on abdominal CT. There is limited data on the impact of documentation of incidentally detected hepatic steatosis in radiology reports on PCP identification and their decision-making. The purpose of this study was to evaluate the impact of structured reporting of incidentally detected hepatic steatosis on PCP decision-making and patient management.

METHOD AND MATERIALS
This retrospective study included patients who underwent abdominal CT scans for evaluation of hematuria or nephrolithiasis between January 2008 and October 2011. An independent reader evaluated the CT reports for documentation of hepatic steatosis, nature of reporting (body of report vs impression), presence of recommendations and physician contact at the time of reporting. The patient medical records were then reviewed for diagnosis of steatosis, alcohol use, medications, diagnosis of hypertension, hyperlipidemia, and diabetes. The laboratory values were also examined prior to and after CT scanning.

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CLINICAL RELEVANCE/APPLICATION
Structured reporting of incidentally detected hepatic steatosis in CT scans will enable the treating physician to take decisive action allowing significant impact on patient care and management.
SSK10-05 • Second-opinion Consultations in Musculoskeletal Radiology

**Majid Chalian MD (Presenter) ; Filippo Del Grande MD, MBA ; Rashmi S Thakkar MD ; Sahar J Farahani MBBS ; Avneesh Chhabra MD * ; Shadpour Demehri MD ; Laura M Fayad MD ; John A Carrino MD, MPH * **

**PURPOSE**
To assess the patient care benefit of an institutional policy requiring official second-opinion consultation for all imaging examinations performed outside the institution.

**METHOD AND MATERIALS**
The institutional review board approved the retrospective review of patient data for this HIPAA-compliant study and waived the need for individual informed consent. Two trained radiology fellows compared the second-opinion consultation reports for outside musculoskeletal radiology exams within calendar years 2010 and 2011 with the outside original reports. The reports were categorized by using a five-point ordinal rating scale: 1, no difference in interpretation; 2, clinically unimportant difference in detection; 3, clinically unimportant difference in interpretation; 4, clinically important difference in detection; and 5, clinically important difference in interpretation. Clinically important differences were defined as those likely to change patient care or diagnoses. Inter-observer reliability was assessed using linear-weighted kappa.

**RESULTS**
Of 3165 exams, 2326 (73.5%) had an outside report for comparison. There were 472 (20.3%) instances with clinically important differences. Of these 472 discrepancies, 214 (45.3%) were category 4 and 258 (54.7%) were category 5. When definitive diagnoses was obtainable from pathology reports (580 exams), 102 (17.4%) studies had clinically important discrepancies between inside and outside reports. There was a very good agreement (kappa=0.93) between readers in scoring the discrepancies.

**CONCLUSION**
A 20.3% rate of discrepant interpretations (472 of 2326 studies) was noted for a service offering second-opinion consultations for outside examinations. Most were discrepancies in interpreting identified abnormalities rather than in detecting abnormalities. When a definitive diagnosis was obtainable, there was clinically important discrepancy in 17.4% of studies between the second-opinion consultation and the outside reports.

**CLINICAL RELEVANCE/APPLICATION**
Results of this study could be helpful for health care decision makers regarding second-opinion subspecialty consultation value in musculoskeletal radiology.

SSK10-06 • The Effect of Increasing Imaging Volumes on Radiologist Fatigue: The eFatigue Phenomenon

**Robert J McDonald MD, PhD (Presenter) ; Kara M Schwartz MD ; Felix E Diehn MD ; Laurence J Eckel MD ; Christopher H Hunt MD ; Bradley J Erickson MD, PhD * ; David F Kallmes MD * **

**PURPOSE**
Cross-sectional imaging utilization has dramatically increased over the past two decades. Driven by technical innovations that have improved anatomic resolution, acquisition time, and applicability of CT and MRI, cross-sectional modalities have supplanted use of traditional radiographs in many clinical practice guidelines. Rising utilization coupled with innovation has increased Radiologists' workload through with respect to the total number of studies and images that must be interpreted. In the current study, we quantified changes in imaging workload over time as a surrogate measure of fatigue.

**METHOD AND MATERIALS**
Monthly counts of CT and MRI studies performed at our institution from 1999-2010 were identified. Total numbers of images per exam were also extracted from the associated studies. Imaging workload data were normalized to the number of dedicated CT and MRI daily work assignments to determine the average radiologist workload assuming a 235-work day calendar and 8-hour workday. Temporal trends in institutional and individual workload were assessed by Sen's slope analysis (Q) using a normal Z-test statistic.

**RESULTS**
From 1999-2010, a total of 1,517,149 cross-sectional imaging studies (CT=994,471; MRI=522,678) were evaluated at our institution. Total numbers of annual cross-sectional studies steadily increased from 84,409 in 1999 to 147,336 in 2010, representing a two-fold increase in workload (Q=6465/yr, Z=4.2, p < 0.0001). Imaging volumes have grown at a rate out of proportion to increasing imaging utilization at our institution. The average radiologist must now interpret 1 image every 2-3 seconds in a given 8-hour workday to keep up with workload demands.

**CLINICAL RELEVANCE/APPLICATION**
Growing imaging volumes, and to a lesser extent increasing utilization, are likely major contributors to Radiologist fatigue.
SSK10-07 • Tension between Quality Metrics: The Case of Radiation Dose and Diagnostic Yield in Suspected Chronic Stable Angina

Saurabh Jha MD (Presenter)

PURPOSE
Radiation dose and proportion of negative coronary catheter angiograms (CCA) are potential quality metrics in the management of patients with suspected chronic stable angina. The tension between achieving the metrics when using various gatekeeper tests for coronary artery disease (CAD) is explored.

METHOD AND MATERIALS
Decision model capturing the diagnostic strategies utilizing various gatekeeper tests, either singly or in combination, in a cohort of patients suspected of chronic stable angina was constructed. CCA was assumed to be the gold standard. Patients with positive and non-diagnostic tests were assumed to receive CCA. The outcomes included total radiation dose in the diagnostic pathway and the proportion of negative catheter angiograms.

RESULTS
The typical patient in the cohort is a 55 year old female with atypcial chest pain who has 30 % pre-test probability of obstructive CAD. Cardiac CT achieved one of the lowest negative CCA rate of 33 % (desirable) but the highest radiation dose of 15.04 msv (undesirable). Exercise ECG led to the highest negative CCA rate (undesirable) of 54 % but one of the lowest radiation doses (desirable) of 3.36 msv. A combination of stress echo followed by cardiac CT for the non-diagnostic tests was optimal achieving a negative CCA rate of 26 % and a radiation exposure of 3.93 msv.

CONCLUSION
A strategy employing stress echo and cardiac CT achieved the lowest negative CCA rate and relatively low radiation exposure; both outputs are plausible quality metrics. The scenario highlights that quality metrics can sometimes be oppositional, even if united by a singular underlying goal of improved patient care.

CLINICAL RELEVANCE/APPLICATION
Metrics will become ubiquitous in adjudicating quality and determining value and reimbursement in healthcare.

SSK10-08 • Abdominopelvic MRI for Lesion Characterization: Factors Associated with Likelihood of Added Value

Andrew B Rosenkrantz MD (Presenter); Laura Heacock MS, MD; James S Babb PhD

PURPOSE
To evaluate factors associated with the likelihood that abdominopelvic MRI examinations performed for characterization of lesions identified on other imaging modalities will provide information with potential to add value to patient management.

METHOD AND MATERIALS
1,132 abdominopelvic lesions in 863 patients in which MRI was performed for further characterization following detection by an alternate imaging modality were included in this retrospective study. Reports of the MRI examinations and of the prior studies were reviewed to classify cases in terms of patient, examination, and lesion related factors. The MRI reports were also classified in terms of various measures reflecting inclusion of content with potential to add value to patient management. Data was analyzed using logistic regression for correlated data.

RESULTS
MRI provided a definitive diagnosis (DD) for 79.2% (897/1132) of lesions, upgraded the severity of the favored diagnosis in 6.2% (70/1132) of lesions, downgraded the severity of the favored diagnosis in 34.5% (390/1132) of lesions, and showed an absence of the suspected lesion in 12.0% (136/1132) of lesions. Provision of a DD was significantly associated with the organ containing the lesion (p < 0.01). In step-wise logistic analysis, less experience with liver MRI as measured by a percent of workload dedicated to MRI, exam factors (indication, scanner brand, magnet strength) and work related factors (weekend vs weekday read, presence of preliminary read by trainee).

CONCLUSION
Any interpretive changes were classified by clinical significance and potential change in patient management. Abdominopelvic MRI examinations performed for further lesion characterization may add value to clinical management in a high fraction of cases, the likelihood of which is influenced by factors related to the given examination.

CLINICAL RELEVANCE/APPLICATION
Policy decisions that impact MRI utilization should recognize factors impacting likelihood of added value, rather than the historical approach of treating all utilization in a homogeneous fashion.

SSK10-09 • Improved Accuracy of Gadoxetate Disodium-Enhanced MRI Using a Double Reading Paradigm for Detection and Characterization of Liver Lesions

Sheela Agarwal MD, MS (Presenter); Sandeep S Hedgire MD; Elkan F Halpern PhD *; Mukesh G Harisinghani MD; Pari Pandharipande MD, MPH; Debra A Gervais MD *; Peter F Hahn MD, PhD *; Sanjay Saini MD

PURPOSE
To evaluate the incremental clinical value of double reading gadoxetate liver MRIs for detection and characterization of liver lesions and incidental findings.

METHOD AND MATERIALS
During the 6 month period from 8/1/2012-1/31/2012, 489 patients underwent 544 liver MRIs with the relatively new contrast agent gadoxetate disodium. Each study was read primarily by a fellowship trained staff abdominal radiologist and over-read by a second board certified abdominal radiologist. Change in diagnosis was confirmed by characteristic radiologic findings with consensus review (74%), imaging follow-up (12%), or histopathology (14%). Any interpretive changes were classified with logistic regression analysis, including reader factors (experience level, percent of workload dedicated to MRI), exam factors (indication, scanner brand, magnet strength) and work related factors (weekend vs weekday read, presence of preliminary read by trainee).

RESULTS
Changes in interpretation occurred on 50 examinations (9.2%) with 23 (4.2%) leading to a potential change in clinical management. On multivariate logistic regression analysis, weekend interpretation was an independent predictor increasing likelihood of a change in interpretation (p < 0.01). In step-wise logistic analysis, reading the study alone (without the preliminary read of a trainee) was also found to be a predictor of an interpretive change (p < 0.02). On univariate logistic analysis, less experience with liver MRI as measured by a smaller percentage of one’s workload dedicated to MRI was a significant factor predicting a miss (p < 0.05). Common interpretative discrepancies included omission of one metastasis in the setting of multiple metastases (13), misinterpretation of HCC (9), misinterpretation of hemangiomas (6) and misinterpretation of FNH and adenomas (8).

CONCLUSION
Double reading of gadoxetate-enhanced liver MRI results in improved detection and characterization of liver lesions, with a significant effect on clinical management of patients. This may be considered for better clinical practice in divisions with varying levels of reader experience with hepatobiliary contrast agents.
CLINICAL RELEVANCE/APPLICATION
Radiologists initiating use of gadoxetate for liver MRI should consider a period of double reading until all staff have acquired full familiarity with this new contrast agent.

ISP: Informatics (Quality and Safety)

Wednesday, 10:30 AM - 12:00 PM • S405AB

SSK11 • AMA PRA Category 1 Credit ™:1.5 • ARRT Category A+ Credit:1
Moderator
Woojin Kim , MD *
Moderator
David S Hirschorn , MD

SSK11-01 • Informatics Keynote Speaker: Informatics and Quality
Woojin Kim MD (Presenter) *

SSK11-02 • Crying 'Wolf' about Unsatisfactory Study Quality: A Potential Rift in Communication between Radiologists and Referring Clinicians
Shahine Baghadi MD (Presenter) ; Amy Kunce ARRT ; William W Olmsted MD ; Eliot L Siegel MD *

PURPOSE
Technically unsatisfactory imaging quality (TUIQ) impacts patient care, but there is wide variability in whether and how TUIQ is identified in radiology reports. The purpose of this study was to determine the relative frequency in which TUIQ is explicitly identified in reports of various modalities, how often recommendations for follow up are made, and whether these recommendations are heeded by clinicians.

METHOD AND MATERIALS
Using software to search 130,733 radiology reports (Montage, Philadelphia, PA), we retrospectively identified studies (CR, US, and CT) describing TUIQ. Search terms included: limited, suboptimal, sub-optimal, and poor. Study date, modality, radiologist, indication, limitation(s), and retake recommendations were recorded. Retakes were defined as follow-up exams obtained based on negative remarks about a study's quality, whether or not the radiologist recommended a repeat study. An additional 954 consecutive CR, CT, and US studies were manually reviewed to determine the rate of TUIQ studies and to serve as a control group.

RESULTS
7% of diagnostic imaging reports included at least one comment implying TUIQ. CR had the lowest percentage of TUIQ. Relative to these, the rate of TUIQ was 1.7 times higher for CT and 3.7 times higher for US. 52% of all TUIQ cases underwent no follow up imaging; 29% had a follow up study for clinical reasons other than technical quality and only 19% of cases had follow up imaging performed because of TUIQ (i.e., retake cases). Of these 19%, 52% had a radiologist's recommendation for retake. Conversely, retake occurred in only 36% of total cases where the radiologist recommended one be performed.

CONCLUSION
Descriptions of technical issues are often vague and difficult to discern such as poor, limited, and suboptimal and should be avoided when possible. When these descriptions result in retakes, they are usually performed without an explicit recommendation by the radiologist. In instances when the radiologist recommends a retake, it is performed only about a third of the time.

CLINICAL RELEVANCE/APPLICATION
This study is of interest to all radiologists seeking to improve communication with referring clinicians regarding the diagnostic quality of imaging studies and need for repeat imaging.

SSK11-03 • Updating Radiation Dose Rate in Fukushima Two Years after Severe Accident of Fukushima Nuclear Power Plant
Shoichi D Takekawa MD (Presenter) ; Takahiro Kato PhD

CONCLUSION
The RDR in Fukushima residence area is decreasing by the effort of eradication by removing the surface soil and leaves of trees contaminated by fallout. However, some radiation is still remaining and further observation and effort to remove contaminated materials in the residential areas are necessary.

Evaluation
Data of radiation were collected from the public announcements of Japanese Government of Education and Science and Fukushima City. The dose rate at 1 meter above the ground was measured also by Airplane on June 28 and November 16, 2012. The results of RDR before and after removal of soil and leaves of trees contaminated by radiation were announced by Fukushima City. The RDR measured 4 to 30.35 Sv/hr in the northwestern areas within 20km from FNPP even in March, 2013. It measured 0.24 to 1.175 Sv/hr in Fukushima City on 3-8-13, where it measured 11 to 15.05 Sv/hr on 6-25-11. The RDR at measuring posts on the ground of FNPP measured 3.1 to 6.75 Sv/hr on 3-13. The RDR at the chimney for ventilation of capsule measured over 200 Sv/hr.

Discussion
It was estimated that early decrease of Radiation dose rate in the residence areas was due to the decay of 131I and some influence was due to 137Cs (HL: 2.06 years) and washing effect of rains. The rate of decrease of RDR was exceeding the half life of 137Cs (HL: 30.1 years). The effort to eradicate excess radiation in the residence areas is being made, and it was accomplished in 0 to 100% in Fukushima City by August 2012. The procedure to remove some of contaminated soil and plants is going to be started from April, 2013 in Koriyama City, which is the second largest city in Fukushima Prefecture and about 60 km from FNPP. It was estimated that RDR in the soil seems to have been reduced by 20 to 40%, when compared with that of RDR in May, 2011.

SSK11-04 • Evaluation of Non Commercial DICOM De-identification Tools Freeware
K. Y. E. Aryanto ; Matthys Oudkerk MD, PhD ; Peter M Van Ooijen (Presenter)

PURPOSE
To compare freeware DICOM toolkits for their ability to de-identify sensitive elements in the DICOM header that may contain patient's personal health information (PHI).

METHOD AND MATERIALS
Ten non commercial DICOM toolkits were selected and tested to be compared for their de-identification utility. The selection was made through an internet search to get as many tools as possible. The tests were performed in two scenarios. First, de-identification was performed using tools' default setting and then by using the best possible customized settings. The toolkits were also examined for their...
RESULTS
The DICOM toolkits were tested to eliminate fifty elements in the DICOM header which are considered to contain private information that may be used to reveal the identity of a patient. Not all of the toolkits provide a full customizable de-identification profile. Two tools use a fixed configuration. In the other eight tools, changes can be made by giving input through user interface, manually into a configuration text file, or providing the appropriate command arguments or options. Using the first scenario, there was only one tool which, by default, was configured to de-identify all selected elements. In the second scenario, three other DICOM toolkits could perform the task after manual adjustment.

CONCLUSION
Only four out of ten selected free DICOM toolkits could de-identify the defined DICOM elements properly. Free DICOM toolkits should therefore be used with extreme care when de-identifying sensitive data since they can have a high risk of disclosing PHI, especially when using the default configuration. In case optimal security is required, one of the four toolkits is proposed.

CLINICAL RELEVANCE/APPLICATION
Guidance to select the proper tool to de-identify DICOM data is important to ensure the security and confidentiality of patient’s personal health information in order to prevent patient data breach.

SSK11-05 • CT Dose Variability for Patients Undergoing Repeat Identical CT Scans: A Retrospective Analysis of 2606 Patients Undergoing 12,632 CT Scans

Douglas G Larson MD (Presenter) ; Daniel T Boll MD * ; Olav Christianson ; Rendon C Nelson MD *

PURPOSE
To evaluate the intrinsic variability in radiation dose delivery of CT scanners in clinical use, independent of patient-specific factors.

METHOD AND MATERIALS
We identified colon cancer, lung cancer, and renal stone patients who underwent the same CT protocol at least twice between 1/2007 and 2/2013. Evaluating patients undergoing multiple scans with identical protocols allowed us to control for any patient- and protocol-specific factors which could affect CT dose. Patient and dose data was taken from DICOM headers and dose sheets in PACS. We performed multivariate analysis to characterize the dose variation for each patient, and to identify any significant cofactors in this variability. We used the total exam Dose Length Product (DLP) in our analyses. CT protocols were: (a) Abdomen/Pelvis with IV contrast (A/P), (b) Chest/Abdomen/Pelvis with IV contrast (C/A/P), (c) Renal Stone, and (d) Chest without IV contrast.

RESULTS
2606 patients underwent 12,632 repeat CT scans (mean 4.8, range 2-33 repeat scans/patient). There were 875 A/P, 4620 C/A/P, 1053 Renal Stone, and 6084 Chest CT scans. The per-patient dose variation was identified, then normalized using coefficients of variation, and ratios of maximum dose to minimum dose. In both cases, a higher value indicates higher dose variability. There was statistically significant variation across all patients and protocols (p < 0.001).

CONCLUSION
There is a statistically significant variation in the radiation dose delivered to a single patient undergoing repeat identical CT scans which varies by scanner and is higher in large patients. The data suggests that there are opportunities to reduce this variability by careful monitoring of key factors, CT table height being one example.

CLINICAL RELEVANCE/APPLICATION
Evaluation and scrutiny of CT dose delivery in clinical practice allows for determination of the intrinsic and controllable variability in an attempt to achieve more consistent patient care.

SSK11-06 • Simulation of Adverse Contrast Reactions - An Educational Tool for Team Training

Taj Kattapuram MD (Presenter) ; Gloria M Salazar MD ; Elkan F Halpern PhD * ; Preston D Stingley MA, MBA ; Shawn Bonk ; Emily Hayden ; Margaret Sande ; James Gordon MD ; Bethany L Niell MD

PURPOSE
Successful management of a serious adverse reaction to contrast media requires prompt recognition and treatment, as well as effective team dynamics among radiologists, technologists, and nurses. Our radiology department implemented an educational simulation program in which teams of nurses, technologists, and physicians are required to manage simulated adverse contrast reactions. This study evaluates whether simulation training emphasizing team dynamics improved an individual’s self-actualization of the management of an adverse contrast reaction.

METHOD AND MATERIALS
Following IRB approval, 56 physicians, 7 nurses, and 56 technologists worked in interprofessional teams of four to manage two cases of simulated adverse contrast reactions. A standardized debriefing occurred immediately following each simulated case, focusing on medical management of adverse contrast reactions, an institutional adverse contrast reaction kit, and team dynamics including role clarity, closed-loop communication, event managers, etc. Participants individually completed pre- and post-simulation questionnaires which included knowledge-based questions regarding the appropriate management of contrast reactions, as well as questions about participants’ perception of their ability to manage adverse contrast reactions. Self-actualization was measured with a 6-point Likert scale. Statistical significance was calculated using McNemar’s test with a p value.

RESULTS
Following completion of simulation training, radiologists, technologists, and nurses reported a statistically significant improvement in their ability to function as a team during a medical emergency, including an adverse contrast reaction (p-value = 0.001).

CONCLUSION
This simulation training program with its emphasis on team training and adverse contrast reaction management was perceived by the participants as an effective tool to improve the self-actualization of radiology personnel managing adverse contrast reactions.

CLINICAL RELEVANCE/APPLICATION
Simulation training is recommended to educate radiology personnel on effective team dynamics in the management of adverse contrast reactions.

SSK11-07 • Comparison of Image Quality and Lesion Detectability between Knowledge Based Iterative Reconstruction (IMR-L1) and iDose4 with 50% and 70% Reduced-dose CT Scan in Evaluation of Small Abdominal (≤3cm) Lesions

Yuanying Gao (Presenter)

PURPOSE
To compare the image quality and lesion detectability of a new reconstruction algorithm IMR-L1 and iDose4 iterative reconstruction technique on a256-slice CT in low-dose abdomen scans, with focus on small (=3cm) lesions detection and evaluation.

METHOD AND MATERIALS
Two sets of images were obtained during arterial phase scanning: standard-dose filtered back projection (FBP) for each, and low-dose scans were performed randomly on 24 patients (10 male and 14 female; mean age 51.3 years) with acknowledged small lesions. (Group 1, 50% dose reduction for 11 patients), (Group 2, 70% dose reduction for 13 patients). Image quality of the iDose and IMR Level 1 (L1) images was evaluated according to these features: lesion sharpness, low contrast detectability, overall diagnostic confidence (1 [poor] to 5 [excellent]). The CNRs for lesions were measured in CT images reconstructed by iDose4and IMR, and compared using the paired-t test.

RESULTS
Group 1 (50% reduction), IMR L1 was better than iDose4 in lesion sharpness and low contrast detectability (P<0.05; 3.04±0.59, 2.98±0.65, P>0.05). In group 2 (70% reduction), IMR L1 was better than iDose4 in lesion sharpness and low contrast detectability (P<0.05).

CONCLUSION
IMR-L1 enhances lesion’s sharpness, and thus improves small lesion’s detectability both in 50% and 70% dose-reduced group.

CLINICAL RELEVANCE/APPLICATION
IMR does enhance the interface contrast between different tissues and Sharpen the edges of Small lesions, thus improved the low contrast lesions detectability.

SSK11-08 • CT Protocol Optimization Using an Automated IT Solution Provided Size Specific Patient Doses, Automatic Tube Current Modulation Information, and Radiologist Feedback

Timothy P Szczylutowicz PhD (Presenter) *; Frank R N Ranallo PhD ; Walter W Peppler PhD *; Richard J Bruce MD *; Myron A Poznaiak MD *

CONCLUSION
Monitoring the radiation dose and image quality of CT examinations is essential to ethical patient care. This work represents a large stride in giving an institution’s CT protocol optimization team the tools it needs to carry out that task.

Background
CT protocol optimization for a large multi center institution is complex due to: variations in CT architecture; the wide array of clinical sections using CT; the large number of required protocols to service each clinical section; and highly varied patient populations (i.e. size and age). To aid in this process, our institution has developed an automated system that collects information about patients, the scanner output and configuration for each patient, and a radiologist quality assessment report. All of this information is gathered digitally, and is fully automated. Patient information is taken from DICOM headers. Scanner output information is extracted from structured dose reports and the configuration of the scanner is taken from the DICOM images from individual image series. Patient sizes are measured using the scout images and every axial image slice. All of this information is used to guide protocol development, monitor the function of the automatic mA control, and identify outliers in terms of low or high dose, which may help identify reoccurring errors in patient scanning.

Evaluation
Prior to using the automated system, small subsets of patients were examined individually by medical physicists. This was a laborious task in which patient sizes, DICOM data, the maximum and minimum mA values, and dose information were manually recorded. Compared to this older method, the new automated method provides more information and requires little to no user input. The automated patient sizing information was found to agree to the manual method within the uncertainty of the manual method.

Discussion
The creation of this system at our institution required IT staff, medical physicists, CT technologists, and radiologist support. The implementation of such a system at a center without a CT protocol optimization team would likely be limited.

SSK11-09 • ACR Dose Index Registry Pilot Project: Comparing Digital Radiography Exposure Indices across Facilities

Steven Don MD (Presenter) *; Mythreyi Bhargavan PhD ; J. Anthony Seibert PhD ; Stephen M Moore MS ; Scott R Steingall ARRT ; Richard L Morin PhD *

PURPOSE
To describe a new digital radiography (DR) national database registry using standardized, automated data collection methods.

METHOD AND MATERIALS
The Dose Index Registry (DIR) DR pilot project collects and compares exposure indices across both adult and children's facilities nationwide. The new International Electrotechnical Commission exposure index standard for digital x-ray systems (IEC 62494-1) is used, eliminating proprietary indices. Elements from DICOM Structured Reporting (SR) are extracted by the American College of Radiology (ACR) Triad software. Captured elements include age, gender, body part, technique factors (kVp, tube current), Exposure Index, Target Exposure Index, and Deviation Index. The information is de-identified and automatically transmitted to the ACR.

RESULTS
Three vendors (Agfa, Fujifilm, and Siemens) currently have equipment that uses the IEC terminology and the DICOM SR with more vendors adding equipment in the near future. Six adult and three children's facilities are participating in the pilot project. To avoid the problems associated with individual institutional examination naming convention, each study is mapped to the new RadLex Digital Radiography Lexicon Playbook. Experiences learned from the DIR CT are used to overcome problems associated with the new DIR DR.

CONCLUSION
A DIR DR national database using standard methods of data collection to monitor changes in exposure indices over time is urgently needed. The ability to track trends in exposure indices is useful to individual practices wishing to compare their own exposure indices against established benchmarks or national practice patterns. This data is useful to advisory radiation safety bodies. The data can be used to document exposure and variability for common examinations nationally and to create diagnostic reference levels for DR.

CLINICAL RELEVANCE/APPLICATION
Exposure creep is common with DR. By participating in national registries, a practice can monitor their DR exposures, monitor trends, and compare their exposures with other centers.
SSM23-01 • A New Angiographic Imaging Technology Enables Substantial Dose Reduction without Compromise to Image Quality

Marco J Van Strijen MD (Presenter); Thijs Grunhagen MSc, DPhil *; Jan Albert Vos; Marc Van Leersum MD; Daniel A Van Den Heuvel MD

PURPOSE
Increasing use of radiation for medical imaging is a growing concern. Recently a new angiographic imaging platform has become available that can result in a considerable reduction in radiation dose without compromising image quality. The potential of this novel technique for reducing patient radiation exposure was studied in relation to the clinical image quality in digital subtraction angiography (DSA). The objective of this study was to establish the degree of patient dose reduction, while preserving equivalent image quality.

METHOD AND MATERIALS
In 50 Prospective patients scheduled for iliac intervention two angiographic runs were performed at the start of the procedure. One run was acquired using the conventional imaging platform (Allura Xper, Philips Healthcare); the other run was acquired using the new imaging platform (AlluraClarity, Philips Healthcare) at lower X-ray dose. The conventional-dose and low-dose acquisitions were performed in random order. Air Kerma and Dose Area Product values were recorded in all acquisitions and at the end of the procedure. In the second part of the study, qualitative image quality assessment of both runs was performed by five experienced interventional radiologists. The readers were blinded to the imaging parameters and imaging platform.

RESULTS
50 patients were prospectively included. Evaluation of the radiation dose in all procedures showed a mean reduction of radiation dose in iliac DSA of 83%. In all patients the new imaging technology was used in the remainder of the procedure, as image quality was considered sufficient for performing the intervention. Likewise, the qualitative image quality assessment revealed equivalence in image quality between the two paired runs.

CONCLUSION
With the new imaging technology, a reduction in radiation dose of 83% is possible without a compromise in image quality.

CLINICAL RELEVANCE/APPLICATION
Revolutionary and substantial dose reduction in interventional radiology without compromise of image quality.


Kelvin Cortis MD, MRCS, FRCR (Presenter); Roberto Miraglia MD; Luigi Maruzzelli MD; Roberta Gerasia; Corrado Tafaro; Angelo Luca MD

PURPOSE
To determine whether grid removal during routine biliary interventional procedures performed in a flat panel interventional suite results in adequate image quality and in a significant reduction of the patient radiation exposure.

METHOD AND MATERIALS
Routine biliary interventional procedures were defined as those in which absence of fine image detail during fluoroscopy carries no procedural impact including change of internal-external biliary drains (BCC) or balloon dilatation of biliary anastomosis (bilioplasty). 10 consecutive patients were enrolled, 8 had a BCC and 2 bilioplasty. The study population consisted of 8 adults with an average Body Surface Area (BSA) of 1.64, and 2 children with an average BSA of 0.49. All patients had a previous procedure in which the grid was used. Constant object-to-detector and source-to-image distance were maintained in each patient during the grid/no-grid procedures. The same fluoroscopy protocol was used for all examinations. The dose area product (DAP given in cGy.cm2) and procedure fluoroscopy time (given in seconds) were recorded for each procedure. DAP was normalized per unit of fluoroscopy time (nDAP, cGy.cm2/s). In order to quantify the change in nDAP, the nDAP of the procedure done without the grid was divided by that done with the grill for each patient, and the change in dose expressed as a percentage.

RESULTS
In all procedures image quality was considered adequate by two different interventional radiologists and all procedures were successfully completed without significant changes in fluoroscopy time between the two groups (p=0.37). In every procedure without the grid nDAP was inferior as compared to the nDAP in procedures performed using the grid. The mean reduction in dose was 32.3±21.1% (p=0.01).

CONCLUSION
Our preliminary data shows that removal of the grid in routine biliary procedures is feasible and results in a significant reduction of patient radiation exposure. Larger studies with more procedures are warranted to confirm this data.

CLINICAL RELEVANCE/APPLICATION
Most routine biliary procedures can be performed without a grid with reduction in radiation exposure. This seems of particular relevance since most of these patients require frequent re-intervention.

SSM23-03 • Comparison of Radiation Exposure and Image Quality of 14 and 16 Bit Angiographic C-Arm CT and MDCT

Bernhard C Meyer (Presenter) *; Thomas Werncke MD, Dipl Phys; Oliver A Meissner MD *; Frank K Wacker MD *; Christian Von Falck MD *

PURPOSE
To compare image quality and radiation exposure of a 64-row CT (MDCT) and angiographic C-Arm CT (CACT) using 14 bit and 16 bit flat detector angiographic systems for abdominal imaging.

METHOD AND MATERIALS
An anthropomorphic phantom (AP) representing a 70kg male was used for this study. To assess contrast resolution, one high contrast phantom insert with five line pair objects (LPO; 6, 8, 10, 11 and 12lp/cm) and four low contrast phantom inserts mimicking 32 spherical objects (SPO; 8 diameters, range 2 to 10 mm) and 24 tubular objects (TUO; 6 diameters, range 1.2 to 7mm) were inserted into the AP. MDCT imaging was conducted on a 64-row MDCT (Somatom Definition, Siemens Healthcare) using the standard abdominal acquisition protocol (120kV, 1mAs, SL 0.6mm). CACT imaging was acquired on 14 and 16 bit flat detector angiographic systems (CACT1: Artis zee, CACT2: Artis zee Q, Siemens Healthcare) using standard abdominal CACT presets (both systems) and a reduced dose preset (CACT2). For each imaging protocol, effective dose (ED) was measured. The detectability of low and high contrast objects was assessed in 3mm transversal slabs. Objects were classified as visible when they were independently rated as clearly delineable by 3 readers.

RESULTS
The highest low contrast detectability was obtained by MDCT (SPO:14/32, TUO:10/24, ED 4.6mSv) followed by standard abdominal CACT using CACT2 (SPO:14/32, TUO:9/24, ED 6.1mSv) and CACT1 (SPO:12, TUO:8, ED 6.1mSv). The use of a reduced dose protocol (-38%ED) on CACT2 showed only a minor reduction of low contrast resolution (SPO: 11/32, TUO 9/24, ED 3.8mSv). Best high contrast resolution (LPO:2/5) was observed for CACT2 (LPO:2/5, both protocols) followed by MDCT and CACT1 (LPO:1/5).

CONCLUSION

16 bit CACT imaging provides improved low and high contrast resolution compared to 14 bit CACT. In comparison to MDCT, CACT is still slightly inferior for low contrast but superior with regard to high contrast resolution. Using significantly reduced dose protocols, a similar image quality compared to 14 bit CACT was observed.

CLINICAL RELEVANCE/APPLICATION
The outstanding low and high contrast resolution of 16 bit CACT provides excellent guidance during interventional procedures in unenhanced and contrast-enhanced images.

SSM23-04 • Retrospective Analysis of the Effectiveness of Real Time Dosimetry Combined with Increased Emphasis on Radiation Safety in Reducing Healthcare Worker Exposure to Radiation

Oleg Mironov MD (Presenter) ; Thomas Lostracco MD ; David L Waldman MD, PhD ; Frederic Mis PhD

PURPOSE
The University of Rochester Medical Center (URMC) recently evaluated healthcare worker radiation exposure in high radiation areas. In 2011 there were multiple incidents of physician exposure in excess of 4 rem and approaching the 5 rem legal limit. Simultaneously, the University hired a new radiation safety officer who began a major radiation dose-lowering strategy which included education and real time exposure awareness. The purpose of this study was to measure the effect.

METHOD AND MATERIALS
Retrospective analysis was undertaken looking at historical radiation exposure to workers from 2010 to 2012. The radiation safety records of 253 physicians and staff were included in the study (49 faculty, 39 residents and 165 support staff). An aggressive radiation safety education program was initiated. A real time dosimetry (DoseAware, Philips Medical, Andover MA in conjunction with Unfors Instruments AB, Göteborg Sweden) for healthcare workers in high exposure radiation areas (Cath labs, Interventional Radiology labs, hybrid OR and Interventional CT scanner) was installed in March 2012.

RESULTS
Physician and staff collective exposure in 2010 and 2011 was 127 person-rem and 124 person-rem respectively. In 2011 there was a quarterly average of 18 Level 1 and 6 Level 2 ALARA radiation safety letters indicating excessive dose. In 2012 the exposure dropped by more than 50% to a collective exposure of 60 person-rem. ALARA letters declined by 50% in 2012 as compared to the 2 previous calendar years. Total staff dose continues to decline. In the most recent quarter there were zero employee ALARA notification letters.

CONCLUSION
The dose lowering initiative successfully achieved a 50% reduction in radiation exposure for health care providers working in high radiation areas. It remains uncertain if this accomplishment was the result of an aggressive education program or due to real time feedback from instantaneous dose monitoring. Regardless of the cause, the decrease in radiation exposure is significant and a pleasant surprise.

CLINICAL RELEVANCE/APPLICATION
Significant reductions in staff exposure to radiation can be achieved with the combination of increased emphasis on radiation safety and real time dosimetry thus creating a safer working environment.

SSM23-05 • Effectiveness of Using a Novel Lead Curtain Applied to the Image Detector to Protect Operator and Staff in the Angiography Suite

Zubin Irani MD (Presenter) ; Bailin Alexander BA ; Da Zhang PhD ; Bob Liu PhD ; Rahmi Oklu MD, PhD

PURPOSE
Recent research suggests that long-term low-dose radiation exposure in the interventional (angiographic) suite may lead to greater stochastic effects than previously believed. Sufficient shielding from scatter radiation during fluoroscopy still remains a formidable challenge. We designed and tested the utility of a disposable, sterile lead curtain applied to the image detector to reduce scatter radiation to the operator and staff during IR procedures.

METHOD AND MATERIALS
To simulate standard patient positioning on the angiography table, an anthropological phantom was used. Using a computer aided design software, a grid was overlaid on the procedure room. Using a high sensitivity radiation survey meter, measurements of scatter radiation from the phantom were made throughout the grid. Sequential measurements were made before and after the application of the curtain using a full field of view, a coned field of view and with maximal KvP. Results are presented as standard error of the mean. Statistical significance was measured using a student’s t-test.

RESULTS
Scatter radiation was attenuated throughout the grid (room). The highest level of scatter radiation was detected immediately adjacent to the phantom at 2 feet distance. In this location, which would approximate the position of the operator, attenuation by the curtain was also maximal averaging at 60% less dose to the operator. The use of the curtain did not result in increase scatter radiation detection to the operator (patient).

CONCLUSION
The use of this lead curtain significantly reduces scatter radiation in the procedure room. Specifically, the curtain leads to reduction in radiation exposure to the operator at levels averaging 60%.

CLINICAL RELEVANCE/APPLICATION
Radiation exposure is known to have detrimental sequelae. This curtain reduces radiation exposure to the operator and staff in the angiography room and may have significant impact on radiation safety.

SSM23-06 • Efficacy of Radiation Safety Glasses in Interventional Radiology

Bart Van Rooijen (Presenter) ; Michiel W De Haan MD, PhD ; Marco Das MD * ; Carsten Arnoldussen MD ; Rick De Graaf MD, PhD ; Wim Van Zwam MD ; Walter H Backes PhD ; Cecile R Jeukens PhD

PURPOSE
Recent evidence suggests that radiation-induced cataract to the eye occurs at a lower dose than previously thought. We have assessed how the design of radiation protection glasses and positioning of the operator influence the reduction of the eye lens dose.

METHOD AND MATERIALS
The scatter free attenuation and the dose reduction with the glasses were determined for several different spectacle designs on an anthropomorphic head phantom. The phantom head was positioned at different locations relative to the radiation source to assess the effects of geometry and head rotation on the dose reduction.

 RESULTS
The eye dose reduction achieved in clinical practice was measured using TLD dosimetry during 9 procedures with protective glasses and 13 procedures without.

RESULTS
The scatter-free attenuation of the glasses was approximately a factor of 100. For frontal irradiation of the phantom head, the dose reduction factor was in the range of 7.9 to 10.0. With the head phantom at a location typical for radiological interventions, the dose reduction factor was in the range of 3.4 to 8.3 (left eye) and 1.5 to 2.3 for the right eye. When the phantom head was rotated 45 degrees away from the tube in the axial plane, there was no significant dose reduction for the right eye and the dose reduction for the left eye was 1.1 to 2.5.

In clinical practice wearing leaded glasses resulted in a dose reduction of 2.1 (left eye) and 0.8 (right eye).
CONCLUSION
The dose reduction of radiation protection glasses reduces when incoming radiation faces the head laterally of inferiorly. Physicians performing x-ray guided interventions should be aware of these effects to optimize their posture and choose the appropriate model of glasses.

CLINICAL RELEVANCE/APPLICATION
- Protective eyewear should shield radiation entering from the side and below.
- The radiologist's posture and the room layout should be adjusted to prevent radiation entering from the side or below.
LEARNING OBJECTIVES
1) An overview of best practice for medical radiation technologists in Canada. 2) A detailed overview of the processes used to develop the evidenced-based recommendations within each guideline. 3) An understanding of the collaborative approach used to vet the recommendations. 4) A brief tutorial on how to use the guidelines. 5) Discuss how the guidelines are being used to change practice.

ABSTRACT
Guidelines provide a tool to help individuals enhance their professional lives and keep up with changes in their field. The opportunity to develop best practice documentation for medical radiation technologists in Canada was identified as an important strategic step for the profession and a key component of the push to gain greater recognition. In 2010, the Canadian Association of Medical Radiation Technologists (CAMRT) assembled a multidisciplinary committee from across Canada to develop Best Practice Guidelines. Since that time, the group has been identifying and developing new guidelines for MRT professionals across Canada to use in their daily practice. The process of working with this diverse group and developing an interactive Best Practice Guidelines website has been an evolution from start to finish. It provides many lessons and innovations to share with those who wish to pursue this path in the future.

Minicourse: Recording and Reporting Radiation Dose: Interventional/Angiography/Fluoroscopy

Thursday, 08:30 AM - 10:00 AM • N229

RC623 ▪ AMA PRA Category 1 Credit ™: 1.5 ▪ ARRT Category A+ Credit: 1.5
Director
J. Anthony Seibert, PhD

RC623A ▪ Issues in Interventional Fluoroscopy Procedures

Stephen Balter, PhD (Presenter)

LEARNING OBJECTIVES
1) Be able to describe effects on patient's skin, hair, eyes, and other tissues resulting from fluoroscopically-guided interventional procedures. 2) Be able to adequately communicate FGI radiation risk as part of the informed consent process. 3) Understand the use of real-time displays of radiation quantities and their relation to radiation risks.

ABSTRACT
Some fluoroscopically-guided interventional procedures (FGI) require the use of a substantial amount of radiation for their completion. Radiation can be regarded as a toxic agent in the same sense that contrast-media and drugs can be toxic if inappropriately used. The interventional radiologist should have reasonable knowledge of the toxic effects of radiation on patients at dose levels that may occur during IR procedures. These include short-term tissue reactions on the skin, hair loss, and radiogenic cataracts. Longer term effects such as cancer induction are of importance for some patients. Because radiation is potentially toxic, its risks should be appropriately discussed during the informed consent process. The display of reference air kerma and kerma area product provide risk information to the radiologist while performing a procedure. This is intended to provide ongoing inputs into a continuous evaluation of benefit-risk.

RC623B ▪ Measurements and Dose Calculations

Beth A Schueler, PhD (Presenter)

LEARNING OBJECTIVES
1) Review methods of measuring patient radiation dose during fluoroscopically-guided interventional procedures. 2) Compare the advantages and limitations of dose measurement methods. 3) Understand parameters that are used to describe patient entrance dose. 4) Learn about new methods for skin dose calculation and recording.

ABSTRACT
The measurement of patient dose during fluoroscopically-guided interventional procedures is an important tool for assessment of individual patient radiation risk. Moreover, the display of patient dose is valuable as feedback to the operator to aid in optimization of radiation exposure. Many different methods of measuring fluoroscopy dose have been developed, including direct methods (dosimeters and film) and indirect methods (fluoroscopy time, dose-area-product meters and reference point air kerma estimation). This presentation will review the advantages and limitations of each of these methods, along with common dose metrics that fluoroscopy operators, medical physicists and technologists should be familiar with. In addition, we will discuss skin dose mapping methods that are currently being developed.

RC623C ▪ Establishing an Interventional Radiology Patient Radiation Safety Program

Aaron K Jones, PhD (Presenter)

LEARNING OBJECTIVES
1) List the radiation dose descriptors that should be recorded at the conclusion of a fluoroscopy-guided procedure. 2) Describe the actions that may be taken during the three phases of a fluoroscopy-guided procedure to enhance patient safety. 3) Discuss how to recognize cases that are outside the normal control limits of an interventional radiology practice.

ABSTRACT
An interventional radiology patient safety program is essential to better educate patients who are scheduled to undergo fluoroscopically-guided interventional radiology procedures; monitor radiation doses delivered during procedures and reduce the risk of tissue effects; ensure appropriate medical management of patients experiencing significant peak skin doses; and for practice quality improvement through analysis of procedural data and exceptional cases. The program combines preprocedure evaluation and counseling, inprocedure monitoring, and postprocedure documentation and counseling consistent with guidelines from the National Cancer Institute and the Society of Interventional Radiology. Implementation of a patient safety program is straightforward, requires little infrastructure and few resources, and can be applied in most interventional radiology practices.

Cardiac Radiology Series: Cardiac Dual Energy CT

Thursday, 08:30 AM - 12:00 PM • S404CD

VSCA51 ▪ AMA PRA Category 1 Credit ™: 3.75 ▪ ARRT Category A+ Credit: 4
Moderator
U. Joseph Schoepf, MD *
Moderator
James P Earls, MD *

VSCA51-01 ▪ Technique

Willi A Kalender, PhD (Presenter) *
LEARNING OBJECTIVES
1) To learn about the basic principles and data acquisition strategies of dual energy CT. 2) To understand the different acquisition strategies for cardiac CT. 3) To learn about dose implications in cardiac dual energy CT.

ABSTRACT
Dual-energy cardiac CT represents the combination of two of the most demanding CT applications; special hardware, scan protocols and dedicated data processing algorithms are demanded for both, high scan speed is an additional prerequisite. Dual energy CT (DECT) data acquisition can be achieved by taking two separate scans at different voltages, by rapid kV-switching, or by using dual-source CT operating with different voltages and pre-filtrations. These concepts and the resulting options to determine tissue parameters will be explained.

Cardiac CT requires data acquisition in time intervals as short as possible based on either prospective triggering or retrospective gating. The technical options available allow either single or dual source spiral CT or stepwise sequential acquisition and will also be explained. Dose levels for cardiac dual energy CT are moderate in general. Details and examples are given in the following lectures.

VSCA51-02 • Dose Levels and Image Quality of Second-generation 128-slice Dual-source Coronary CT Angiography - Comparison of High-pitch Spiral, Sequential, Retrospectively ECG-gated Spiral and Dual-energy Acquisition Mode

Julian L Wichmann MD (Presenter) ; Xiaohan Hu MD ; Alexander Engler MD ; Ralf W Bauer MD * ; Claudia Frellesen ; Boris Bodelle MD ; Thomas Lehner MD ; Martin Beeres MD ; Thomas J Vogl MD, PhD ; Josef Matthias Kerl MD *

PURPOSE
To compare the radiation exposure and image quality of coronary CT angiography (cCTA) protocols on a second generation 128-slice dual-source CT (DSCT) scanner.

METHOD AND MATERIALS
We prospectively included 100 patients referred for cCTA. Patients with a heart rate below 65 bpm were randomized between prospectively ECG-gated high-pitch spiral (group 1) and narrow-window sequential (group 2) acquisition. Patients with a heart rate above 65 bpm were randomly assigned to a retrospectively ECG-gated spiral acquisition protocol in either dual-source (group 3) or dual-energy (group 4) mode. CT dose index volume, dose length product, effective dose, contrast-to-noise and signal-to-noise ratio were compared. Subjective image quality was rated by two observers blinded to the used protocol.

RESULTS
High-pitch spiral cCTA showed a mean estimated radiation dose of 1.27±0.64 mSv, significantly (p=0.05), ranging from 16.03±6.3 (group 1) to 19.3±9.5 (group 4) and 20.1±16.5 (group 2) up to 26.4±23.0 (group 3). Each protocol showed diagnostic image quality in at least 98.4% of evaluated coronary segments.

CONCLUSION
Prospectively ECG-gated DSCT protocols allow cCTA with significant dose reduction. High-pitch spiral mode generates less than 1/2 of the estimated radiation exposure of sequential acquisition mode. In patients with a heart rate above 65 bpm, dual-energy mode should be preferred over spiral DSCT as it significantly decreases estimated dose without compromising diagnostic image quality.

CLINICAL RELEVANCE/APPLICATION
Second-generation DSCT scanners allow cCTA in patients with normo- or arrhythmia that result in significant dose reduction while maintaining diagnostic image quality.

VSCA51-03 • Diagnostic Performance of Dual-energy Computed Tomography Stress Myocardial Perfusion Imaging: A Direct Comparison to Cardiac Magnetic Resonance

Sung Min Ko (Presenter) ; Jin-Woo Choi ; Hweung Kgon Hwang ; Meong Gun Song

PURPOSE
This study aimed to determine the diagnostic performance of stress testing by dual-energy computed tomography (DECT) for identification and exclusion of hemodynamically significant stenoses when compared to combined conventional coronary angiography (CCA) and stress perfusion cardiac magnetic resonance (SP-CMR) as reference standards.

METHOD AND MATERIALS
One hundred patients without prior known coronary artery disease without chronic myocardial infarction detected by coronary CT angiography (CTA) were included and underwent SP-DECT, SP-CMR, and CCA. All CT examinations were performed using a Somatom Definition scanner. DECT-based iodine maps were used for detecting myocardial perfusion defects (MPDs) (per-vessel and per-segment) and compared with SP-CMR. The assessment of MPDs was based on visual analysis instead of quantitative analysis because DECT-based iodine map highlights areas of decreased iodine in the left ventricular myocardium. SP-CMR exams were performed on a Signa HDt 1.5-T system with an 8-element phased array surface coil or a Magnetom Skyla 3.0-T system with a 32-channel body coil after SP-DECT. Diagnostic values of CCTA for detecting hemodynamically significant stenosis were assessed before and after SP-DECT on a per-vessel basis compared with CCA/SP-CMR as the reference standard.

RESULTS
The performance of SP-DECT for detecting MPDs compared with SP-CMR was sensitivity, 89%; specificity, 74%; positive predictive value (PPV), 73%; negative predictive value (NPV), 90% (per-vessel). Compared to the combined CCA/SP-CMR for identifying hemodynamically significant stenosis, per-vessel territory sensitivity, specificity, PPV, and NPV of CTA were 95%, 61%, 61%, and 95%, respectively, those by using SP-DECT were 92%, 72%, 68%, and 94%, respectively, and those by using CTA/SP-DECT were 88%, 79%, 73%, and 91%, respectively. The area under the receiver operating characteristic curve increased from 0.78 to 0.84 (p=0.02) using CTA/SP-DECT compared with CTA.

CONCLUSION
SP-DECT can play a complimentary role to enhance the accuracy of CTA for identifying hemodynamically significant stenosis.

CLINICAL RELEVANCE/APPLICATION
SP-DECT has the potential to become a robust clinical tool for the detection of myocardial ischemia and can be used as an alternative to other perfusion imaging techniques such as SP-CMR and SPECT.

VSCA51-04 • Diagnostic Value of Dual-energy Computed Tomography (DECT) Combined CT Perfusion and CT Angiography in Patients after Coronary Stent Implantation

Lingyan Kong MD (Presenter) ; Zhengyu Jin MD ; Yining Wang MD

PURPOSE
To evaluate the diagnostic value of dual-energy computed tomography (DECT) combined CT perfusion (CTP) and CT angiography (CTA) in patients after coronary stent implantation, in compare with quantitative coronary angiography (QCA).

METHOD AND MATERIALS
RESULTS
Using QCA as a reference standard, the sensitivity and specificity of DE-CTA for detecting in-stent stenosis was 75.0% and 100%, respectively. The accuracy was 94.3%. For detecting non-stent stenosis on the vessel-based analysis, DE-CTA showed sensitivity of 87.5%, specificity of 100%, and accuracy of 93.3%, while the combination of CTA and CTP showed accuracy of 100%.
CONCLUSION
DECT has a high diagnostic accuracy for the detection of in-stent restenosis. CTA combined with CTP may improve the diagnostic accuracy for detecting non-stent significant coronary stenosis.

CLINICAL RELEVANCE/APPLICATION
DECT may evaluate both stenosis of coronary artery and myocardial perfusion in the assessment of coronary artery disease, and shows value in follow up of coronary stent implantation.

VSCA51-05 • Reduced Contrast Medium in 100kVp Coronary Artery Angiography with Dual-source CT
Dan Han MD (Presenter); Jun Zhang

PURPOSE
To evaluate the image quality of 100kVp dual-source CT coronary angiography using three different contrast media (CM) injection protocols.

METHOD AND MATERIALS
In this IRB approved study, dual-source CT coronary angiography scans were performed in 120 patients, who were randomly divided into three groups using contrast medium with concentration of 370 mg I/mL, 320 mg I/mL and 270 mg I/mL at the same injection rate (5.0 mL/s, 14 s). The CT scan protocol was the same in three groups (prospective scan, 100kVp, reference mAs: 400 mAs) with automatic tube current modulation activated. Two observers evaluated the visibility of 4 main branches of coronary arteries. The mean CT values in coronary artery, image noise, signal-to-noise ratio (SNR), contrast-to-noise ratio (CNR), radiation dose, patient BMI were recorded and compared using one way ANOVA test among three groups.

RESULTS
The three groups all had an average body mass index (BMI) value of 22 kg/m². The assigned CM volume was 60 mL in 370 group, 65 mL in 320 group and 65 mL in 270 group. The visibility of 4 main branches of coronary arteries are all 100% in three groups by two observers. The mean CT value in 270 group (390.65 +/- 50.34 HU) was lower than 320 group (466.76 +/- 45.65 HU) and 370 group (471.32 +/- 45.65 HU), where the difference was statistically significant (p < 0.05). The SNRs and CNRs were 27.42 +/- 4.21 and 21.7 +/- 4.4 for 370 group; 27.68 +/- 4.09 and 20.1 +/- 5.2 for 320 group; 26.12 +/- 4.13 and 21.2 +/- 5.7 for 270 group. There was no statistical difference were found in image noise, SNR, CNR and radiation dose (p > 0.05).

CONCLUSION
Using 270 mg I/mL iodine Contrast Medium and 100 kVp tube voltage scan protocol with dual-source CT coronary angiography is feasible in patients with normal BMI. This scan protocol can substantially reduce iodine intakes for patients while preserve good diagnostic image quality.

CLINICAL RELEVANCE/APPLICATION
Using 270 mg I/mL iodine Contrast Medium with dual-source CT coronary angiography is equal to 370 mg I/mL in detecting plaque of coronary.

VSCA51-06 • Multiple Vulnerable Plaque Characteristic Factors Co-existing in Single Non-obstructive Non Calcified or Mixed Plaques in Coronary Arteries are Higher Risk Predictors of Major Cardiac Events on CT
Hiroyuki Takaoka MD, PhD (Presenter); Nobusada Funabashi MD, PhD; Masae Uehara MD; Koya Ozawa MD; Yoshihide Fujimoto; Yoshio Kobayashi

PURPOSE
To evaluate the significance of presence of three vulnerable plaque characteristics (VPC) co-existing in single non calcified plaques (NCP) or mixed plaques (MP) in non obstructed coronary arteries on CT: 1) low attenuation (LA) (< 30HU), 2) positive remodeling (PR) and 3) spotty calcification (SC), for the risk of major adverse cardiac events (MACE).

METHOD AND MATERIALS
166 consecutive subjects with suspected coronary artery disease (81 male; 62 ± 13 years; hypertension, 61%; diabetes mellitus, 21%; dyslipidemia, 56%; smokers, 45%; obese, 49%) underwent cardiac CT (Light speed Ultra 16, GE Healthcare) from 2003 to 2004. On CT no significant stenosis (> 50%) of coronary arteries was observed; subjects were retrospectively followed for a median of 103 months after CT and incidence of MACE was compared. Subjects with old myocardial infarction or myocardial diseases were excluded from the analysis. MACE included cardiac death, acute coronary syndromes, new onset of angina pectoris, and cardiac failure.

RESULTS
39 subjects had NCP (17) or MP (22), of whom 8, 29, and 14 subjects had LA, PR, and SC in NCP or MP, respectively. These were classified into 4 groups, 1) 128 who did not have NCP or MP with any VPCs, 2) 20 who had NCP or MP with one VPC, 3) 14 who had NCP or MP with two VPCs and 4) 2 who had NCP or MP with three VPCs. 6 subjects (4%) had MACE. Subjects who had NCP or MP with = two VPCs (n=16) had a higher risk of MACE than subjects with = one VPC (n=150) (P < 0.05) during the observation period. Significant differences between subjects with NCP or MP with = two VPCs and others (zero, one VPC groups) were observed at each time point when the whole period of follow-up was compared by Kaplan Meier analysis and log rank test (P < 0.001). A Cox proportional hazard model revealed that presence of NCP or MP with = two VPCs on coronary arteries on CT was a greater predictor of MACE (Hazard ratio 7.5, 95% confidential interval 1.0-55.4, P < 0.05 than other factors.

CONCLUSION
Presence of NCP or MP with = two VPCs in non obstructed coronary arteries on CT were critical factors for the prediction of MACE in subjects with normal myocardium on follow-up for a median of 103 months.

CLINICAL RELEVANCE/APPLICATION
Even in subjects without significant stenosis in coronary arteries on CT, if NCP or MP with = two VPCs are observed on CT, careful follow-up with control of risk factors is desired.

VSCA51-07 • Radiation Dose
James P Earls MD (Presenter) *

LEARNING OBJECTIVES
1) Understand how the use of dual energy technique affects radiation dose from CT exams. 2) Identify which parameters can be changed to reduce the dose of dual energy exams. 3) Discuss the relative differences in radiation dose of dual energy and single energy CT exams.

ABSTRACT
Dual energy techniques have been developed and are now available for imaging the heart with CT. This course will discuss how different techniques, dual source and single source fast kV switching, can effect the dose of the exams. We will review how the scan protocols can be manipulated to minimize the dose to the patient. We will also compare doses from dual energy and single energy exams.

VSCA51-08 • Dual Energy versus Single Energy CT in the Evaluation of Myocardial Perfusion in Correlation with SPECT Studies
Patricia M Carrascosa MD (Presenter) *; Carlos Capunay MD; Alejandro Deviggiano MD; Javier Vallejos MD; Roxana Campisi; Maria Munain; Carlos Tajer; Jorge M Carrascosa MD

PURPOSE
A main challenge of myocardial CT perfusion (CTP) is beam hardening. With the developments of dual-energy CT (DECT) scanning, the beam hardening artifact could be reduced with the generation of monochromatic images. The objective of this paper is to determine the usefulness of Stress-Rest DECT versus Single Energy CT (SECT) in the evaluation of myocardial perfusion in correlation with SPECT findings.

METHOD AND MATERIALS
Forty patients with known or suspected coronary artery disease who had a positive stress test for ischemia or had an indication of SPECT study were included. Twenty patients were scanned using a DECT scanner and the other 20 using a SECT scanner. Demographic data was similar in both groups. In all patients, a stress CT scan was carried out first, and 30 minutes later a rest CT scan was complemented. Dipiridamol was used for stress myocardial perfusion imaging in both CT and SPECT studies.

A 17 segmental-model analysis was done to determine myocardial segments with perfusion defects. Monochromatic images at different keV from the DECT data and SECT images were evaluated for the detection of myocardial perfusion defects based on Hounsfield units. CT analysis was carried out blinded to SPECT results, considered as the gold standard. Statistical analysis: The 95% confidence interval of the proportions was calculated by the exact binomial method to determine the presence of myocardial perfusion defects. Correlation between DECT, SECT and SPECT studies was measured by the kappa coefficient.

RESULTS
The mean radiation dose for each patient was 7.1 +/- 1.2 mSv on DECT exams and 8.1 +/- 1.1 mSv on SECT scans. For detection of the presence of myocardial perfusion defects, DECT showed a sensitivity of 82.1%; specificity 96.7%; PPV 85.5%; NPV 96%, with a k=0.77. SECT showed a sensitivity of 70.3%; specificity 90.7%; PPV 79.3%; NPV 85.7%, with a k=0.62.

CONCLUSION
Stress-Rest DECT myocardial perfusion demonstrated higher sensitivity and specificity than SECT in correlation with SPECT for the detection of myocardial perfusion defects using similar radiation dose. More studies have to be done to validate these results.

CLINICAL RELEVANCE/APPLICATION
Quantitative myocardial CT perfusion for the assessment of coronary artery disease may have a significant effect on patient care, giving a functional significance to a coronary stenosis.

VSCA51-09 • One-step Dual-energy Cardiac CT Scan for Diagnostic and Prognostic Evaluation of Coronary Artery Disease

Patricia M Carrascosa MD (Presenter) *; Carlos Capunay MD; Alejandro Deviggianno MD; Javier Vallejos MD; Jorge M Carrascosa MD

PURPOSE
Coronary artery calcium score (CCS) is used for risk stratification and early detection of coronary atherosclerosis. It is well known that CCS is an independent predictor of cardiovascular events and it adds value to the Framingham risk score. The objective of this study is to evaluate the possibility of obtaining the information given by CCS from a contrast enhanced dual energy coronary CT angiography (DE-CCTA).

METHOD AND MATERIALS
Twenty five patients were evaluated with a 128 slice CT scanner (Discovery CT750 HD; GE Medical Systems). All patients underwent a non-contrast calcium scan and a contrast enhanced DE-CCTA. First the non contrast CCS scan was evaluated with a dedicated software tool (Xeleris; GE Medical Systems) in order to quantify the calcium score of each patient. Additionally, mass and volume of burdened calcium plaque were obtained from the same software. The contrast enhanced DE-CCTA data was decomposed into monochromatic images at 140 keV obtaining a virtual non-contrast serie and calcium [iodine] material images. The volume of burden calcium plaque was obtained by using a 3-D voxel quantification method. Correlation between results of calcium volumes from CCS software and DE-CCTA data was performed by the intra-class correlation coefficient.

RESULTS
By coronary calcium score software, the median of Agatston score was 208 (range: 0-2045), the median coronary calcium mass was 36 mg (range: 0-264 mg), and the median of calcium plaque volume was 92 mm3 (range: 0-778 mm3), while the median of calcium volume by 3-D quantification from the DE-CCTA data was 98 mm3 (range: 0-771 mm3), without significant differences between both methods (p >0.05). Correlation between CCS and DE-CCTA in calcium volume quantification was r: 0.98.

CONCLUSION
There was a linear relationship with excellent correlation between the amounts of calcium measured by coronary calcium score software and those by the 3-D quantification obtained from contrast enhanced DE-CCTA. In this way, prognostic as well diagnostic information could be obtained from a single scan reducing the total radiation dose and costs.

CLINICAL RELEVANCE/APPLICATION
Coronary artery is an independent predictor of cardiovascular events and it adds value to the Framingham risk score. Having its information from a dual energy coronary CT angiography is feasible.

VSCA51-10 • A Randomized Trial of Low Contrast Volume vs. Standard Contrast Volume CT Angiography Using Rapid kVp Switching Dual Energy CT

Sasi R Gangaraju MBChB (Presenter); Angus G Thompson PhD, MBBS; Kristy Lee MD; Giang Nguyen MD; Carolyn Taylor MD; Jonathan A Leispc MD *; Brett Hellbronn MD, FRCP; Tae-Hyun Yang; James P Earls MD *; James K Min *; Jennifer D Ellis MD; Cameron J Hague MD

PURPOSE
CCTA is a robust tool for evaluating CAD. Its application is limited in those with borderline renal function out of concern for contrast-induced nephropathy (CIN). We evaluated qualitative and quantitative measures of image quality and diagnostic efficacy of a reduced iodine contrast volume Dual Energy CCTA(DE) vs the standard iodine contrast volume CCTA(STD).

METHOD AND MATERIALS
A prospective single centre double-blind trial recruited 77 consecutive outpatients who were then randomised to 2 cohorts; STD with BMI based tube potential selection (100-120 kVp) (n=41) or DE with rapid kVp switching (n=35). STD protocol used 110cc iodinated contrast via a triple phase injection and the DE protocol used 55cc of iodinated contrast with the reduced volume being substituted with saline. Demographics and cardiac history was obtained via a questionnaire at the time of CCTA. 2 readers measured signal and noise in the left main, left anterior descending, circumflex and right coronary artery, and SNR and CNR was calculated. A 5-point Likert scale subjectively evaluated vascular enhancement, noise and overall image quality (5:excellent, 1:non-diagnostic, scores

RESULTS
DE CCTA results in inferior image quality scores, but demonstrates comparable SNR and CNR and rate of diagnostic interpretability with no radiation dose penalty, while allowing for a 50% reduction in contrast volume compared to standard CCTA.

CONCLUSION
DE reduced contrast volume CCTA may be considered a viable imaging option in patients at higher risk for CIN.

VSCA51-11 • Feasibility of Low Concentration Contrast Medium in Dual Energy Spectral Coronary CT Angiography

Xinhuai Wu (Presenter); Wei Han; Junliang Lu
Patients with Stable Chest Pain

VSCA51-15 •

CLINICAL RELEVANCE/APPLICATION
Significant stenoses compared with rest-DECT. Stress-DECT has superior performance for detection of MPDs and incremental value when used with CCTA for detecting hemodynamically significant stenosis was assessed before and after stress- and rest-DECT, respectively, on a per-vessel basis, compared with CCA/CMR.

RESULTS
The mean CT values of LAD, LCX and RCA (389.6±54.3, 421±61.3, 415.3±58.4) in group B had no significant difference with those in group A (379.4±48.3, 356.7±55.8, 402.9±77.2) (each p>0.05). The image noise of group A (21.43±7.69) was lower than that of group B (27.28±7.14). The mean CNR of LAD, LCX and RCA in group B (23.44±8.23) was higher than that in group A (17.69±7.95) (p<0.023). Effective radiation dose was similar between group A and group B (2.75±0.43 mSv vs 2.49±0.57mSv, p=0.17).

CONCLUSION
Dual energy spectral CCTA (70keV monochromatic images) provides better image quality than conventional CCTA and reduces the contrast medium demand.

CLINICAL RELEVANCE/APPLICATION
Dual energy spectral CCTA provides better image quality, and should better choice for elder patients who have impaired renal function.

VSCA51-12 • Applications

U. Joseph Schoepf MD (Presenter) *

LEARNING OBJECTIVES
1) To select suitable clinical image acquisition protocols for cardiac dual-energy CT. 2) To discuss the role of pharmacological stress for dual-energy CT imaging of myocardial ischemia. 3) To identify potential future applications of cardiac dual-energy CT in the diagnostic algorithm of coronary heart disease.

VSCA51-13 • Dual Energy Subtraction Radiography in the Evaluation of Calcific Valve Disease

Calen Frolikis BA (Presenter) ; Robert C Gilkeson MD * ; Alan H Markowitz MD

PURPOSE
This retrospective study investigates the diagnostic implications of Dual Energy Subtraction Radiography (DES) in the work up of cardiovascular disease.

METHOD AND MATERIALS
Four hundred patients who underwent Aortic and/or Mitral valve replacement and/or repair from February 2010 to November 2012 were identified. Of those, 222 patients met inclusion criteria: record of both pre-operative DES chest radiography, and Chest CT or CT Angiography. Dual Energy Subtraction protocol included an initial 60kV acquisition, 150msec delay, followed by 140kV acquisition. The subtracted low energy bone algorithm was evaluated, and compared to standard 140kV CXR for visualization of cardiovascular calcification. Those cases where cardiovascular disease was better visualized on bone window were then further screened, and disease confirmed with coronary CT images. Primary findings were coronary artery calcification (CAC), valvular calcification (both mitral and aortic), Mitral annular calcification (MAC), and aortic arch or descending aorta disease. The final patient cohort was 47, with 29 women (61.7%), and 18 men (38.2%). The age range was 38-92, with an average age of 74.4 yrs. Of these patients, 21 underwent subsequent AVR. Twelve patients underwent Aortic Root Reconstruction with valve conduit enlargement. Eight patients underwent AVR and MVR. Three patients underwent subsequent MVR, 2 patients underwent AV-repair with MVR, and 1 patient had AV-repair with MVR.

RESULTS
Of the 47 patients with significant findings on DES radiography, the most common finding was Mitral Annular Calcification with 31 cases (65.9%). Coronary Artery Calcification was the next most common finding, seen in 23 cases (48.9%). Calcific aortic valve (CAX) was seen in 22 patients (46.8%). MV disease was seen in 8 cases, and aortic disease in 5 patients.

CONCLUSION
Dual Energy Subtraction improves visualization of calcified cardiovascular structures. The use of both CT and DES offers an intriguing clinical correlation in the evaluation of cardiovascular calcification. Further prospective studies are warranted.

CLINICAL RELEVANCE/APPLICATION
Dual Energy Radiography enables an enhanced detection of cardiovascular disease compared to standard radiographic techniques.

VSCA51-15 • Direct Comparison of Stress- and Rest-dual-Energy Computed Tomography with Cardiac Magnetic Resonance for Detection of Myocardial Perfusion Defect

Sung Min Ko (Presenter) ; Jin-Woo Choi ; Hweung Kgon Hwang ; Meong Gun Song

PURPOSE
We assessed the diagnostic performance of stress- and rest-dual-energy computed tomography (DECT) and their incremental value when used with coronary CT angiography (CCTA) for detecting hemodynamically significant stenosis causing myocardial perfusion defect (MPD) compared with combined conventional coronary angiography (CCA)/cardiac magnetic resonance (CMR).

METHOD AND MATERIALS
Seventy-one patients with known coronary artery disease (CAD) detected by CCTA underwent stress-DECT followed by rest-DECT. Among those, 46 patients underwent CMR and 62 underwent CCA. DECT-based iodine maps were compared with CMR. Diagnostic value of CCTA for detecting hemodynamically significant stenosis was assessed before and after stress- and rest-DECT, respectively, on a per-vessel basis, compared with CCA/CMR.

RESULTS
Forty (56%) patients completed all the protocol. Compared to CMR (n=46), sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of stress-DECT for detecting segment (vessel)-based MPDs were 73 (94%), 85 (78%), 70(72%), and 87 (95%), respectively, and those by using rest-DECT were 29 (47%), 89 (80%), 54 (59)%, and 74 (72)%, respectively. There was moderate (r=0.45) agreement between stress- and rest-DECT iodine maps in identifying segments with MPDs. Compared with the CCA/CMR (n=40) for identifying hemodynamically significant stenosis, per-vessel territory sensitivity, specificity, PPV, and NPV of CCTA were 91%, 56%, 55%, and 91%, respectively, those by using CCTA/stress-DECT were 87%, 79%, 71%, and 91%, respectively, and those by using CCTA/rest-DECT were 42%, 83%, 59%, and 70%, respectively. The area under the receiver operating characteristic curve increased from 0.74 to 0.83 (p=0.02) but decreased to 0.62 (p=0.06), respectively, if using CCTA/stress-DECT and CCTA/rest-DECT, respectively.

CONCLUSION
Stress-DECT has superior performance for detection of MPDs and incremental value when used with CCTA for detecting hemodynamically significant stenoses compared with rest-DECT.

CLINICAL RELEVANCE/APPLICATION
The use of combined coronary CT angiography and stress-dual-energy CT may provide accurate assessment of hemodynamically significant coronary stenosis inducing myocardial perfusion defect.

VSCA51-16 • Relation between Stenosis Severity, CT-derived Myocardial Blood Flow, and CT-derived Myocardial Flow Reserve in Patients with Stable Chest Pain
PROPOSED

The functional significance of coronary stenosis of intermediate severity is often difficult to determine from anatomical information alone derived from coronary angiography. Therefore, the aim of our study was to assess the relationship between hyperaemic myocardial blood flow (MBF) and flow reserve measured by dynamic CT perfusion imaging and stenosis severity on invasive coronary angiography (ICA) in patients with stable chest pain.

METHOD AND MATERIALS

Forty-seven patients with stable chest pain referred to ICA and invasive fractional flow reserve (FFR) were included in the study. All patients underwent stress and rest dynamic CT perfusion imaging using a second generation dual source CT. Hyperaemic stress was induced by continuous infusion of adenosine (140 µg/kg body weight) for 3 to 5 minutes. Hyperaemic and rest MBF (ml/100ml/min) were computed using a model-based parametric deconvolution method. Hyperaemic and rest MBF were obtained from regions of interest following a standard 16-segment model. Individual myocardial segments supplied by the same coronary vessel were considered as parts of the same territory. Myocardial flow reserve was calculated as the ratio of hyperaemic MBF and rest MBF. Stenosis severity in each coronary vessel was classified from ICA as mild (=30% lumen narrowing), intermediate non-functionally significant (INFS, 30%-85% and FFR>0.80), intermediate functionally significant (IFS, 30%-85% and FFR=0.80), and severe (=85%).

RESULTS

A total of 133 coronary vessels and myocardial territories were analysed. Rest MBF was similar in all groups of coronary stenosis (p>0.05). Hyperaemic MBF and myocardial flow reserve progressively decreased with increasing coronary stenosis severity following a non-linear relationship (all p-values <0.05). The FFR was lower in the severe stenosis compared to mild and intermediate stenosis (p<0.05). The MBF and myocardial flow reserve were inversely related to stenosis severity as defined by ICA and FFR. In intermediate lesions, hyperaemic MBF can discriminate IFS from INFS coronary stenoses.

CONCLUSION

CT-derived hyperaemic MBF and myocardial flow reserve provide functional characterization of anatomically defined coronary stenoses.

VSCA51-17 • Comparison of ECG-gated Coronary CT Angiography with Stress Nuclear Imaging for Evaluation of Myocardial Perfusion

Jacob P Deutsch ; Ethan J Halpern MD (Presenter)

PROPOSED

To compare myocardial perfusion data obtained during coronary CT angiography (cCTA) with stress nuclear imaging.

METHOD AND MATERIALS

We retrospectively identified 53 patients with ECG-gated cCTA and stress nuclear perfusion imaging performed within 30 days. Among these patients, 37 had helical cCTA with both diastolic and systolic imaging; 16 had only diastolic imaging. cCTA was performed with the ICT 256 slice scanner (Philips Medical Systems), and myocardial perfusion was evaluated with the comprehensive cardiac analysis application (Philips Intellispace Portal version 5.0). Areas of perfusion abnormality were identified by subjective evaluation of a binary polar map based upon the American Heart Association standardized 16 myocardial segment model. cCTA perfusion abnormalities were also identified automatically by quantitative analysis of a defect probability map using a cutoff probability of 15%.

RESULTS

Fifteen of 53 patients demonstrated perfusion defects on nuclear imaging, including 11 fixed defects and 15 reversible defects. There was complete agreement between the subjective assessment of cCTA polar maps and the automated quantitative cCTA analysis on location of defects, although the size of one defect was larger by subjective assessment while two defects were judged to be larger by quantitative assessment. Eleven of these 15 patients had cCTA imaging in both systole and diastole. In a by-patient analysis, true positive perfusion defects were identified on cCTA in 10/15 (67%) by diastolic imaging and in 9/11 (82%) by systolic imaging (p=0.17). False positive perfusion defects were identified in 37/53 (70%) of patients by diastolic cCTA imaging and in 36/37 (97%) of patients by systolic cCTA imaging. Furthermore, among true positive cases, cCTA overestimated defect size in 10/10 (100%) of cases.

CONCLUSION

Systolic phase cCTA imaging of the myocardium may be more sensitive for detection of perfusion defects as compared to diastolic phase imaging. Although the majority of myocardial perfusion defects found by nuclear imaging are detected on cCTA with the comprehensive cardiac analysis application, this technique is unlikely to be clinically useful, given the high rate of false positive perfusion cCTA defects.

CLINICAL RELEVANCE/APPLICATION

A majority of myocardial perfusion can be identified by cCTA, but many of the apparent myocardial defects found during cCTA do not correspond with perfusion defects on nuclear imaging.

VSCA51-18 • Prognostic Value of SYNTAX Score Based on Coronary Computed Tomography Angiography

Young Joo Suh MD (Presenter) ; Sae Rom Hong MD ; Yoo Jin Hong MD ; Hye-Jeong Lee MD ; Jin Hur MD ; Young Jin Kim MD ; Byoung Wook Choi MD

PROPOSED

The SYNTAX score is an angiographic score to quantify the complexity of coronary artery disease (CAD). It has been reported as an independent predictor of major adverse cardiac events (MACEs) in populations with a varying extent of CAD. The SYNTAX score (cCTA) can be a useful modality to score non-invasively estimate SYNTAX score. The aim of our study was to investigate the prognostic value of CT-based SYNTAX for prediction of MACEs.

METHOD AND MATERIALS

Institutional review board approval was obtained. We included 375 patients (mean age, 60.9 years; 224 men and 151 women) with a suspicion of CAD at coronary CTA. The SYNTAX scores were obtained based on CTA. Follow-up clinical outcome data regarding composite MACEs were procured. Cumulative event rates were obtained by using the Kaplan-Meier method for coronary CTA-diagnosed CAD and CT-based SYNTAX score (threshold level >22), respectively. Cox proportional hazards model was developed to predict MACE.

RESULTS

During the mean follow-up of 1070 days ± 121, there were 12 MACEs, for and event rate of 3.2%. The presence of obstructive CAD at coronary CTA showed a positive correlation with CT-based SYNTAX score (P <0.05). The SYNTAX score based on coronary CTA can be a useful method for noninvasively predicting MACEs.

CLINICAL RELEVANCE/APPLICATION

The SYNTAX score based on coronary CTA can be a useful method for noninvasively predicting MACEs.
**SSQ04-01 • Chest CT at One-Fifth of a mSv: Can Sparse Sampled Data Reconstructed with Iterative Reconstructive Technique Help Make the Cut?**

Ranish D Khawaja MBBS, MD (Presenter); Sarabjeet Singh MD; Diego A Lira MD; Synho Do PhD *; Atul Padole MD; Mannudeep K Kalra MD *; Sarvenaz Pourjabbar MD; Rolf Bippus *; Thomas Koehler PhD *; Kevin M Brown MS *

**PURPOSE**
To compare pulmonary lesion detection, visibility of tiny structures and diagnostic acceptability in sparse-sampled CT data of sub-milliSievert chest CT (SpS-SmSv) reconstructed with Iterative Reconstruction Technique (IRT).

**METHOD AND MATERIALS**
Ten non-obese patients (BMI2, age range: 48-82 years) were scanned at standard-dose CT (SD) and at sub milli-sievert (SmSv at 0.9 mSv) dose on a Philips 256-slice CT scanner with double z-sampling in a prospective study. Sparse angular sampling data were reconstructed using 25% of the angular projections from the sub- mSv sinogram to reduce the number of views and radiation dose by about 4-fold (estimated ED 0.2mSv). Three image series were generated per patient (sparse sampled reconstructed with IRT: SpS-SmSv IRT; fully sampled: SmSv-FBP and SD-FBP). Two radiologists independently assessed these image series for detection of lung lesions, visibility of small structures and diagnostic acceptability. Objective noise was measured in thoracic aorta and noise spectral density (NSD) was obtained for SpS-SmSv IRT, SmSv-FBP and SD-FBP.

**RESULTS**
SpS-SmSv IRT resulted in 75%(0.2/0.9 mSv) and 92%(0.2/2.9 mSv) dose reduction, when compared to fully sampled submSv-FBP and SD-FBP, respectively. SpS-SmSv images displayed all 36 lesions (most <1 cm, 31 lung nodules and 5 ground glass opacities) seen on SmSv-FBP and SD-FBP datasets. Lesion margins with sparse sampled data were deemed acceptable compared to both SmSv-FBP and SD-FBP. Overall diagnostic acceptability was maintained with SpS-SmSv IRT despite presence of minor pixilation artifacts in 3/10 cases. Interobserver agreement was statistically significant (kappa value 0.88; p<0.05). NSD showed that SpS-SmSv IRT gives a linear decrease over frequency in the semilog plot and an exponential decrease of noise power over frequency compared to submSv FBP and SD-FBP.

**CONCLUSION**
It is possible to reduce chest CT dose to fifth of a mSv for sparse-sampled CT images reconstructed with IRT while retaining lesion detection and diagnostic acceptability for evaluation of pulmonary findings.

**CLINICAL RELEVANCE/APPLICATION**
More than 90% dose reduction could be achieved with one fourth sparse-sampled and sub milliSievert chest CT examination when reconstructed with iterative reconstruction technique.

**SSQ04-02 • Lung and Nodule Perfusion Assessments on Dynamic First-pass Perfusion Area-detector CT: Capability of Adaptive Iterative Dose Reduction Using 3D Processing (AIDR 3D) for Radiation Dose Reduction as Compared with Filter Back Projection (FBP)**

Yoshiharu Ohno MD, PhD (Presenter); Mizuho Nishio MD *; Takeshi Yoshikawa MD *; Sumiaki Matsumoto MD, PhD *; Yasuko Fujisawa MS *; Naoki Sugihara MENG *; Hisanobu Koyama MD; Shinichiro Seki; Maho Tsubakimoto MD; Tohru Murakami; Masakazu Kanzawa RT; Kazuo Sugimura MD, PhD *

**PURPOSE**
To directly compare the capability for radiation dose reduction on dynamic chest perfusion area-detector CT (ADCT) aiming lung and nodule perfusion assessments between adaptive iterative dose reduction using 3D processing (AIDR 3D) and filter back projection (FBP) methods.

**METHOD AND MATERIALS**
36 consecutive patients (25 male, 11 female; mean age 75 years) with 36 nodules underwent standard-dose perfusion ADCT (SDCT) using the following parameters: 320×0.5 mm collimation, 80kVp, 120mA, and 0.5 sec gantry rotation time. From SDCT raw data, low-dose perfusion ADCTs (LDCTs) at 80mA, 60mA and 40mA were computationally simulated. Then, SDCT and each LDCT were reconstructed by AIDR 3D and FBP methods. From each CT data, perfusion map was computationally generated. Then, image noises of lung parenchyma and nodule, lung and nodule perfusions were evaluated by ROI measurements. To determine the utility of AIDR 3D for radiation dose reduction, both image noises and perfusion parameters from all CT data were statistically compared each other by using Wilcoxon rank sum test (NSD) and Tukey’s HSD test. Correlations of both perfusion parameters were evaluated between SDCT and others. Finally, to assess the radiation dose reduction capability between two methods, the limits of agreements (mean±1.96×standard deviation) of each parameter between SDCT and others was assessed by using Bland-Altman analysis.

**RESULTS**
When applied AIDR 3D, image noises of LDCTs at 80mA and 60mA were significantly lower than those by FBP (p<0.05). NSD showed that SpS-SmSv IRT gives a linear decrease over frequency in the semilog plot and an exponential decrease of noise power over frequency compared to submSv FBP and SD-FBP. Correlations of both perfusion parameters were evaluated between SDCT and others. Finally, to assess the radiation dose reduction capability between two methods, the limits of agreements (mean±1.96×standard deviation) of each parameter between SDCT and others was assessed by using Bland-Altman analysis.

**CONCLUSION**
Interobserver agreement was statistically significant (kappa value 0.88; p<0.05). NSD showed that SpS-SmSv IRT gives a linear decrease over frequency in the semilog plot and an exponential decrease of noise power over frequency compared to submSv FBP and SD-FBP. SpS-SmSv IRT resulted in 75%(0.2/0.9 mSv) and 92%(0.2/2.9 mSv) dose reduction, when compared to fully sampled submSv-FBP and SD-FBP, respectively. SpS-SmSv images displayed all 36 lesions (most <1 cm, 31 lung nodules and 5 ground glass opacities) seen on SmSv-FBP and SD-FBP datasets. Lesion margins with sparse sampled data were deemed acceptable compared to both SmSv-FBP and SD-FBP. Overall diagnostic acceptability was maintained with SpS-SmSv IRT despite presence of minor pixilation artifacts in 3/10 cases. Interobserver agreement was statistically significant (kappa value 0.88; p<0.05). NSD showed that SpS-SmSv IRT gives a linear decrease over frequency in the semilog plot and an exponential decrease of noise power over frequency compared to submSv FBP and SD-FBP.

**CLINICAL RELEVANCE/APPLICATION**
More than 90% dose reduction could be achieved with one fourth sparse-sampled and sub milliSievert chest CT examination when reconstructed with iterative reconstruction technique.

**SSQ04-03 • Breast Dose Reduction during Thoracic CT: Comparison between Shielding and Low Kilovoltage for Various Breast Thicknesses**

Marie-Pierre Revel (Presenter); Isabelle Fitton; Etienne Audureau; Marie Laure Chabi; Pascal Rousset MD

**PURPOSE**
To compare breast dose and image noise on CT acquisitions performed with low kilovoltage or bismuth shielding, on a phantom study with different prosthetic breast thicknesses.

**METHOD AND MATERIALS**
Phantom study with 3 different breast thicknesses, defined as the distance perpendicular to the breast tangency line. Five consecutive 64-detector CT acquisitions (Light-speed VCT, GE) performed for each breast thickness at 120 kVp (reference acquisition), then at 100 kVp and 120kVp with shielding. Breast dose measured using two Optically Stimulated Luminescence Dosimeters (OSLD) placed both superficially and deep within the prosthetic breast. CT number standard deviation measured within 4 central ROIs at increasing depths for image noise evaluation.

**RESULTS**
Intraclass correlation coefficient for dose measurements was 0.825 [95%CI: 0.726 ; 0.923]
Considering all breast thicknesses, averaged breast dose (mean of superficial and deep measurements) was reduced by 42.1 % with...
Enhanced CT Imaging of the Chest - A Dose Finding Cadaver Study

Study data were reconstructed in soft tissue kernel using ASIR 50%). These baseline raw data were also reconstructed with MBIR (D0).

GE Healthcare, Waukesha, IL) using a standard-of-care protocol (0.625mm helical, 0.984 pitch, 120kV, 10-400mA modulation, noise

Arterial=800ml; Venous=1200ml; Virtangio, Fumedica, Muri; Switzerland) a full-dose baseline reference (FBR) was acquired (CT HD750; 11 human cadavers were included (79±18.5kg; 72.5±17.2y/o; BMI 26.3±5.1). Following injection of contrast media (Angiofil-Macro: HP-LDCT was achieved approximately 22% reduction of mean radiation dose with improvement of the suppression of cardiac pulsation and

CONCLUSION
DLPs for HP-LDCT and LDCT were 90.22 ± 4.34 mGycm and 106.14 ± 6.48 mGycm, respectively (p<0.073). The

RESULTS
Mean CTDIvol were 8±4.4 and 1.8±0.2 mGy for standard and submSv CT, respectively. Of the 287 detected lesions, 196 were less than 1 cm nodules and GGO. Lesion margins were well seen on all submSv reconstruction images except MBIR where they were poorly visualized. Likewise, only submSv MBIR images were deemed suboptimal for visibility of normal structures such as lung vessels in outer 2cm, minor fissures, and segmental bronchi. Visibility of pericardium was superior on submSv MBIR compared to the other image series. FBP, ASIR, and SafeCT showed similar NSD pattern, although SafeCT had more consistent decrease of NSD over frequency. MBIR had the lowest image noise with different and more homogeneous noise spectrum as compared to other techniques.

CONCLUSION
SafeCT, ASIR and MBIR can allow optimal lesion evaluation in chest CT acquired at CTDI vol of 2 mGy. Evaluation of lesion margins is better on SafeCT as compared to some of the other reconstruction techniques although greatest noise reduction is seen with MBIR.

CLINICAL RELEVANCE/APPLICATION
Diagnostically acceptable submSv chest CT images can be obtained when using image and model based iterative reconstructions.

SSQ04-04 • Prospective Clinical Trial to Acquire Sub Millisievert Chest CT and Compare 4 Different Reconstruction Techniques (Filtered Back Projection, Image Based, Adaptive Statistical and Model Based Iterative Reconstruction)

Atul Padole MD (Presenter) ; Sarabjeet Singh MD ; Carol C Wu MD * ; Jeanne B Ackman MD ; Jo-Anne O Shepard MD * ; Mannudeep K Kalra MD * ; Synho Do PhD * ; Sarvenaz Pourjabbar MD ; Ranish D Khawaja MBBS, MD ; Subba R Digumarthy MD

PURPOSE
To assess diagnostic image quality in sub-milli-Sievert chest CT reconstructed with Filter Back Projection (FBP), SafeCT (image based), Adaptive Statistical (ASIR) and Model Based (MBIR) iterative reconstruction techniques.

METHOD AND MATERIALS
In an IRB approved, prospective clinical study, 50 patients (mean age 62 ± 10 years, M:F 33:17, undergoing routine chest CT on a 64 channel MDCT (GE Discovery CT750 MD) gave written informed consent for acquisition of an additional sub-milli-Sievert (submSv) chest CT series. The latter series were acquired with reduced tube current but identical scan length compared to the routine chest CT. Sinogram data of submSv series were reconstructed with FBP, SafeCT (3 settings; Chest4, Lung1, Lung2; MedicVision Inc.), ASIR (SS50, SS70, GE Healthcare) and MBIR (GE Healthcare) and compared with FBP images at standard dose chest CT (n= 8*50=400 series). Three board certified thoracic radiologists performed independent, randomized and blinded comparison for lesion detection, lesion margin, visibility of small structures and ground glass opacities (GGO) and diagnostic acceptability. Objective measurements, noise spectral density (NSD) was obtained.

SSQ04-05 • High-pitch Low Dose Chest CT Scan for Radiation Dose Reduction Comparing Standard Low Dose Chest CT: A Pilot Study

Chanyeong Park MD (Presenter) ; Hong-II Ha MD ; Hye Sun Hwang ; Hye Jeon Hwang MD ; In Jae Lee

PURPOSE
To assess the effectiveness of high-pitch low dose chest CT (HP-LDCT) in reducing radiation dose without deterioration of image quality compared with standard low-dose chest CT (LDCT).

METHOD AND MATERIALS
In this Institutional Review Board approved HIPAA-compliant study, 35 patients underwent HP-LDCT and another 35 patients underwent LDCT. HP-LDCT scan parameters were as follows: pitch=3.0, 128 x 0.6 mm slice acquisition, 0.28 seconds gantry rotation time and fixed

1 cm nodules and GGO. Lesion margins were well seen on all submSv reconstruction images except MBIR where they were poorly visualized. Likewise, only submSv MBIR images were deemed suboptimal for visibility of normal structures such as lung vessels in outer 2cm, minor fissures, and segmental bronchi. Visibility of pericardium was superior on submSv MBIR compared to the other image series. FBP, ASIR, and SafeCT showed similar NSD pattern, although SafeCT had more consistent decrease of NSD over frequency. MBIR had the lowest image noise with different and more homogeneous noise spectrum as compared to other techniques.

CONCLUSION
SafeCT, ASIR and MBIR can allow optimal lesion evaluation in chest CT acquired at CTDI vol of 2 mGy. Evaluation of lesion margins is better on SafeCT as compared to some of the other reconstruction techniques although greatest noise reduction is seen with MBIR.

CLINICAL RELEVANCE/APPLICATION
Diagnostically acceptable submSv chest CT images can be obtained when using image and model based iterative reconstructions.

SSQ04-06 • How Low Can We Go: Dose Saving Potential of Model-based Iterative Image Reconstruction (MBIR) in Contrast Enhanced CT Imaging of the Chest - A Dose Finding Cadaver Study

Fabian Mueck (Presenter) ; Zsuzsanna Deak MD ; Susan Notohampirojo MD ; Florian Fischer MD ; Jochen M Grimm MD ; Maximilian F Reiser MD ; Stefan Wirth MD *

PURPOSE
To compare image quality (IQ) of 64-row CT scans of the chest, respectively acquired at varying dose levels and reconstructed with model based iterative reconstruction (MBIR), to standard baseline examinations at full dose and using adaptive statistical iterative image reconstruction (ASIR).

METHOD AND MATERIALS
11 human cadavers were included (79±18.5kg; 72.5±17.2y/o; BMI 26.3±5.1). Following injection of contrast media (Angiofil-Macro: Arterial=800ml; Venous=1200ml; Virtangio, Fumedica, Muri; Switzerland) a full-dose baseline reference (FBR) was acquired (CT HD750; GE Healthcare, Waukesha, IL) using a standard-of-care protocol (0.625mm helical, 0.984 pitch, 120kV, 10-400mA modulation, noise

index NI=39 VS=0.625; NI = allowed proportional level of noise in a water phantom in virtual slices of varying thickness (VS mm); raw data were reconstructed in soft tissue kernel using ASIR 50%). These baseline raw data were also reconstructed with MBIR (D0).
RESULTS

Mean values were (CTD1vol in mGy: D0 = 10.4±0.9, D1 = 7.4±2.6, D2 = 6.6±2.5, D3 = 4.3±1.8, D4 = 2.1±0.9, D5 = 1.1±0.5); (IQ: D0 = +1.9±1.2, D1 = +1.7±0.1, D2 = +1.3±0.3, D3 = +1.0±0.3, D4 = +0.4±0.3, D5 = -0.9±0.5). All values were significantly different from one another; p

CONCLUSION

CLINICAL RELEVANCE/APPLICATION

For standard chest examinations of non-emergency patients, MBIR allows for diagnostic, enhanced CT scans of the chest below 1mSv without loss of image quality.

SSQ04-07 • Lung Nodule Volumetry on Low- and Ultra-low-Dose CT with Adaptive Iterative Dose Reduction (AIDR 3D): A Phantom Study

Sumiaki Matsumoto MD, PhD (Presenter) *; Yoshiharu Ohno MD, PhD *; Tomoya Okazaki MS *; Atsushi Yaguchi MENG *; Tomoyuki Takeguchi PhD *; Hiroyasu Inokawa *; Kota Aoyagi *; Hitoshi Yamagata PhD *; Kazuro Sugimura MD, PhD *

PURPOSE
To evaluate the effect of adaptive iterative dose reduction (AIDR 3D) on the accuracy and precision of lung nodule volumetry on low- and ultra-low-dose CT.

METHOD AND MATERIALS
This study employed an anthropomorphic thoracic phantom (Lungman, Kyoto Kagaku) and 24 spherical synthetic nodules of 3 density types (100, ~630, and ~800 HU) with each type comprising of 8 nodules ranging 3-12 mm in diameter. The nodules were placed such that each nodule was attached to either the phantom lung vasculature or mediastinum. The phantom was then scanned with an area-detector CT (Aquilion ONE, Toshiba Medical Systems) using 4 protocols consisting of different tube current settings (80, 40, 20, and 10 mA) and other identical acquisition parameters, where 3 scans were obtained for each protocol. Each scanned data were reconstructed into 1-mm-thick images without and with AIDR 3D, thus resulting in two image datasets per scan. The volumes of all nodules in every image dataset were measured using newly developed software, and measurements were converted to percentage absolute biases (abs-B) and percentage inter-scan standard deviation (iSTD) relative to known volumes of nodules. Resultant values were analyzed by means of mixed effects analysis of variance in order to assess the effect of AIDR 3D on abs-B and iSTD.

RESULTS
AIDR 3D had a significant effect on reducing abs-B (p

CONCLUSION

The results of this study suggest that, by the use of AIDR 3D, lung nodule volumetry can be improved in terms of accuracy on low-dose CT and both accuracy and precision on ultra-low-dose CT.

SSQ04-08 • Comparison of Dose-length Product between Craniocaudal and Caudocranial Chest CT Scans Using Automatic Exposure Control: A Phantom Experiment with Four Different CT Machines

Yong Hwan Chung RT (Presenter); Tae Hyun Nam; Chang Min Dae; Kwan Hong Min; Kyoung Ho Lee MD; Bohyoung Kim PhD

PURPOSE
To compare dose-length product (DLP) between craniocaudal and caudocranial scan directions in scanning the chest of four humanoid phantoms with four CT scanners with automatic exposure control (AEC).

METHOD AND MATERIALS
We scanned four different humanoid phantoms of PBU-50, Norris, Wendy, and Female Rando in the two directions, with Light speed VCT (GE), Aquilion 64 (Toshiba), Somatom Definition Flash (Siemens), and Brilliance iCT (Philips) in two hospitals. The scan length was set the same for the two directions for each phantom. Other scan parameters including automatic exposure control followed the standard-of-practice in each test site. The difference in DLP between the two directions was measured in terms of (craniocaudal DLP - caudocranial DLP) / caudocranial DLP (%).

RESULTS
DLPs were higher with caudocranial direction than with caudocranial direction for all 16 combinations of the four phantoms and four scanners. For the four phantoms, the percentage difference in DLP ranged 8.6%-10.5%, 10.3%-10.8% 5.4%-7.4%, and 5.2% -6.4% for the GE, Toshiba, Siemens, and Philips machines, respectively. No notable difference was found in the overall image quality between the two directions.

CONCLUSION

With the same other scan parameters, caudocranial scanning had consistently higher radiation dose than caudocranial scanning by up to 10% in the four tested machines.

CLINICAL RELEVANCE/APPLICATION

We recommend the same phantom test comparing the two directions, when chest CT scan program is set up in a machine.

SSQ04-09 • Organ-based Tube-current Modulation (OBTCM): Impact of Breast Position

Stephen Taylor MD (Presenter); Diana Litmanovich MD; Maryam Shahrzad MD; Alexander A Bankier MD, PhD *; Pierre A Gevenois MD; Denis M Tack MD, PhD

PURPOSE
To determine the location of breast tissue with respect to the zone of decreased versus increased radiation delivered by OBTCM.

METHOD AND MATERIALS
In two academic centers from the US and Europe, data were collected from 532 clinical thoracic CT examinations performed in women aged 17 to 95 years (498 supine and 34 prone scans US=332, Europe=200). Inner and outer limits of breast tissue were determined by measuring their angles with respect to the isocenter of the gantry rotation. The percentage of women with breast tissue within and without the zone of decreased radiation (

RESULTS
In supine position, mean angles of external and of internal breasts limits were 79° (range, 75° to 86°) and 29° (range, 19° to 37°) for both breasts. In prone position, these angles were 66°(range,62° to 70°) and 21° (range, 19° to 25°). In supine and prone position, respectively, 99% and 82% of women had at least one external breast limit in the increased dose zone.14% of patients in supine position had their entire breasts in the increased dose zone. Increasing patient age was associated with increasing thoracic dimensions and with an increasingly lateral position of the breasts (r = -0.198 to 0.334);
In supine and in prone positions, respectively, 99% and 80% of women will have at least one breast in the zone of increased dose, as determined by OMBTC. 

**CLINICAL RELEVANCE/APPLICATION**
Because most breasts are at least in their external part exposed to higher tube current, OBTCM may increase rather than decrease the radiation dose to the breast.

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**ISSP: Genitourinary (Contrast and Safety Issues Involving the GU Tract)**

**Thursday, 10:30 AM - 12:00 PM • E353B**

**SSQ09 • AHA PRA Category 1 Credit ™ • ARRT Category A+ Credit:1.5**

**Moderator**
Richard C Semelka, MD

**Moderator**
Aart J Van Der Molen, MD

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**SSQ09-01 • Safety of Gadobutrol in Renally Impaired Patients: Interim Results from a Prospective International Multicenter Trial after End of Recruitment**

**Richard C Semelka MD (Presenter)**

- Henrik J Michaely MD (Presenter) *
- Brigitte Lorenz *
- Manuela Aschauer MD
- Matthias Gutberlet MD, PhD
- Ryan P Rebello MD
- Georg M Bongartz MD *
- Francesco A De Cobelli MD

**PURPOSE**
To prospectively investigate the safety and potential occurrence of nephrogenic systemic fibrosis (NSF) of gadobutrol in renally impaired patients a prospective open label international multicenter observational study (GRIP-gadovist in renally impaired patients) is being conducted of which interim-data after the end of recruitment are presented.

**METHOD AND MATERIALS**
The GRIP study is conducted at 62 sites in 9 countries (among them Australia, Canada, Germany, Italy and Korea) and is registered at clinicaltrials.gov under NCT00828737. Gadobutrol (Gadovist 1.0, BayerHealthCare, Berlin) a 1-molar macrocyclic Gd-chelate agent was used at single dose (0.1mmol/kg). Main inclusion criteria were a eGFR of = 65ml/min/1.7m², indication for imaging within the gadobutrol label, no administration of another MR-contrast agent within the last 6 month to prevent confounding and the willingness to participate in follow-up phone calls at 1, 3, 6, and 18 month post contrast administration as well to come back for a physical examination 12 and 24 month post contrast administration. A baseline physical exam of the patient is conducted and the patient is informed about the potential manifestations of NSF about which the patient will be interviewed telephonically at the above given follow-up dates. Recruitment was stopped on 12/31/2012.

**RESULTS**
928 patients (male/female 575/311, sex details missing 1, as per clinical database 28 Feb 2013 892 patients entered database, mean age 66.6 years, age range 19-94 years, mean weight 76.9 kg) were recruited. The mean gadobutrol dose administered was 9.3 ml (range 1.4-30 ml) of the 928 patients 252 dropped out due to loss of follow-up and death and due to centrally assessed eGFR too high. The eGFR of the remaining 676 patients was =30ml/min/1.7m² in 203 patients and 30-65ml/min/1m² in 473 patients. 280 patients have finished the 24 month follow-up period. 383 patients are still being followed up. So far, no changes indicative of NSF have been encountered in any of the patients.

**CONCLUSION**
Based on the limited available data from this prospective study, the application of gadobutrol in patients with impaired renal function has not led to a single case of NSF. The study will continue following up patients and is estimated to end 12/31/2014.

**CLINICAL RELEVANCE/APPLICATION**
No cases of NSF have occurred after administration of 0.1mmol/kg gadobutrol in this prospective study in renally impaired patients so far.

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**SSQ09-03 • High Serum Creatinine Variability Prior to Intravenous Contrast Material Administration May Confound a Diagnosis of Contrast-induced Nephropathy**

**Jennifer S McDonald PhD (Presenter) *; Robert J McDonald MD, PhD; Eric E Williamson MD *; David F Kallmes MD * **

**PURPOSE**
Administration of iodinated contrast material has been associated with the development of acute kidney injury (AKI), termed contrast-induced nephropathy, however contrast-independent sources of AKI can confound this diagnosis. We sought to determine the effect of serum creatinine (Scr) variability prior to intravenous contrast exposure on the incidence of AKI.

**METHOD AND MATERIALS**
All contrast-enhanced and unenhanced abdominal, pelvic, and thoracic CT scans performed at our institution between 2000-2010 were identified. Patients were stratified by baseline Scr into < 1.5 mg/dL, 1.5 - 2.0 mg/dL, and > 2.0 mg/dL mg/dL subgroups. Patients with high pre-scan Scr variability (delta > 0.5 mg/dL in the 7 days prior to scan) were identified and subdivided into increasing Scr or decreasing Scr subgroups. The effect of pre-scan Scr on the incidence of post-scan AKI (Scr = 0.5 mg/dL over baseline in the 1-3 days post-scan) was assessed using Fisher’s Exact test.

**RESULTS**
A total of 49,421 scans performed on 29,422 patients met inclusion criteria. Incidence of high Scr variability increased with increasing baseline Scr (11% for baseline < 1.5 mg/dL, 42% for baseline 1.5-2.0 mg/dL, 75% for baseline > 2.0 mg/dL) of the 4370 patients who developed AKI, 2417 (55%) had high pre-scan Scr variability. Patients who developed post-scan AKI were more than four times likely to have high pre-scan Scr variability compared to patients who did not develop AKI (23% versus 5%, OR= 5.51 (95% CI 5.17-5.88), p <0.0001). Patients with elevated baseline Scr frequently demonstrate high Scr variability independent of intravenous contrast material exposure.

**CLINICAL RELEVANCE/APPLICATION**
A substantial percentage of AKI following intravenous contrast material exposure may be attributable to Scr variability instead of contrast-mediated renal injury.

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**SSQ09-04 • Short-term Variations in Serum Creatinine as a Novel Control to Assess the Risk of Nephropathy Caused by Intravenous Radioccontrast**

**Travis Stradford BA (Presenter); Jianhua Li; Firas Ahmed MD; Jeffrey H Newhouse MD**

**PURPOSE**
Individual patients’ creatinine (Cr) levels vary from day to day; the more severe a patient’s background renal failure, the more severe the variations. If a patient who receives contrast subsequently has a Cr rise, the change may be erroneously attributed to the contrast. We
assessed daily Cr variations in patients who later received intravenous contrast as controls to determine which post-contrast Cr variations might not be due to the contrast.

METHOD AND MATERIALS

A HIPAA-compliant IRB-approved review of our hospital's electronic medical record identified patients who had Cr determinations on each day of a 7 or 9 day period, who also had intravenous contrast administered on the 4th or 5th day respectively of these periods, and who had not had contrast for at least a week prior to the examined period. Using a threshold of a 0.5 mg/dl rise in Cr to identify 'nephropathy,' episodes of nephropathy pre-contrast (using the first day as baseline) and post contrast (using the contrast-receiving day as baseline) were determined. Percent of patients who experienced pre- and post-contrast nephropathy were compared after stratification by baseline Cr levels. The short duration of the observation periods minimized differences between control and post-contrast periods in prevalences of other factors which might have altered kidney function.

RESULTS

3953 patients were identified. The groups whose Cr rose to or beyond the nephropathy threshold increased as baseline Cr levels increased in both pre-contrast and post-contrast periods. There was no significant difference in nephropathy risk for baseline Cr up to 0.9 mg/dl. For baseline Cr values between 1.0 and 2.8 mg/dl, creatinine rises to or beyond the threshold occurred significantly more frequently after contrast (61% v. 39%; p

CONCLUSION

Although most post-contrast acute rises in serum Cr are due to non-contrast-related natural variation, about 22% of these rises may be due to the contrast when baseline Cr levels are between 1.0 and 2.8 mg/dl.

CLINICAL RELEVANCE/APPLICATION

Intravenous contrast usually does not cause nephropathy, but slightly raises the risk in some patients with renal failure. This risk should be considered before giving contrast to such patients.

SSQ09-05 • Kidney Transplant: The Diagnosis of Chronic Allograft Nephropathy (CAN) with Real Time Elastography (RTE). Comparative Evaluation between RTE Data and Hystological Findings

Fabrizio Chegai MD (Presenter) ; Antonio Orlacchio MD ; Costantino Del Giudice MD ; Elena Di Caprera ; Daniela Tosti ; Giovanni Simonetti MD ; Elisa Costanzo

PURPOSE

METHOD AND MATERIALS

45 patients clinically-suspected of CAN (CAN group) and 18 patients with a stable graft function (control group) were enrolled in our study. RTE was performed and tissue mean elasticity (TME) was calculated by a single operator who was unaware of the renal function data of all patients. Kidney tissue elasticity measurements were performed using a Philips iU 22 Ultrasound Machine equipped with the L12-5 linear probe (MHz). CAN group patients underwent biopsy after RTE and the findings were correlated to the histological Banff score. Furthermore ecocoloDoppler was performed and intrarenal resistance index (RI) and pulsatility index (PI) were measured.

RESULTS

CONCLUSION

CLINICAL RELEVANCE/APPLICATION

RTE can identify non-invasively the CAN with results comparable to biopsy, and could be recommended for the evaluation of fibrosis in these patients.

SSQ09-06 • Single Center Experience with 1,585 Injections of Gadoteridol in Patients with Renal Dysfunction

Rupan Sanyal MD (Presenter) * ; Jonathon P Stidham MD ; John V Thomas MD, MRCP ; Desiree E Morgan MD *

PURPOSE

Evaluate incidence of nephrogenic systemic fibrosis in patients with renal dysfunction who undergo contrast enhanced MRI with Gadoteridol.

METHOD AND MATERIALS

IRB approved/HIPAA compliant retrospective study of patients with Grade 3-5 renal dysfunction who underwent weight based Gadoteridol enhanced MRI and had same day eGFR testing. Gadoteridol is a macrocyclic gadolinium contrast agent that has an extracellular biodistribution. The following variables were recorded: eGFR on the day of examination; volume of Gadoteridol injected; history of diabetes, dialysis or renal transplant; length of clinical follow up after MR examination; development of or biopsy of any skin lesion during follow up.

RESULTS

1585 weight based Gadoteridol doses were administered to 1292 patients (893 females) with Grade 3-5 renal dysfunction. 204 patients had diabetes, 2 had renal transplant and 1 was on dialysis. 1266 doses were administered to patients with Grade 3A renal dysfunction (eGFR 45-59), 303 administrations to patients with Grade 3B renal dysfunction (eGFR 30-44) and 16 administrations to patients with Grade 4-5 renal dysfunction (eGFR 30-44). There was significant difference in nephrogenic systemic fibrosis development st between pre-contrast and post-contrast periods in prevalences of other factors which might have altered kidney function.

CONCLUSION

No cases of nephrogenic systemic fibrosis developed after 1583 doses of Gadoteridol in 1292 patients with eGFR 2.

CLINICAL RELEVANCE/APPLICATION

This study suggests that Gadoteridol can be safely administered in patients with Grade 3 renal failure without causing nephrogenic systemic fibrosis.

SSQ09-07 • NSsaFe Study: Observational Study on the Incidence of Nephrogenic Systemic Fibrosis in Renal Impaired Patients Following Gadoterate Meglumine Administration

Thomas Voigtlaender (Presenter)

PURPOSE

To prospectively estimate the incidence of NSF in patients with moderate to severe renal impairment after administration of gadoterate meglumine.

METHOD AND MATERIALS

An ongoing worldwide post-marketing study (PMS) is conducted to collect safety data in 1,000 patients (adults and children) with moderate to severe and end stage renal impairment, scheduled to undergo a routine contrast-enhanced magnetic resonance (MR) imaging using gadoterate meglumine (Dotarem®). For each patient, risk factors at inclusion, indications for MR imaging, and occurrence of adverse events are recorded. Three follow up visits (between 3 months and 27 months after MRI) are performed in order to detect any suspicion or occurrence of NSF.

RESULTS

As of January 18, 2013, the cut-off date for the interim safety analysis, this ongoing PMS included data on 232 patients (mean age: 70.2 years (range: 21-92); male: 62.5%). The mean eGFR was 36.5 ±16.1 ml/min/1.73m² (range: 4.0-59.1) including 64.2% of moderate, 18.5% of severe, 14.2% of end stage renal insufficiency and 2.6% of kidney transplanted patients. CNS MR examinations accounted for nearly 25%. The first follow-up visit was done for 67 patients (29%) and no NSF occurred. Only 1 patient (0.4%) had two serious adverse events not related to gadoterate meglumine.
CONCLUSION
This interim analysis already confirms the very good safety profile of gadoterate meglumine in renal impaired patients.

CLINICAL RELEVANCE/APPLICATION
Interim analysis showed a good safety profile of gadoterate meglumine in renal impaired patients.

SSQ09-08 • Functional Assessment of Early Renal Allograft Dysfunction with Blood Oxygenation Level-dependent MR Imaging and Diffusion-weighted MR Imaging at 3T

Wooil Kim (Presenter); Chan Kyo Kim MD, PhD; Sung Yoon Park; Jungmin Bae; Byung Kwan Park MD; Wooseong Huh; Sung Ju Kim

PURPOSE
To evaluate the feasibility of blood oxygenation level-dependent (BOLD) MR imaging (MRI) and diffusion-weighted MR imaging (DWI) at 3T for functional assessment of early renal allograft dysfunction.

METHOD AND MATERIALS
This study was approved by the local ethics committee; written informed consent was obtained. Between April 2011 and December 2012, 46 patients with a renal allograft (early dysfunction, n = 36; normal, n = 10) were prospectively enrolled. BOLD MRI (multiple fast-field echo sequence with 8 and 16 gradient echoes) and DWI (single-shot echo planar imaging sequence with b values of 0, 500, and 800 sec/mm2) were performed at 3T. In patients with early renal allograft dysfunction, ultrasound-guided biopsies confirmed 21 acute rejections (AR), 7 acute tubulointerstitial necrosis (ATN), and 8 other pathologic conditions. R2* and apparent diffusion coefficient (ADC) were measured in the cortex and medulla of all renal allografts. The correlation between R2* or ADC values and estimated glomerular filtration rate (eGFR) was investigated in all the subjects using Spearman's correlation coefficient. Both R2* and ADCs were compared among AR, ATN, and normal groups by using the Student t-test.

RESULTS
In renal allografts, the medullary R2* and cortical ADCs demonstrated a moderate correlation with eGFR (correlation coefficient, 0.487, p < 0.01) and the cortical R2* of 16 echoes and medullary ADCs had a weak correlation (correlation coefficient, 0.317, p < 0.05). The cortical R2* of 8 echoes did not show a correlation with eGFR (p = 0.111). In both cortex and medulla, AR had significantly lower R2* and ADCs than normal renal allografts (p < 0.01). In both cortex and medulla, the R2* of ATN were significantly lower than that of normal renal allografts (p < 0.05), while the ADCs of ATN were not significantly different from normal renal allografts (p < 0.05). Between AR and ATN, there was no significant difference in both R2* and ADCs (p > 0.05).

CONCLUSION
BOLD MRI and DWI at 3T, as noninvasive tools, may demonstrate early functional state of renal allografts. However, current these techniques appear to have the limited capability for characterizing a cause of renal allograft dysfunction.

CLINICAL RELEVANCE/APPLICATION
As unenhanced functional imaging techniques, BOLD MRI and DWI at 3T may help to noninvasively assess functional state of patients with renal allografts.

SSQ09-09 • Potential Role of MDCT Spectral Imaging by Using Material Density Analysis on Virtual Unenhanced Images in Renal Insufficiency

Catherine Roy MD (Presenter); Philippe Host MD; Mickael Ohanna; Isham Labani; Gauthier Bazille MD; Herve Lang

PURPOSE
To assess the potential role of quantitative assessment of water within the kidney parenchyma using MDCT Spectral Imaging in order to evaluate patients with renal insufficiency (RI).

METHOD AND MATERIALS
210 patients (no special recommendation for hydration) including 3 groups of 70 patients: a control group of normal patients, a group with moderate RI (GFR > 40 mL/min) and a group with severe RI (GFR < 40 mL/min) underwent an unenhanced acquisition using Helical CT (GE Discovery CT750HD 64-slice) scanner with Spectral Imaging single source fast switching. We used same helical pitch and detector collimation for all scans (1.375, 0.625mm). Among monochromatic CT images ranging from 40 to 140 keV, three levels were then reconstructed at 75 KeV, 55 KeV, 45 KeV. An identical ROI was drawn in the medium part of renal parenchyma on both kidneys. A Gemstone Spectral Imaging (GSI) Viewer, using material-density basis pairs provided values of water in mg/cc with standard deviation on unenhanced images and on virtual unenhanced images of the water-iodine pair for control group. Water values in mg/cc were measured in the cortex and medulla of all renal allografts. The correlation between R2* or ADC values and estimated glomerular filtration rate (eGFR) was investigated in all the subjects using Spearman's correlation coefficient. Both R2* and ADCs were compared among AR, ATN, and normal groups by using the Student t-test.

RESULTS
Mean water content in control group was 1010 ±13 mg/cc (range: 997 ± 1030), respectively for three levels of monochromatic images. There was no difference between both kidneys. There was no statistically significant difference in renal water content between virtual unenhanced images of the water-iodine MD pair and unenhanced acquisition for control group.

Mean water content in RI groups were 991±.25 mg/cc, 1032±38 mg/cc for severe and moderate for three levels of monochromatic images, respectively.

There was no statistically significant difference in renal water content among the three groups. Noise index was higher for 45 KeV, but image quality was satisfactory.

CONCLUSION
The water content is not significantly different in impaired kidneys and normal kidneys parenchyma. It could not be used to assess renal impairment.

CLINICAL RELEVANCE/APPLICATION
There was no significant difference of water content inside kidney parenchyma in different forms of renal impairment.
SSQ18-02 • Reduction of Radiation Exposure, Effective Dose and Organ Dose in Pediatric Body CT Using BMI-based kVp Adjustment

Vana M Derderian BS (Presenter) ; Jennifer W Siegelman MD, MPH ; Choonsik Lee PhD ; Elizabeth C Jones MD ; Mahadevappa Mahesh MS, PhD * ; Les R Follo DO, MPH

PURPOSE
Understanding organ dose from CT in the context of age and body size is evolving. As part of efforts to balance CT radiation risk and its diagnostic benefit, we assessed the effectiveness of a BMI-based (Body Mass Index) kVp adjustment on dose in a pediatric cohort over time. We compared exposure and calculated patient-specific organ and effective dose from long z-axis exams in children before and after kVp reduction.

METHOD AND MATERIALS
To evaluate the effectiveness of BMI-based kVp adjustment, we retrospectively reviewed all kVp-adjusted CT scans in children (2012; n=358). Scans with kVp-adjusted Chest, Abdomen and Pelvis (CAP) or CAP with neck with one or more scans covering the same region prior to 2011 (program implementation) were included (n=13). Technical parameters (kVp, mAs, automatic exposure control (AEC) use) as well as exposure data (CTDIvol, DLP) from four CT units extracted from Radiance/PACS were compared with SSDE (Size Specific Dose Estimate) effective diameter at the middle slice, organ and effective doses at two time points (2010 and 2012). Computational phantoms representing six different age groups (newborn to adult) and two genders were used for Monte Carlo simulation of organ dose.

RESULTS
Comparing 2012 with 2010 as baseline, CTDIvol, DLP, and SSDE in 2012 were 22% (p=0.082), 20% (p=0.2982), and 26% (p=0.012) lower than baseline, similar to the reduction seen in SSDE. Urinary bladder and active marrow showed the maximum (28%) and minimum reduction (25%), respectively. No studies were repeated; no additional costs were incurred.

CONCLUSION
SSDE and average organ doses were, on average, 26% reduced after BMI-dependent kVp adjusted scans in 13 children. Use of BMI-based kVp adjustment is an economical dose reduction method that can maintain quality.

CLINICAL RELEVANCE/APPLICATION
Economical radiation dose reduction and organ dose estimation methods should help pediatric dose optimization efforts in hospitals and clinics without additional capital or infrastructure investment.

SSQ18-03 • High-pitch Dual Source Computed Tomography of Pediatric Abdomen

Eray Atli MD (Presenter) ; Erhan Akpinar MD ; Berna Sayan Oguz MD ; Mithat Haliloglu MD

PURPOSE
To assess radiation dose reduction and image quality with high-pitch dual-source CT (DSCT) in comparison with standard pitch with conventional pediatric abdominal CT.

METHOD AND MATERIALS
A total of 48 patients (median age, 51,8 months) underwent high-pitch abdominal CT in this institutional review board-approved HIPAA-compliant prospective study. High-pitch (value:3) mode CT was performed with 64-slice DSCT. This was compared to a group of 37 patients (median age, 60,7 months) who underwent conventional pediatric abdominal CT (pitch:

RESULTS
Both patient groups were similar with respect to age, APD, LD, ED and SL. Mean ST of high-pitch abdomen CT was 1.57 secs, while it was 9.94 secs in standard pitch mode CT. In comparison with conventional pitch mode, high pitch mode of DSCT reduced radiation exposure by 67% (5.18 vs. 1.7 mGy, SSDE according to ED); CTDIvolume, DLE and SSDE parameters were significantly lower in high pitch mode (p.

CONCLUSION
The use of high pitch DSCT significantly decreases scan times and radiation exposure when compared to conventional CT. Image quality and diagnostic confidence, however, is still similar in both imaging techniques.

CLINICAL RELEVANCE/APPLICATION
In pediatric abdominal imaging, high pitch DSCT provides fast scanning, less motion artifacts and significant reductions in radiation exposure without adversely affecting image quality.

SSQ18-04 • Dose Reduction in Pediatric Body-CT due to Fully-integrated-Digital 'Stellar®' Detector

Jennifer L Cullmann (Presenter) ; Khoschey Schawkat MD ; Daniel Ott MD ; Stefan Puig MD, MSc

PURPOSE
This study aims to investigate PSDE which considers individual body habitus, attenuation/absorption characteristics of tissue and material included in pediatric CT using a Monte-Carlo simulation tool. Another aim is to devise a method to determine CT dose from scatter radiation and the proportion of scatter to displayed CTDIvol. Measures of all components of CT radiation; direct beam, over-ranging, and scatter are made with improved accuracy to produce a PDSE dose profile and compared to SSDE and CTDIvol.
PURPOSE
To evaluate the potential reduction of radiation dose in pediatric body CTs after implementation of a new fully-integrated-digital detector (Stellar®, Siemens Healthcare, Germany) compared with a conventional Ultra-Fast-Ceramic® (UFC) solid-state-detector.

METHOD AND MATERIALS
152 routine CT examinations (112 thoracic, 8 abdominal and 32 thoracoabdominal) of 114 children (58 male, 56 female) between 1 day and 16 years of age were included in the analysis. The following parameters were recorded: age, scan length, maximum body diameter, and CTDIvol, dose-length-product (DLP). The effective radiation dose (ED) was estimated from the DLP and an organ weighting factor (k): ED[mSv] = k × DLP[mGy×cm]. All examinations were performed on a single dual source multi-detector CT (Somatom Definition Flash; Siemens Healthcare, Erlangen, Germany), 93 examinations before the exchange of the detector unit, with a UFC solid-state-detector, and 59 with the new digital Stellar®-detector. The scanning protocols were kept the same before and after replacement of the detector unit. Independent two-sample t-tests were used to assess statistical differences, the level of significance was defined as p = .05.

RESULTS
Age and body diameter did not show significant differences in both groups. The mean CTDIvol was about 16% lower after detector change (1.77 vs. 1.52 mSv). However, this difference was statistically not significant (p=.30). The mean ED was significantly lower with the digital Stellar detector (0.74 mSv ± .6) compared with the previous UFC solid-state-detector (1.09 mSv ± 1.3) (p=.02). This was obviously achieved due to a significantly lower mean scan-length of 270 mm ± 123.6 vs. 231mm ± 89.5 (p=.3) resulting in a significantly lower DLP: 70.2 mGy×cm ± 88.4 vs. 45.2 mGy×cm ± 41.6 (p=.02).

CONCLUSION
Fully digital Stellar®-detector may achieve a mild reduction of radiation in pediatric patients. However, the main difference of the DLP was due to differences of the scan length before and after exchange of the detector unit.

CLINICAL RELEVANCE/APPLICATION
There may be some radiation dose reduction due to fully digital detectors. However, other factors such as scan length still have a major influence on radiation dose.

SSQ18-05 • Pediatric CT Radiation Dose Variability: Affecting Factors at a Large Academic Institute
Ranish D Khawaja MBBS, MD (Presenter) ; Sarabjeet Singh MD ; Beth Vettiyil MBBS ; Sarvenaz Pourjabbar MD ; Atul Padole MD ; Mannudeep K Kalra MD * ; Diego A Lira MD

PURPOSE
Children are more susceptible to radiation-induced carcinogenesis because of greater organ radiosensitivity and a longer life-span. Since children have a wide variability in their body sizes and expected variations in radiation doses, we aimed to compare pediatric CT radiation doses across different body weight groups and across scanners, operators and body regions in pediatric CT.

METHOD AND MATERIALS
In an IRB-approved study, 544 consecutive pediatric (= 18years) chest (C) and abdomen-pelvis (A) CT (nC=204; nA=340; M:F=309:235) were assessed with an web based dose monitoring software (Exposure, Radiometrics) from 1/2011 to 1/2013. Demographics of patient (age, sex, body weight, and body diameter); body regions; age, sex, training experience of CT technologist, scanner type (availability of Iterative Reconstruction ™IR™), off-centering, and estimated effective dose (EED) were recorded. Corresponding EED values were also recorded for adult CT (n=14,000; nC=6,000; nA=8,000) for comparison. Analysis of variance (ANOVA) was used to evaluate differences in ED across above variables.

RESULTS
Mean EED (ICRP-103) in pediatric cohort was 6.9±6.5 (EEDC: 4.7±5.3; EEDAp: 8.1±6.8; mean age:12.0±5.0 years). Compared to adults mean EED was 7.4±4.1 (EEDC: 4.6±2.7; EEDAp: 10.2±5.5). Mean EED for pediatric abdominal CT was significantly low compared corresponding adult dose (p<0.001). Mean EED varies considerably across CT scanners, body regions and with BW in pediatric patients. Mean EED varies significantly in children weighing 27-100Kg across scanners. This variability is low for lightweight (CLINICAL RELEVANCE/APPLICATION
In our experience of pediatric CT, the only modifiers that affect the radiation dose variability include CT exam performed on IR versus non-IR scanners, and body weight of patient.

SSQ18-06 • Is Wide-detector Better than Helical Acquisition in Children Undergoing Torso CT Imaging?
Robert F Buchman DO (Presenter) ; S. Bruce Greenberg MD

PURPOSE
We have shown a 45% reduction in radiation exposure with no loss in image quality for torso CT imaging of children by shifting from filtered back projection to Adaptive Iterative Dose Reduction (AIDR 3D). Our purpose was to evaluate if additional dose reduction or improved image quality could be obtained by changing from helical to wide-detector technique.

METHOD AND MATERIALS
The study groups include 100 children who had undergone helical torso CT and 50 who had undergone wide-detector torso CT. Wide-detector technique is a step and shoot technique that allows for up to 16cm of coverage per rotation with stitching of multiple rotation acquisitions. The helical group average age was 9.4 years (SD 5.7) and the wide-detector group 10.0 years (SD 5.9) which was not significantly different (p = .54). Size-Specific Dose Estimates (SSDE) were calculated for each study. Image noise was used as a proxy for image quality. Three 1.0 cm² round regions of interest (ROI) were created, two in the right paraspinal muscles at the levels of the right pulmonary artery and the right kidney and one in the right gluteus maximus muscle. The standard deviation in each ROI constituted the measure of image noise. Unpaired t tests compared the SSDE and image noise for each group.

RESULTS
The results are summarized in the table. No significant difference in the SSDE was present between the two study groups (p = .58). Children less than 7 years old undergoing wide-detector acquisition had a mean SSDE of 2.8 mGy (SD 0.5) while those undergoing helical acquisition had a mean SSDE of 3.2 mGy (SD 0.9). This difference was not significant (p = .09) but showed a trend towards reduced dose in younger children. Image noise in the abdomen was improved by wide-detector technique, but the difference was not significant (p = .18). A 7% reduction in pelvis image noise by wide-detector technique was significant (p = .04).

CONCLUSION
Radiation exposure was not significantly improved by the use of wide-detector scanning, but a trend towards modest improvement in younger, smaller children was observed. Pelvis image quality was significantly improved and a trend towards improvement in the abdomen was observed. Helical images are likely to have increased noise compared to wide-detector technique due to inherent smearing associated with helical technique.

CLINICAL RELEVANCE/APPLICATION
The information acquired allows for optimization of computed tomography in children.

SSQ18-07 • Usefulness of Large Beam-shaping Filters at Different Tube Voltages of Pediatric CT
Takanori Masuda (Presenter) ; Yoshinori Funama PhD ; Naoyuki Imada ; Takayuki Oku ; Satoshi Inada ; Kazuo Awai MD

PURPOSE
As children are more susceptible to radiation-induced damage than adults it is necessary to use a lower radiation dose at pediatric CT. An effective reduction methods is the selection of large beam-shaping filters. We compared the radiation dose with small and large beam-shaping filters at different tube voltages and document the usefulness of large beam-shaping filters at pediatric CT.

METHOD AND MATERIALS

We used a 15-cm diameter cylindrical water phantom and inserted a 10-cm long pencil ionization chamber into the phantom center. Helical CT acquisitions were on a 64-detector CT scanner (VCT, GE Healthcare). The tube voltage was 80-, 100-, or 120 kVp; the beam pitch and gantry rotation time were 1.375 and 0.4 sec. The tube current was automatically set with automatic exposure control (noise index: 10-F view) FOV was 15- and 50 cm with small and large beam-shaping filters, respectively. Scans with a 50-cm FOV were reconstructed at a 15-cm display FOV. The radiation dose and image noise (SD of the CT number) were compared on all reconstructed images.

RESULTS

The radiation dose with the small beam-shaping filter was 2.08 mGy at 80-, 2.07 mGy at 100-, and 2.24 mGy at 120 kVp, respectively. With the large filter it was decreased to 1.9, 1.94, and 1.77 mGy at 80-, 100-, and 120 kVp. At each tube voltage the radiation dose was lower with the large- than the small filter. The image noise was 8.42 HU at 80-, 8.34 HU at 100-, and 8.26 HU at 120 kVp with the small filter, respectively; with the large filter it was 8.52, 8.23, and 8.45 HU. There was no significant difference in image noise between small and large beam-shaping filters at all tube voltages (p>0.05).

CONCLUSION

The use of a large beam-shaping filter facilitates, radiation dose reductions by 10-20% without image quality degradation at pediatric CT.

CLINICAL RELEVANCE/APPLICATION

Large beam-shaping filters help to reduce the radiation dose at 64-detector CT, eliminating the need for investments in new technology.

SSQ18-08 • Organ and Effective Doses in Dual-energy CT of Pediatric Contrast-enhanced Examinations: Comparison to Single-energy CT Using Low Tube Potential

Juan Carlos Ramirez Giraldo PhD (Presenter) ; Marilyn J Siegel MD * ; R Bankwitz * ; Marga Leuthe * ; Bernhard Schmidt PhD *

PURPOSE

To evaluate the organ and effective doses of dual-energy CT (DECT) in pediatric-sized phantoms in comparison to low tube potential single-energy CT (SECT) with the same radiation output.

METHOD AND MATERIALS

Two anthropomorphic phantoms simulating a 1-year-old and a 5-year-old that had inserted thermoluminescent dosimeters (TLDs) were scanned using a dual-source 128-slice CT system operated with conventional SECT at low tube potential and also DECT at 80/140 kVp with tin filtration. The scan range included both abdomen and pelvis. For the SECT scans, the tube potential and corresponding tube current were selected by using an automated tube potential selection tool (CARE kV), using 120 kVp and 150 mAs as reference, with optimization for CT angiology. The scanner output, as measured by the volume CT dose index (CTDIvol), was recorded and used to adjust the mAs in the DECT scans such that CTDIvol was the same as the SECT scan. Organ doses in mGy were measured and the effective dose in mSv was calculated by summing the absorbed doses (mGy) of individual organs considering ICRP103 weighting factors.

RESULTS

The resulting CTDIvol values were 0.67 mGy and 2.73 mGy for the 1-year-old and 5-year-old phantoms, respectively. The calculated effective doses were 1 and 1 mSv (1 year-old), and 3 and 3 mSv (5 year-old) for the 80 kVp and 80/140 kVp scans, respectively. In the 1-year-old phantom, organ doses were statistically the same with average difference of 0.11 mGy (P=0.07) between 80 kVp and 80/140 kVp. In the 5-year-old phantom, organ doses were also statistically the same with average difference of 0.35 mGy (P=0.15) between 80 kVp and 80/140 kVp.

CONCLUSION

At matched radiation scanner output, organ and effective doses of DECT scans are comparable to those from conventional SECT at a low tube potential of 80 kVp.

CLINICAL RELEVANCE/APPLICATION

The ability of DECT to achieve comparable organ and effective doses relative to optimized low-tube potential CT angiography in pediatrics, is a pre-requisite for consideration of its use clinically.

SSQ18-09 • The Optimal Dose Reduction Level in Chest CT with 640-slice CT Volume Scan Mode Using Iterative Reconstruction (AIDR 3D) in Little Swine Model

Qin Liu MA, BA (Presenter) ; Yang Hou MD ; Pengfei Zhao ; Qiyong Guo MD

PURPOSE

To estimate the radiation dose and image quality (IQ) of an iterative reconstruction (AIDR 3D) in combination with SureExposure3D on a 640-slice CT and determine the optimal dose reduction level using AIDR 3D for neonates and children chest CT that can provide IQ comparable to filtered back projection (FBP).

METHOD AND MATERIALS

29 normal swines whose weight ranged 3-12kg (7.62±2.67) underwent 640-slice MDCT chest CT(Aquilion one, Toshiba) for 5 times with 80kvp and different mAs. SureExposure3D technique were used and the index of noise were set to SD10 (Group A, routine dose), SD12.5, SD15, SD17.5, SD20 (Group B-E) to reduce dose successively. Group A were reconstructed with FBP, Group B-E were reconstructed using AIDR 3D (strong level). Two radiologists graded subject image quality in both lung and mediastinal images using a 5-point scale in a blinded manner. Object IQ parameters of image noise, signal-to-noise (SNR) were measured in each group. A receiver-operating characteristic (ROC) analysis was performed to establish a radiation reduction threshold up to which comparable IQ (score=4) was maintained.

RESULTS

Group B, C, D has significantly lower noise , better SNR than Group A(P<0.05)

CONCLUSION

Using AIDR3D technique, 80kvp with SureExposure3D (SD17.5) can provide comparable or even better IQ compared with routine dose with FBP reconstruction, and reduce 43% dose in little swine model.

CLINICAL RELEVANCE/APPLICATION

The results of little swine model may be applied to reducing radiation dose of chest CT in neonates and children with serious lung infections.
Back to Top
Minicourse: Recording and Reporting Radiation Dose: Nuclear Medicine

Friday, 08:30 AM - 10:00 AM • S403B

RC823 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Director
J. Anthony Seibert, PhD

RC823A • Nuclear Medicine Dose Indices

Wesley E Bolch PhD (Presenter)

LEARNING OBJECTIVES
1) Identify the more common radiopharmaceuticals used in functional imaging of normal and diseased tissues. 2) Demonstrate understanding of the parameters needed to estimate tissue dose during nuclear medicine imaging and therapy. 3) Identify fundamental data sources for organ and effective dose per unit administered activity. 4) Demonstrate understanding of the physiological and anatomic sources of individual variability in organ and effective dose per unit administered activity. 5) Identify key features of new generation anatomical models that can reduce dose uncertainties through improved matching of patient body morphometry.

ABSTRACT
A main clinical application of nuclear medicine is that of functional imaging of normal and diseased tissue, and the localization of malignant tissue and its potential metastatic spread. In these applications, the amount of administered activity is such that the absorbed dose to both imaged and non-imaged tissues are typically very low and thus stochastic risks of cancer induction are greatly outweighed by the diagnostic benefit of the imaging procedure. Nevertheless, these tissues doses and their stochastic risks should be quantified for each patient, and placed in context of both their cumulative values received over multiple imaging sessions, and of doses and risks received by other diagnostic imaging procedures they may have (fluoroscopy and computed tomography, for example). The role of internal dosimetry in diagnostic nuclear medicine is thus to provide the basis for stochastic risk quantification. Once this risk is quantified, it may be used to optimize the amount of administered activity in order to maximize image quality while minimizing patient risk. This optimization process is of particular importance for pediatric patients owing to their enhanced organ radiosensitivities and years over which any stochastic effects may become manifest. This optimization should consider, as much as possible, patient age, gender, and body morphometry, and pharmacokinetics, along with all available image acquisition and processing techniques. Unlike other forms of diagnostic imaging, for which dose indices are readily measured, only the administered radioactivity is typically available for dose tracking. In this course, we will review data sources for organ and effective dose per unit administered activity for the more common molecular imaging radiopharmaceuticals. Particular attention will be given to sources of individual variability in both organ and effective dose attributed to both physiological and anatomical variations among patients. Advances in computational tools for dose estimation and optimization will be introduced.

RC823B • Tracking Doses in the Pediatric Population

Frederic H Fahey DSc (Presenter)

LEARNING OBJECTIVES
1) List three considerations in estimating the radiation dose from pediatric nuclear medicine. 2) Discuss three factors that affect the radiation dose from the CT component of hybrid imaging. 3) Describe three factors that can affect the appropriate choice of administered activity for a nuclear medicine study. 4) List 2 advances that may lead to further reduction in the administered activity in pediatric nuclear medicine.

Current and Next Generation Health IT Tools To Enable Radiation Exposure Reduction - A Practical Guide

Friday, 08:30 AM - 10:00 AM • S403A

RC830 • AMA PRA Category 1 Credit™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Ramin Khorasani, MD *

RC830A • Before the Scan: Optimizing Dose Before the Patient Is On the Table

Rasul B Shrestha MD, MBA (Presenter) *

LEARNING OBJECTIVES
1) Number of CT scans is increasing annually. 2) Wider adoption/ availability of CT scanners. 3) Indications for CT use are increasing (without possible consideration for risks). 4) Rapid increase in number of protocols: Varying equipment leading to protocol variance. Children are at greater risk from a given dose of radiation compared with adults. A thorough look at the issues around radiation dose in children will also be provided.

ABSTRACT
The acceptance of the risks associated with radiation is conditional on the benefits to be gained from the use of radiation. The risks must be restricted and protected against by the application of radiation safety standards. A significant part of the challenge of patient dose management in CT arises from the fact that over-exposure in CT is frequently not detected. In contrast to film based radiography where overexposure results in a dark image, increasing dose in CT and in other digital imaging techniques results in images with: (1) less noise (improved visual appearance) and (2) fewer streak artifacts, (3) although not necessarily with greater diagnostic information. Image quality in CT often exceeds the clinical requirements for diagnosis. It is critical to have a thorough understanding of the basics of radiation dose in CT before we explore the multiple issues around opportunities to reduce these dose parameters. Furthermore, it is also critical to comprehend the role of newer technologies and developments that are rapidly taking place to address radiation dose reduction in CT - both on the vendor side as well as on the private and academic communities. Through comprehensive understanding of the quality and patient safety issues around this is also critical to making sound decisions around imaging on multiple levels. Different organs have different sensitivities to radiation. Tissue Weighted Factor, WT takes into account the risk to the person exposed to radiation that is not uniform over the entire body. As an example, if 1 mSv is received only by the lungs, this results in an effective dose to that person of 0.12 mSv. This means that 1 mSv received by the lungs poses approximately the same risk as 0.12 mSv to the entire body. Fundamentals such as these will be presented in easily digestible chunks in the refresher course. Also covered will be Protocol Optimization, Scanner Interfacing, Data Connectivity and Interoperability.

RC830B • During the Scan: Patient-Centric Imaging

William W Boonn MD (Presenter) *
LEARNING OBJECTIVES
1) Learn how modifications in CT scan protocol can affect image quality and radiation dose. 2) Understand how to optimize scanning protocols based on clinical indication and patient specific factors. 3) Learn how to measure and monitor protocols and dose to track and optimize performance.

RC83OC ● After the Scan: Data-Mining Dose Data for Improved Quality, Safety, and Outcomes
Aaron D Sodickson MD, PhD (Presenter)

LEARNING OBJECTIVES
1) Understand available metrics of CT radiation exposure, and how they relate to patient dose. 2) Demonstrate methods to extract exposure data on a large scale. 3) Highlight quality improvement and patient safety applications of large radiation exposure databases.

Interventional Radiology Series: Top 5 Complications in Interventional Oncology - Avoidance, Recognition and Management
Friday, 08:30 AM - 12:00 PM ● E451A

VSIR61 ● AMA PRA Category 1 Credit ™:3.25 ● ARRT Category A+ Credit:3.75
Moderator
Charles E Ray, MD, PhD *

LEARNING OBJECTIVES
1) List 2 important recent publications in interventional oncology. 2) Explain the mechanism of one complication related to thermal ablation. 3) Describe pros and cons of chemoembolization versus radioembolization of hepatocellular carcinoma with portal vein thrombosis. 4) Outline 3 complications in combination therapy for hepatocellular carcinoma. 5) List 3 complications of chemo-embolization. 6) Describe rationale for and against interventional oncology as a distinct specialty.

VSIR61-02 ● Chemo-Embolization Cxs
Charles E Ray MD, PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

VSIR61-03 ● Tc-99m Macroaggregated Albumine Lung Shunt Calculation Overestimates the Lung Dose in Radioembolization
Mattij Elschot MSc; Jip F Prince MSc (Presenter); Maarten L Smits; Marnix G Lam MD; Johannes F Nijsen PhD; Bernhard A Zonnenberg MD; Max A Viergever *; Maurice A Van Den Bosch MD, PhD; Hugo W De Jong PhD

PURPOSE
Hepatic radioembolization is preceded by a safety procedure in which a scout dose of 99mTc-MAA is infused in the hepatic artery for assessment of lung shunting. If the lung shunt is substantial, the treatment dose is reduced to minimize the risk of radiation pneumonitis, which may lead to inadequate absorbed doses to tumors. The purpose of this study was to assess the accuracy of 99mTc-MAA lung shunt calculations.

METHOD AND MATERIALS
Fourteen patients were treated with radioembolization using holmium-166-loaded microspheres (166Ho). These particles can be quantified with SPECT and can be used for scout dose and treatment. During preparatory angiography, 99mTc-MAA (150 MBq) was injected, followed by (planar) scintigraphy and SPECT-CT. At the day of treatment, a scout dose of 166Ho-microspheres (250 MBq) was first injected, followed by SPECT-CT imaging. Subsequently, a treatment dose of 166Ho-microspheres was injected and imaged with SPECT-CT. Lung shunting was calculated on 99mTc-MAA scintigraphy. Mean lung doses were calculated on quantitative SPECT images for all three procedures and also on scintigraphy for 99mTc-MAA. The activity in the lungs was converted into absorbed dose (Gy) corresponding to the net injected treatment dose. The pre-treatment estimations were compared to the lung dose after actual treatment, as measured with post-treatment SPECT.

RESULTS
No signs of radiation pneumonitis were seen in any patient during three months follow up. The median lung shunt based on 99mTc-MAA scintigraphy was 4.1% (range 2.2 – 11.3%). The median lung dose after 166Ho-radioembolization was 0.2 Gy (range 0 – 0.7 Gy), based on quantitative SPECT. This lung dose was significantly overestimated by 99mTc-MAA scintigraphy (median difference (? 5.1 Gy, range 1.4 – 17.1 Gy, p < 0.001) and by 99mTc-MAA SPECT (? 2.3 Gy, range 0.5 – 11.8 Gy, p < 0.001). The estimations on SPECT images of the 166Ho-scout dose did not differ significantly from treatment (? 0.0 Gy, range -0.7 – 0.3 Gy, p = 0.542).

CONCLUSION
99mTc-MAA lung shunt calculations significantly overestimate the mean lung dose after radioembolization with 166Ho microspheres. In contrast, a scout dose of 166Ho-microspheres accurately predicts the mean lung dose after treatment.

CLINICAL RELEVANCE/APPLICATION
The mean absorbed dose to lung parenchyma of patients treated with 166Ho radioembolization is significantly overestimated by 99mTc-MAA planar scintigraphy and SPECT-based lung dose calculations.

VSIR61-05 ● Y-90 Cxs
Robert J Lewandowski MD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

VSIR61-06 ● Trans-arterial Radioembolization (TARE) of Intermediate-advances HCC: Does Portal Vein Thrombosis Affect Survival?
Francesco Fiore MD (Presenter); Francesco Somma MD; Roberto D'Angelo MD; Rosa Ambrosio MD; Sergio Setola; Francesco Izzo MD

PURPOSE
Our purpose is to assess and compare the survival of patients with portal vein thrombosis (PVT) and patients without PVT after a TARE using Y-90 microspheres of unresectable HCC, not responsive to other loco-regional treatments.

METHOD AND MATERIALS
Between November 2005 and February 2013, 81 TARE were performed in 74 patients (43% male; 57% female; range of age 28-84years) with unresectable HCC (size of lesions 1.1 to 5.5cm) and bilirubine values up to 2.6 mg/dl, 21 with PVT. Every patient was studied with Multislice Computed Tomography (MSCT) scans and angiography while just 12 of them underwent the embolization of the Gastro-duodenal artery, using micro-coils. In these cases, a previous study was performed with the injection of TC-99MAA through a 3F microcatheter. Proton-Pump Inhibitors (PPI) were administered to prevent gastritis and ulcers.
RESULTS
The average dose administered was 1.7Gbq. After the treatment, fever and abdominal pain were found in 29 and 19 patients, respectively. No other side-effect was observed. According to the mRECIST criteria at least a partial response was found in 70% of patients three months after the procedure and in 90.5% at nine months. The mean survival of patients with PVT was similar to those without thrombosis. Moreover, a regression of PVT was registered in more than 50% of patients.

CONCLUSION
TARE using Y-90 microspheres showed to be a safe and effective technique even in patients with PVT. Among the loco-regional treatments of intermediate-advanced HCC, TARE is extremely useful in case of relapse after trans-arterial embolization (TAE) or chemoembolization (TACE) in improving the survival of these patients.

CLINICAL RELEVANCE/APPLICATION
Portal vein thrombosis does not affect survival of patients who undergo the Y-90 TARE of intermediate-advanced HCC not responsive to other loco-regional

VSIR61-07 • Debate: HCC With Portal Vein Thrombosis
Charles E Ray MD, PhD (Presenter) *; Robert J Lewandowski MD (Presenter) *

LEARNING OBJECTIVES
1) Discern the impact of transcatheter intra-arterial embolotherapy in patients with hepatocellular carcinoma and portal vein thrombosis.
2) Understand the microembolic effects of radioembolization, and the potential advantages of this treatment over other intra-arterial embolotherapies.
3) Become familiar with the current literature regarding radioembolization of patients with unresectable hepatocellular carcinoma with portal vein thrombosis.

VSIR61-08 • Thermal Ablation Cxs
Daniel B Brown MD (Presenter) *

LEARNING OBJECTIVES
1) Techniques to avoid complications with thermal ablation. 2) How to manage complications of thermal ablation.

ABSTRACT
Complications are unusual with thermal ablation but can be severe. This presentation is designed to avoid complications as well as identify untoward events early after therapy to optimize management.

VSIR61-09 • Evaluation of Thrombotic Risk in Hepatic Vessels during Microwave Tumor Ablations: Does Size Really Matter?
Jason Chiang BS (Presenter); Bridgett J Willey *; Alejandro Munoz Del Rio PhD; Christopher L Brace PhD *

PURPOSE
Microwave tumor ablation is a powerful tool that can more effectively overcome the heat-sink effect of nearby vasculatures. Such power may also increase the risk of thrombosing larger vessels, which can have devastating consequences for a patient whose liver is already compromised. The goal of this study is to correlate the risk of vascular thrombosis with vessel size, blood velocity and proximity to heating zone during microwave ablations.

METHOD AND MATERIALS
Microwave antennas were placed in-vivo, 5-20 mm away from a portal vein, hepatic vein and hepatic artery in a porcine liver (n=6). Vessel sizes, flow velocities and distance from antenna were measured under Doppler and ultrasound imaging. Microwave ablations were then created at 100 W for 5 minutes. Post-ablation ultrasound was used to determine presence of thrombus in each vessel. Uni- and multivariable logistic regressions were fitted to model the relationship predictors to thrombotic events in each kind of vessel. Fitted models were compared to each other using the area under the receiver operator characteristic curves (AUC); 95% confidence intervals for AUC were also obtained.

RESULTS
Thrombus formation was detected in 53.3% of portal veins (8/15), 13.3% of hepatic veins (2/15) and 0.0% in hepatic arteries (0/15). The hepatic vein AUC of velocity, spacing and diameter were 0.885 [95% CI: 0.617-0.989], 0.923 [0.667-0.997] and 0.904 [0.641-0.994], respectively. Portal vein AUC of velocity, spacing and diameter were 0.509 [0.163-0.853], 0.643 [0.340-0.946] and 0.536 [0.168-0.814], respectively. Multivariate prediction models of both hepatic and portal veins did not show significant increase in AUC over their respective individual univariate models.

CONCLUSION
The risk of thrombosis decreased with increasing vessel velocity, size and spacing in hepatic veins. Portal veins thrombosed at a rate four times higher than hepatic veins, but our analysis was not able to discriminate which factors were most relevant. Further study is required to elucidate the physical and biochemical mechanisms behind this discrepancy in thrombotic rates.

CLINICAL RELEVANCE/APPLICATION
Portal veins have greater, but less predictable risk for thrombosis compared to hepatic veins in microwave tumor ablation procedures.

VSIR61-10 • The Effect on Renal Function Following Image Guided Radiofrequency Ablation (RFA) of Renal Tumors
Tze M Wah MBChB, FRCR (Presenter) ; Walter Gregory PhD; Henry C Irving MBBS; Jon Cartledge MD; Adrian D Joyce MD; Peter J Selby MD, DSc

PURPOSE
To analyse changes in GFR in patients who had image-guided RFA of their renal tumors and to correlate the percentage GFR change (% GFR change) with tumor size, polar position, tumor treatment location, the total size of the tumor treated per ablation session, number of tumors treated, and solitary kidney status.

METHOD AND MATERIALS
From June 2004-2012, a total of 165 patients (109 men, 56 women; mean age 67.7 years) had image-guided RFA of 200 renal tumors with size ranging from 1-5.6cm (mean= 2.9cm). The position of the renal tumors was: upper (n=63), middle (n=86) and lower (n=51). The tumor location was: exophytic (n=43), mixed (n=100), parenchymal (n=41) and central (n=41). All patients had renal function measured immediately before and at 24 hours post-RFA. Multivariate logistic regression analysis was performed to determine any association between % GFR change with the tumor size, polar position (upper, middle and lower pole of the kidney), tumor treatment location (exophytic, mixed, parenchymal and central), the total size of the tumor treated per ablation session, number of tumors treated and solitary kidney status.

RESULTS
The mean GFR pre- and post-renal RFA were: 54.7 ml/min/1.73m2 (+/- SD 18.2 ml/min/1.73m2) vs. 52.7 ml/min/1.73m2 (+/- SD 18.5 ml/min/1.73m2). There is a significant difference between the pre- and post-RFA GFR measurements (p 25% decrease in GFR) whilst in the majority (98%) of the patients renal function was preserved. The mean % change of GFR pre- and post-RFA was 1.7% (+/- SD 15.2%). However, using multivariate logistic regression analysis there is no association between the % of GFR change with tumor size, polar position, tumor treatment location, the total size of the tumor treated per ablation session, number of tumors treated and solitary kidney status.
Preservation of the renal function can be achieved following image-guided RFA of renal tumors and the percentage of GFR change was not influenced by tumor factors or solitary kidney status.

Any change in renal function following image-guided renal RFA is not influenced by tumors factors (size, polar position, treatment location, number of tumors treated) or solitary kidney status.

Combination therapy utilizing both transarterial chemoembolization and thermal ablation will be discussed with an emphasis on complications. Different techniques of TACE will be shown, in combination with either radiofrequency ablation or microwave ablation. Management of complications will also be discussed.

Combination therapy utilizing both transarterial chemoembolization and thermal ablation will be discussed with an emphasis on complications. Different techniques of TACE will be shown, in combination with either radiofrequency ablation or microwave ablation. Management of complications will also be discussed.

This paper characterizes the key technical parameters that determine the cumulative dose exposure for patients during digital breast tomosynthesis screening.

CT localized radiographs (LR), also known e.g. as topogram or scout view, in the past were not perceived as contributing significantly to the effective dose of a CT examination. In modern low-dose CT, however, this contribution has to be taken into account. The purpose of our study was to assess typical LR dose values based on simulations and measurements.
SST14-05 • Preliminary Clinical Evaluation of an Online Intrascan Motion-correction Algorithm for Interventional C-arm Flat-detector CT

Julia Wicklein * ; Oliver Beuing * ; Martin Skalej MD, PhD * ; Steffen Serowy * ; Willi A Kalender PhD * ; Yiannis Kyriakou PhD (Presenter) * ; Holger Kunze MS *

Kenji Suzuki PhD (Presenter) *; Yipeng Liu MS; Toru Higaki PhD; Yoshinori Funama PhD; Kazuo Awai MD *

Purpose
Reduction of radiation dose in CT is highly demanded. Our purpose was to develop a supervised pixel-based machine-learning technique for converting ultra-low-dose (ULD) CT to virtual higher-dose (HD) CT images with less noise or artifact.

Method and Materials
We developed a pixel-based machine-learning technique based on a massive-training artificial neural network (MTANN) filter that is trained with input ULDCT images and corresponding HDCT images. Through training, the MTANN learns the relationship between the input and teaching images to convert ULDCT into HDCT images. Once trained, the MTANN no longer requires HDCT images; and it produced HDCT-like images from non-training ULDCT images. To train our MTANN filter and make a reference, we acquired 6 sets of CT scans of an anthropomorphic chest phantom (Kyoto Kagaku, Kyoto, Japan) with a tube voltage of 120 kV, tube currents of 10, 25, 50, 100, 150, and 300 mA, and a collimation of 5 mm. A 10 mA ULDCT image and the corresponding 300 mA HDCT image were used for training our MTANN filter. To evaluate the performance of our MTANN, we acquired ULDCT scans of 3 patients with a tube voltage of 120 kV and a tube current of 10 mA. The effective radiation dose of an ULDCT study was 0.1 mSv. We evaluated the image quality of CT images by using signal-to-noise ratio (SNR) in each image.

Results
With our trained MTANN filter, noise and artifacts (e.g., streaks) in ULDCT images (0.1 mSv) were reduced substantially, while details of soft tissue such as pulmonary vessels and bones were maintained. The average SNR of 0.1 mSv ULDCT images for patients was improved from 2.3 ± 1.8 to 13.0 ± 2.5 dB (two-tailed t-test; P < 0.001).

Conclusion
Supervised conversion of ULDCT into HDCT images was improved substantially to the quality comparable to 1.5 mSv HDCT; thus, radiation dose can potentially be reduced by 93%.

Clinical Relevance/Application
Advantage of our technique over iterative reconstruction is substantial reduction of radiation dose in CT with a very short processing time, which would be beneficial to patients and radiologists.

The Influence of kV and Patient Positioning on CT Image Quality and Dose: Why Low kV CT Scans Have a Higher Sensitivity to Patient Positioning

Timothy P Szczypkutowicz PhD (Presenter) *; Frank N Ranallo PhD; Kara Gill MD; Myron A Pozniak MD *

Purpose
Higher levels of noise non-uniformity were noticed in our pediatric scans. Investigation into the problem lead to the conclusion that due to the low kV used for pediatric scans, errors in patient positioning caused larger increases in noise non-uniformity for pediatric patients relative to similar adult protocols using higher kV settings. The purpose of this work is to explore the physical reason behind this effect and provide guidelines to avoid this problem in the clinic.

Method and Materials
Several clinical cases flagged by our pediatric radiologists were analyzed and motivated an anthropomorphic phantom study. A pediatric protocol was applied using 80 and 140 kV. The phantom was purposely mis-centered low by 0 and 6 cm. The noise uniformity was reported as the ratio of the standard deviation in uniform regions located in the anterior and posterior regions of the phantom. In addition, a numerical simulation was performed in which a bowtie filter was forward projected using an 80 and 140 kV polychromatic spectra and the transmitted fluence examined. This numerical study was meant to provide insight onto why changing the kV can influence noise uniformity when a patient is mis-centered.

Results
It was found that the noise non-uniformity of the 80 and 140 kV scans was 1.33 and 1.27 at 0 cm offset and 1.86 and 1.58 at 6 cm offset respectively. The numerical simulation showed the 140 kV spectra provided a 23% wider fluence profile than 80 kV when both spectra were normalized to have equal fluence through the center of the bowtie.

Conclusion
Novel to this study, it was shown that the degree of non-uniformity depends on kV and the physical reason for this effect was shown via phantom measurements and numerical simulation. This study identifies a new reason to stress the importance of patient positioning, especially for low kV exams (i.e. pediatrics).

Clinical Relevance/Application
Low kV settings, commonly used in pediatric protocols, can increase the chance for an un-diagnosable scan due to the higher dependence of noise non-uniformity on patient mis-centering at lower kVs.
Polyenergetic x-rays with low (100 or 80 kVp) and high tube voltage [140 kVp with or without a tin (Sn) filter] are used in dual-energy computed tomography (DECT). We aimed to evaluate the radiation doses administered during thoracic and abdominal DECT and compare them with those administered during single-energy CT (SECT) of the same regions.

RESULTS
The absorbed doses in the thoracic region were 12.8 ± 2.3, 12.5 ± 2.2, 11.7 ± 1.9, and 12.2 ± 1.6 mGy (p < 0.01, Friedman's test) when the 120 kVp, 100 and Sn/140 kVp, 80 and Sn/140 kVp, and 140 and 80 kVp modes, respectively, were used. The corresponding values for the abdominal region were 24.8 ± 2.2, 24.3 ± 2.0, 22.9 ± 1.7, and 23.3 ± 1.6 mGy (p < 0.01), respectively. The doses absorbed at the surface and center of the abdomen were higher and lower, respectively, when the 140 and 80 kVp mode was used than when the other three modes were used for abdominal CT.

CONCLUSION
DECT can be performed with a radiation dose that is equivalent to or lower than that required during SECT when the displayed CTDIvol is equivalent. The additional Sn filter used in abdominal DECT can approximate the axial absorbed dose distribution of DECT to that of SECT.

CLINICAL RELEVANCE/APPLICATION
DECT has advantages over SECT. Evaluation of the radiation dose administered during DECT is necessary to determine its indications for application and the energy modes required.

SST14-09 • CT Image Quality Improvement and Dose Reduction Potential with Model-based Iterative Reconstruction Using Autopsy Imaging in the Abdomen: Evaluation of Image Noise and DOSE with Different Noise Index

Tomokatsu Tsukamoto (Presenter); Takashi Takahata RT; Yue Dong; Keisuke Nishihara MD; Kazunari Mesaki MD; Hiroki Mori MD; Ye Ju; Katsuhide Ito MD

PURPOSE
To assess the dose reduction potential and image quality improvement with model-based iterative reconstruction algorithm (Veo) using autopsy imaging by comparing image noise and DOSE (DLP mGy-cm) with the adaptive statistical iterative reconstruction (ASiR) and the filtered back projection (FBP) reconstructions.

METHOD AND MATERIALS
With institutional review board approval, 8 autopsy imaging (AI) underwent abdomen CT with different noise index (NI: 8.5, 10.5, 14.5, 20.5, 30.5) on Discovery CT750HD was included. In addition to the 3 sets of 0.625mm slice thickness CT images were reconstructed with FBP, 50% ASiR and Veo. The image noise (SD) was measured with the same size of regions of interest at the same slice in 3 locations for liver and pelvis. The image noise reduction ratio was defined by SD (at NI30.5)/SD (at NI8.5). Using a 5-point score (1: poor; 3: diagnosis, 5 excellent), 3 radiologists independently and graded overall noise and delineation of the abdomen image.

RESULTS
For the Liver, the image noise reduction with Veo compared with FBP and 50%ASiR for the NI: 8.5, 10.5, 14.5, 20.5, 30.5 and the average were (47.3%, 52.2%, 61.0%, 70.6%, 79.0% and 62.0±13.0%) and (37.7%, 52.2%, 44.4%, 58.1%, 70.1% and 48.5±15.5%), respectively; for Pelvis, (49.2%, 54.3%, 66.3%, 74.1%, 79.8% and 64.7±12.9%) and (28.5%, 34.9%, 52.4%, 63.3%, 71.8% and 50.2±18.4%), respectively. The reduction ratio (NI30.5/NI8.5) of image noise about (Liver and Pelvis) for the Veo, 50%ASiR and FBP were (1.5 and 1.5), (3.2 and 3.9) and (3.9 and 3.9), respectively. All the differences were statistically significant between Veo and FBP (p < 0.01) and ASiR (p < 0.01).

CONCLUSION
The model-based iterative reconstruction algorithm (Veo) advanced reconstruction algorithms greatly reduced image noise to compare FBP and ASiR.

CLINICAL RELEVANCE/APPLICATION
Veo reconstruction technique has the ability to reduce radiation dose through their improvement in image quality compared with the current algorithms such as FBP and ASiR.

Disclosure Index

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