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 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 • VSGI21 • Room: N227 • Gastrointestinal Series: Emerging Issues in Abdominal CT
10:30-12:00 PM • MSAS22 • Room: S105AB • Global Health: Dose Reduction is Our Business (Sponsored by the Associated Sciences Consortium) (An Interactiv...
10:30-12:00 PM • SSC13 • Room: S403A • Physics (CT-Dose Modulation)
01:30-03:00 PM • MSAS23 • Room: S105AB • Reducing CT Dose (Sponsored by the Associated Sciences Consortium) (An Interactive Session)
01:30-02:45 PM • SPPH21 • Room: S102D • AAPM/RSNA Basic Physics Lecture for the Radiologic Technologist: Digital Imaging Exposure Indicators-Implicati...
01:30-05:45 PM • SPPH22 • Room: S102C • Physics Symposium: Uncertainties in Radiation Therapy 2
03:00-04:00 PM • SSE07 • Room: E353A • Gastrointestinal (CT Dose Reduction II)
04:30-06:00 PM • SPSI21 • Room: E351 • Special Interest Session: Image Wisely®: Update on Issues in Adult Radiation Protection
04:30-06:00 PM • SPSI22 • Room: N229 • Special Interest Session: Getting Radiologist Peer Review Right

Tuesday, December 03, 2013
08:30-10:00 AM • MSQI31 • Room: S406B • Quality Improvement: Safety at Work
08:30-10:00 AM • RC323 • Room: S404AB • Minicourse: Current Topics in Medical Physics-Radiation Dose Reduction in Medical Imaging
08:30-10:00 AM • RC329 • Room: E353B • HCC Diagnosis Using LI-RADS (An Interactive Session)
10:30-12:00 PM • MSQI32 • Room: S406B • Quality Improvement: Keeping our Customers Satisfied
01:30-03:00 PM • MSQI33 • Room: S406B • Quality Improvement: Strategies for Improving Patient Safety: Root Cause Analysis
03:00-04:00 PM • SSJ22 • Room: S403A • Physics (Population-Dose Survey)
03:00-04:00 PM • SSJ27 • Room: N230 • Vascular/Interventional (CTA: Dose and Contrast Reduction)
04:30-06:00 PM • RC429 • Room: E353C • MRI Safety Update (An Interactive Session)

Wednesday, December 04, 2013
07:15-08:15 AM • SPSC40 • Room: E350 • Controversy Session: MRI Contrast Use: Have Quality and Safety Collided?
08:30-10:00 AM • RC523 • Room: N226 • Minicourse: Recording and Reporting Radiation Dose: National and International Perspectives and Activities
08:30-10:00 AM • RC554 • Room: S401AB • Using RADIANCE for Dose Monitoring and Quality Assurance: A Hands-on Course
10:30-12:00 PM • ICII41 • Room: S501ABC • Next Generation IT Requirements for Improving Quality and Safety for Radiology
10:30-12:00 PM • SSK10 • Room: S102D • ISP: Health Service, Policy and Research (Quality and Reporting)
10:30-12:00 PM • SSK11 • Room: S405AB • ISP: Informatics (Quality and Safety)
12:30-02:00 PM • ICII42 • Room: S501ABC • Meaningful Use: Experience from Radiology Practices in Hospitals and Health Systems
03:00-04:00 PM • SSM23 • Room: E352 • Vascular/Interventional (Radiation Safety and Ergonomics)
03:40-04:40 PM • MSRT43 • Room: N230 • ASRT@RSNA 2013: The Role of the Radiologic Technologist in Patient Safety (HCIAC)
04:30-06:00 PM • SPSC42 • Room: N228 • Controversy Session: CT Radiation and Risk: How Certain Are We of the Uncertainties?
05:00-06:00 PM • MSRT44 • Room: N230 • ASRT@RSNA 2013: The Patient Experience - Our Shared Journey

Thursday, December 05, 2013
08:00-09:00 AM • MSRT51 • Room: N230 • ASRT@RSNA 2013: Moving Towards Best Practice: Developing National Guidelines through a Collaborative Approach
08:30-10:00 AM • RC623 • Room: N229 • Minicourse: Recording and Reporting Radiation Dose: Interventional/Angiography/Fluoroscopy
08:30-12:00 PM • VSCA51 • Room: S404CD • Cardiac Radiology Series: Cardiac Dual Energy CT
10:30-12:00 PM • SSQ04 • Room: S405AB • Chest (Radiation Dose Reduction)
10:30-12:00 PM • SSQ09 • Room: E353B • ISP: Genitourinary (Contrast and Safety Issues Involving the GU Tract)
10:30-12:00 PM • SSQ18 • Room: S102C • Pediatrics (Radiation Dose Reduction)
04:30-06:00 PM • RC723 • Room: E351 • Minicourse: Recording and Reporting Radiation Dose: CT
04:30-06:00 PM • RC754 • Room: S401AB • Using RADIANCE for CT Dose Monitoring and Quality Assurance: A Hands-on Course

Friday, December 06, 2013
08:30-10:00 AM • RC823 • Room: S403B • Minicourse: Recording and Reporting Radiation Dose: Nuclear Medicine
08:30-10:00 AM • RC830 • Room: S403A • Current and Next Generation Health IT Tools To Enable Radiation Exposure Reduction - A Practical Guide
08:30-12:00 PM • VSIR61 • Room: E451A • Interventional Radiology Series: Top 5 Complications in Interventional Oncology - Avoidance, Recognition and M...
10:30-12:00 PM • SST14 • Room: S403B • Physics (CT-Dose Optimization)

AAPM/RSNA Physics Tutorial for Residents: Control of Dose in Computed Tomography

Saturday, 12:00 PM - 02:00 PM • E351

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QA PH CT

SPPH01 • *AMA PRA Category 1 Credit* ™:2 • ARRT Category A+ Credit:2
Moderator
Richard J Massoth , PhD

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.

SPPH01A ● Factors that Affect CT Dose and Dosimetry Methods
Jerry A Thomas MS (Presenter) *

SPPH01B ● Image Reconstruction Techniques which Contribute to Patient Dose Reduction
Richard J Massoth PhD (Presenter)

SPPH01C ● Low Dose Protocols - Source and Review Methodology
Jerry A Thomas MS (Presenter) *

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

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QA PH CT

SPPH02 • *AMA PRA Category 1 Credit* ™:2 • ARRT Category A+ Credit:2
Moderator
Jerry A Thomas , MS *

LEARNING OBJECTIVES
1) To understand the differences in design and imaging reconstruction in commercial systems designed for CT imaging and aftermarket image post processing systems. 2) To appreciate the impact dose reduction techniques have on image quality and the clinical management of disease. 3) To develop a business model for incorporating dose reduction into CT imaging.

SPPH02A ● Image Equipment Overview - CT Dose Reduction Techniques
Jerry A Thomas MS (Presenter) *

SPPH02B ● Impact of Dose Reduction on Image Quality and Medical Diagnosis
Richard J Massoth PhD (Presenter)

SPPH02C ● Building a Business Case for Dose Reduction Technologies in CT
Jerry A Thomas MS (Presenter) *

Patient Assessment: Requirements, Reimbursement and Radiology Procedures (An Interactive Session)

Sunday, 10:30 AM - 11:30 AM ● S402AB

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QA HP

MSRA11 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Joy J Renner , MA, RT(R) *

LEARNING OBJECTIVES
This course will review the organizations and agencies who play a role in determining patient assessment requirements. The link between reimbursement and documented assessment will be addressed in various patient scenarios. The last segment of this session will review and highlight the focused patient assessments most common to radiology procedures.

Cardiac (Radiation Dose Reduction)

Sunday, 10:45 AM - 12:15 PM ● S504AB

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QA IR CT CA

SSA03 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Gregory W Gladish , MD
Moderator
Konstantin Nikolaou , MD *

SSA03-01 ● 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.

CONCLUSION
High-pitch prospectively ECG-triggered cCTA combined with iterative image reconstruction provides high diagnostic accuracy with a radiation dose below 1 mSv for detection of coronary artery stenosis in an unselected patient population.

CLINICAL RELEVANCE/APPLICATION
Continuous reduction in radiation exposure associated with cardiac CT should widen the clinical acceptance and application of this non-invasive test.

SSA03-02 ● Contrast Material and Radiation Dose Reduction Strategy for Triple-rule-Out Cardiac CT Angiography: Feasibility Study of Serial Non-ECG-Gated Low kVp Scan of the Whole Chest

Masafumi Kidoh ; **Takeshi Nakaura** MD (Presenter) ; **Shinichi Nakamura** MD ; **Kazunori Harada** ; **Shouzaburou Uemura** ; **Yasuyuki Yamashita** MD * ; **Tomohiro Namimoto** MD ; **Naritsugu Sakaino**

PURPOSE
The purpose of this study was to investigate the feasibility of a contrast material and radiation dose reduction triple-rule-out (TRO)-CT angiography (CTA) protocol with serial non-ECG-gated low kVp scan of the whole chest, which utilizes a recirculated contrast agent.

METHOD AND MATERIALS
This prospective study received institutional review board approval; prior informed consent to participate was obtained from all patients. The 60 enrolled patients were randomly assigned to 2 TRO-CTA protocols. Thirty patients were scanned with the new TRO-CTA protocol; after the coronary scan with retrospective ECG-gating, non-ECG-gated whole-chest CTA was performed at 80 kVp to evaluate aortic arch (AAr) and pulmonary trunk (PT). The other 30 patients were scanned by our conventional TRO-CTA protocol at 120 kVp with retrospective ECG-gating. We compared estimated effective dose (ED), CM (contrast medium) dose and contrast-to-noise ratio (CNR) of the ascending aorta (AAo) between the two protocols. We also compared the rate of patients who could achieve adequate AAr attenuation (160 HU) and adequate PT attenuation (200 HU) between the two protocols. Two-tailed Student﷽s t-test was used to compare CM dose, ED and CNR on new TRO-CTA and conventional TRO-CTA scans. To compare the success rate of adequate attenuations of the PT and AAr, we used the ?2 test.

RESULTS
The total ED of the new TRO-CTA protocol was significantly lower than that of the conventional protocol (23.5±2.6 mSv vs. 33.4±1.4 mSv, p0.05).

CONCLUSION
The new TRO-CTA protocol could feasibly reduce the total dose of radiation and the contrast dose and yielded adequate vascular enhancement compared with the conventional protocol.

CLINICAL RELEVANCE/APPLICATION
Triple-rule-out-CTA protocol with serial non-ECG-gated low kVp scan of the whole chest could feasibly reduce the total dose of radiation and the contrast dose compared with the conventional protocol.

SSA03-03 ● Assessment of Image Quality and Radiation Dose of Prospectively Triggered Adaptive Coronary CT Angiography: In Comparison with Retrospectively Gated Mode and High Pitch Mode

Yunling Wang (Presenter) ; **Hong Wang**

PURPOSE
The purpose of this study was to evaluate the image quality and radiation dose of dual-source computed tomography (DSCT) application in coronary computed tomography angiography (CTA), using three different modes: prospectively electrocardiogram (ECG)-triggered sequential scan mode, retrospectively ECG gated spiral scan mode and Flash spiral scan mode.

METHOD AND MATERIALS
Ninety eligible patients (47 males and 43 females, mean age 54.3 years), with heart rate within 60 to 80 beat per minute (bpm) and relatively regular heart rhythm (fluctuation =10bpm), were included in this study. They are randomly distributed into three groups: 30 patients in Group A using prospectively ECG-triggered sequential mode, 30 in Group B using retrospectively ECG-gated spiral mode and 30 in Group C using Flash spiral mode. The X-ray tube voltages were selected according to body mass index (BMI). Both the radiation dose and image quality were evaluated and compared, which were based on statistics analysis of image score, HU value standard deviation (SD), Signal-Noise Ratio (SNR, mean/SD), Contrast-Noise Ratio (CNR).

RESULTS
The mean image score in Group A is 3.36±0.39, with effective radiation dose of 5.12±0.77 mSv, SD of 17.8±0.51, SNR of 23.64±0.49, and CNR of 20.77±0.45. The mean image score in Group B is 3.58±0.51, with effective radiation dose of 6.79±0.41 mSv, SD of 18.8±0.46, SNR of 22.12±0.55, and CNR of 27.87±0.38. The mean image score in Group C is 1.47±0.62, with effective radiation dose of 0.89±0.81 mSv, SD of 15.1±0.44, SNR of 34.9±0.67, and CNR of 47.77±0.56. There were significant differences in the radiation dose and image quality among these three groups (p
CONCLUSION
The prospectively triggered mode has a better image quality and lower radiation dose, compared with retrospectively gated mode and Flash mode, which may be the first choice in CTA imaging.

CLINICAL RELEVANCE/APPLICATION
The prospectively triggered mode has a better image quality and lower radiation dose, compared with retrospectively gated mode and Flash mode, which may be the first choice in CTA imaging.

SSA03-04 ● 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 Huellner** MD ; **Andreas Brauchlin** MD ; **Ronny R Buechel** ; **Oliver Gaemperli** MD ; **Philipp A Kaufmann** MD

PURPOSE
Reduction of tube voltage and current for lowering radiation exposure from coronary CT angiography (CCTA) is associated with an increase in noise which may render images uninterpretable. We evaluated the impact of model based iterative reconstruction (MBIR) on noise reduction in ultra-low submillisievert dose CCTA.

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 ﷽ 100 kV; 150 ﷽ 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 ﷽ 40.2 kg/m^2), and the mean weight 75.1 ± 15.3 kg (range 46.5 ﷽ 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 ± 85HU to 563 ± 119 HU, and in RCA from 446 ± 63HU to 503 ± 83 HU (p
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.

CLINICAL RELEVANCE/APPLICATION
New reconstruction algorithms such as MBIR achieve efficient noise reduction allowing substantial radiation dose reduction in cardiac CT scanning.

SSA03-05 ● Dual Source Cardiac Computed Tomography Angiography (CCTA) in the Follow Up of Cardiac Transplant: 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 retrospective-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
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** ; **Najia 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 (20.52) in prospective ECG-triggered coronary CT angiography (CCTA) with low tube voltage.

METHOD AND MATERIALS
One hundred and eighty patients [heart rate: 56±4bpm, 20.52, and 190mA if BMI 22.5-25.0kg/m^2). 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 BMI2: the radiation dose for group A was 0.55±0.11mSv, 32% lower than the 0.81±0.09mSv for group B (p22.5kg/m^2: the radiation dose for group A was 0.73±0.09mSv, 35% lower than the 1.13±0.16mSv for group B (p0.05).

CONCLUSION
Prospective ECG-triggered CCTA with low tube voltage significantly reduces radiation exposure while maintaining acceptable image quality. For the patient population with BMI2, 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 BMI2.

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

In 25 patients undergoing standard low-dose contrast enhanced CCTA (100 – 120 kV; 450 - 700 mA) an additional same-day ultra-low dose (ULD) CCTA was acquired (80 - 100 kV; 150 - 210 mA) and reconstructed with MBIR. Two independent readers semi-quantitatively assessed image quality on a four-point Likert scale in each coronary segment (1: non-diagnostic, 2: good, 3: adequate, 4: excellent).

RESULTS
Over a wide range of weight (47 - 112 kg) and body mass index (18.4 - 40.2 kg/m^2), the mean DLP from standard and ULD CCTA 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 CCTA ($p < 0.001$). Intravenous beta-blockers were administrated for heart rate control prior to CCTA in 20 patients (80%) (10.8 ± 9.5mg, range 3 – 25 mg). The mean heart rate for standard and ULD CCTA 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 CCTA 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 CCTA, and 317 (96%) segments of ULD MBIR (p = ns).

CONCLUSION
Our results document the feasibility of CCTA 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
CCTA scanning with an ultra-low radiation dose may pave the way for the broad clinical implementation of CCTA as an alternative for the invasive coronary angiography.

SSA03-09 • Optimization of Radiation and Contrast Dose for Cardiovascular Computed Tomography

Yajuan Wang PhD (Presenter) * ; **Kassem Soufan** ; **Anjali Kottha** ; **Corey Kemper** PhD * ; **John F Kalafut** PhD * ; **Sandra S Halliburton** PhD *

PURPOSE
Lowering x-ray tube potential is an effective way to reduce both radiation exposure and contrast load from computed tomography (CT). This study evaluated a novel algorithm for optimizing both radiation and contrast dose at cardiovascular CT.

METHOD AND MATERIALS
67 patients referred for evaluation of thoracic aortic disease were imaged with a prospectively ECG-triggered axial technique on a 256-slice CT scanner (Brilliance iCT, Philips). X-ray parameters (tube potential,tube current) were determined from an attenuation measurement on the initial radiograph using a custom algorithm. Based on the tube potential, either 50 mL (100 kV) or 90 mL (120 kV) of contrast with a concentration of 370 mgI/mL was injected at a flow rate = 3.5 mL/s. Five circular regions of interest (ROI) were drawn at multiple locations in the lumen of the aorta along its length and the mean attenuation and standard deviation of attenuation (noise) were recorded. Average aortic attenuation, noise, and signal-to-noise ratio (SNR) were compared between 100 and 120 kV groups using Student's t test.

RESULTS
100 kV [n=40] and 120 kV [27] cohorts had similar age (62±15 vs 59±13 yrs) and height (1.74±0.10 vs 1.78±0.07 m). The cohort imaged at 100kV had significantly lower body mass index (25.7±2.8 vs. 32.0±3.2 kg/m^2) and percentage of males (67.5% vs. 92.6%). Patients scanned at 120 kV had a longer scan delay (33±8 vs. 26±4 s) but similar scan time (12±1 vs. 12±1 s) compared to 100 kV patients. Image quality metrics were equivalent between groups (aortic attenuation: 287±83 vs 281±48 HU; noise: 27±4 vs 26±3 HU; SNR: 11±3 vs 11±2) despite lower contrast dose (50 vs 90 mL) and effective radiation dose (1.8±0.3 vs 3.6±0.4 mSv) at 100 kV.

CONCLUSION
Simultaneous optimization of x-ray parameters and contrast protocols yielded equivalent image noise and blood enhancement across a range of patient sizes for cardiovascular CT. Smaller patients required 49% less radiation and 44% less contrast.

CLINICAL RELEVANCE/APPLICATION
Cardiovascular CT can be performed in smaller patients using lower radiation and contrast doses compared to those used for larger patients without compromising image quality.

Gastrointestinal (CT Dose Reduction I)

Sunday, 10:45 AM - 12:15 PM • E353A

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QA CT GI

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 Kalra** MD * ; **James A Brink** MD

PURPOSE
Recent data from lifespan study from Japanese Atomic Explosion 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
CONCLUSION
SSDE and estimated effective doses are suboptimal for cancer risk estimation and organ doses should be used for solid cancer radiation induced risk estimation, regardless of patient's age

CLINICAL RELEVANCE/APPLICATION
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

years), especially for risk estimations of lung, breast cancers

SSA06-02 ● Multi-reader Detectability of Simulated Low-contrast, Low-attenuation (LCLA) Liver Lesions on MDCT: Effect of Dose and Reconstruction Method

Ajit H Goenka MD (Presenter) ; **Brian R Herts** MD * ; **Nancy A Obuchowski** PhD ; **Andrew Primak** PhD * ; **Frank Dong** PhD * ; **Wadih 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-anthropomorphic phantom containing custom inserts with 36 spherical liver lesions of 3 sizes and attenuations (10 and 15-mm at 6, 12 and 18HU, and 5-mm at 12, 18 and 24HU below 90HU simulated liver) was scanned at 120kVp, 0.6-mm collimation, 200 (CTDIvol 13.49), 150, 100 and 50mAs 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 back projection (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
CONCLUSION
In this LCLA liver lesion 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.

CLINICAL RELEVANCE/APPLICATION
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 0.90) and any levels of ASiR reconstruction (0.90 vs 0.92). However, while ASiR yielded a significant decrease in specificity for lesion detection compared to FBP during the 1st session (0.81 vs. 0.62, 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
CONCLUSION
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.

CLINICAL RELEVANCE/APPLICATION
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 thorax 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 abdomen 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 as well as ATVS was used. Image attenuation and noise was measured in different abdominal and thoracic regions for each patient. To compare the CT density and image noise, signal-to-noise ratio, contrast-to-noise ratio and radiation parameters between both groups a 1-way analysis-of-variance was preformed.

RESULTS
The mean contrast-to-noise ratio and the signal-to-noise ratio of abdomen and chest CT scans was higher in group B if compared to group A (p
CONCLUSION
The simultaneous use of ATVS and ATCM allows for significant radiation dose reduction in abdominal and thoracic contrast enhanced CT examinations when compared to the use of ATCM alone while maintaining adequate image quality and diagnostic confidence without user interaction. 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.

CLINICAL RELEVANCE/APPLICATION
Simultaneous use of ATCM and automatic tube voltage selection allows for significant radiation dose reduction in abdominal/thoracic CT examinations of up to 18% when compared to ATCM alone.

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

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** MBBCh * ; **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-milli-Sievert (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 abdomen 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 suboptimal noise in submSv FBP and hIRT images, whereas noise was acceptable with pIRT. Except for minor pixilated appearance of pIRT images, no significant artifacts were seen. Noise power spectrum analyses showed hIRT retains the noise spectral signature as FBP, in spite of lowering the noise, whereas pIRT had lower noise as well as more regularized noise spectral pattern.

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 Purysko MD (Presenter) ; **Mark E Baker** MD * ; **Andrew Primak** PhD * ; **Erick M Remer** MD ; **Nancy A Obuchowski** PhD ; **Binu John** MD, MPH ; **Federico Aucejo** ; **Brian R 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.

CLINICAL RELEVANCE/APPLICATION
DE scanning protocols can be an alternative to decrease dose in patients undergoing HCC screening who require repetitive imaging.

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 strength levels (S1-S5). Two blinded radiologists recorded scores for the subjective image quality 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 by 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=0.965, HDCT=0.933, p>0.05; for reader 2, S0=0.963, S1-S5=0.964, 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, p<0.05 for S0>S1>S2>S3>S4>S5, p<0.05).
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%, 98.6%, 96.2% and 97.4 and low dose CT was 95.9%- 97.2%, 95.7%, 98.6% and 88%-91.7%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 peri-appendicial fluid and on low dose CT between acute appendicitis and hyperdense wall, periappendicial 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.

Physics (Low-dose CT Imaging)

Sunday, 10:45 AM - 12:15 PM • S404AB

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QA PH CT

SSA20 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Willi A Kalender , PhD *
Moderator
John M Boone , PhD *

SSA20-01 • Is Low-dose CT with Model-based Iterative Image Reconstruction an Advantageous Strategy for Reducing Radiation Dose in Follow Up of Patients with Testicular Cancer? Preliminary Results of a Prospective Study

Kevin Murphy MBBCh, MRCS (Presenter) ; **Lee Crush** MBBCh, FFRRCSI ; **Siobhan O' Neill** MBBCh ; **Micheal A Breen** MD ; **Adrian P Brady** FFRRCSI, FRCR ; **Paul Kelly** MBBCh ; **Derek Power** ; **Jackie Bye** BA * ; **Michael M Maher** MD, FRCR ; **Kevin N O'Regan** MD

CONCLUSION
MBIR facilitated a 66% reduction in ED while producing images that were comparable or superior to CD with standard reconstruction in

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

SSA20-02 ● Comparison of Hybrid (iDose) and Model-based (IMR) Reconstruction Techniques in Sub Milli-Sievert Chest and Abdominal CT: An Ongoing Prospective Blinded Study

Ranish D Khawaja MBBS, MD (Presenter) ; **Michael A Blake** MBBCh * ; **Garry Choy** MD, MS ; **Matthew D Gilman** MD ; **Mannudeep K Kalra** MD * ; **Subba 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 (submSv) chest and abdominal CT reconstructed with iterative model reconstruction (IMR) and iDose^4.

METHOD AND MATERIALS
In a prospective clinical study, 20 patients (BMI2, **chest**, n=10 *age range:*26-90; **abdomen**, n=10 *age range*:30-84) gave written informed consent for the acquisitions of submSv additional images (0.9mSv) on a 256-slice CT (iCT, Philips). In addition to their clinical standard-dose (SD) CT (chest: 2.9mSv; abdomen: 5.6mSv), submSv images were reconstructed with low-dose (LD) FBP, iDose^4 (idose levels ID_2, ID_4) and IMR (**i**1-5) techniques resulting in 9 stacks. Two thoracic and 3 abdominal radiologists independently evaluated in a blinded manner for *lesion detection*, *lesion margins*, *diagnostic acceptability* and *visibility of small structures*. Objective noise was measured in the descending thoracic aorta and abdominal aorta and noise spectral density (NSD) was obtained. Data were analyzed using Wilcoxon Signed Rank test and analysis of variance (ANOVA).

RESULTS
Lesion detection in abdominal CT (11 lymph nodes, 9 liver/renal lesions, and 8 kidney stones) and chest CT (31 lung nodules, and 10 ground glass opacities), and *lesion margin* evaluation was identical for SD-FBP, LD-FBP, iDose^4 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 iDose^4. Visibility of abdominal structures (adrenal glands and pancreatic contour), and overall diagnostic acceptability of submSv iDose and IMR were similar to SD-FBP (*kappa value* 0.72-0.88; p2,iD_4 and 51%-85% noise reduction with IMR (**i**1-5; p
CONCLUSION
Although lesion detectability is 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 iDose^4 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 milli-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 by 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 are 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
CONCLUSION
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) ; **Jiang 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 mgI/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 heart beats 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
SP80 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 -32.9 to 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)). 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 Kockelkoren (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) 61 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 and demographics, 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**

Bruners MD ; **Peter Isfort** MD ; **Andreas H Mahnken** MD * ; **Saskia Westphal** ; **Ruth Knuchel-Clarke** PhD ; **Christiane K Kuhl** MD *

PURPOSE
To systematically test the potential for dose savings in computed tomography (CT) through iterative reconstruction in a contrast enhanced human cadaveric model.

METHOD AND MATERIALS
Fifteen human cadavers scheduled for contrast enhanced virtual autopsy were injected with hyperdense contrast agent through the iliac arteries. A series of thoracic and abdominal tube current scaled CT scans (11 scans, 20mAseff - 200 mAseff in steps of 20mAs) were performed and reconstructed using standard filtered back projection (FBP) and iterative reconstruction algorithms (IR) in soft and sharp reconstruction kernels. The imaging datasets were evaluated in randomizedly and blinded to the reconstruction method by defining minimally necessary doses for CT quality criteria as defined in EU16262 (36 items, 17 thoracical, 6 mediastinal, 13 abdominal) independently by three radiologists (36x15x3x4=6480 data points). Minimal doses for every of the two reconstruction methods and kernel types in their respective applications were compared statistically.

RESULTS
In all subjects a sufficient contrast filling for further analysis was achieved. Average minimal doses for soft tissue applications (soft kernels) were 132.3±44.6 mAs (FBP) vs. 115.6±46.7 mAs (IR, p=0.0001), for bone and lung applications (sharp kernels) 140.9±47.1 mAs (FBP) vs. 130.9±49.1 mAs (IR, p=0.0001). The achieved amount of tube current saving were 12.6% (soft kernels) and 7.1% (sharp kernels).

CONCLUSION
In a blinded, randomized study, iterative reconstruction yielded a statistically significant dose saving in soft tissue and sharp kernel applications. While many publications claim dose savings of up to 5o% throughout the spectrum of CT vendors, the savings yield was considerably lower in this study. Most probably, the reason for this result is the comparison to lowest achievable doses also in standard algorithms (and not the usual 160-180mAs). Hence the dose savings numbers of iterative reconstruction of earlier studies might be partially explained by unused dose saving potential in standard FBP.

CLINICAL RELEVANCE/APPLICATION
The results give an insight in to how high the dose saving potential of iterative reconstruction but also filtered back projection is, potentially translating in to clinical CT parameter choices.

SSA20-08 ● Massive Dose Reduction and Image Quality Improvement Using a Commercial Iterative Reconstruction Algorithm in CT

Artur Latorre-Musoll MSc (Presenter) ; **Agustin Ruiz Martinez** MSc ; **Rosa M Pallerol Pinzano** ARRT ; **Pablo Carrasco De Fez** PhD ; **Teresa Eudaldo Puell** PhD ; **Nuria Jornet Sala** PhD ; **Montserrat Ribas Morales** PhD

CONCLUSION
Dose reductions up to 66% with no significant loss of image quality can be achieved using iDose compared to FBP algorithm. In the light of these promising results, iDose is increasingly used in our hospital. As dose and image quality should be balanced according to patient needs, we are presently studying the adequate choice of iDose level using clinical data.

Background
Radiation exposure from medical imaging has become a public health concern due to the increasing use of CT. Attempts to lower the radiation dose associated with CT studies are limited by image noise on FBP-based reconstructions. We assessed the dose reduction capabilities and in-phantom image quality metrics of a commercial iterative reconstruction algorithm.

Evaluation
We compared the performance of the iterative reconstruction algorithm iDose to the standard FBP algorithm supplied with the 256-slice MDCT Brilliance iCT (Philips Healthcare). We used a Catphan 504 (The Phantom Laboratory) to assess image quality in terms of CT number calibration, image noise, low contrast detectability and spatial resolution. We reconstructed 35 helical acquisitions (varying kV and mAs/slice) using FBP and 6 noise reduction levels provided by iDose. We measured the dosimetric index $CTDI_{vol}$ of all acquisitions using the solid state detector/multimeter CT Dose Profiler/Barracuda (RTI Electronics) and a phantom assembled with 3 standard PMMA body phantoms of 32 cm diameter and 3x15 cm length.

Discussion
CT number calibration obtained using iDose levels and FBP was compatible within 1%. iDose reduced image noise from 10% (iDose1) to 41% (iDose6) compared to FBP, regardless of the $CTDI_{vol}$ of the study. Conversely, the dose reduction capability of iDose ranged from 19% (iDose1) to 66% (iDose6) maintaining the same image noise as FBP. These results are compatible with the manufacturer's specifications. Low contrast detectability improved compared to FBP, as contrast-to-noise ratio increased because of the noise reduction: from 11% (iDose1) to 71% (iDose6). Spatial resolution improved slightly compared to FBP. However, we are now devising new measurements to fully quantify the iDose spatial resolution capabilities.

SSA20-09 ● Evaluation of TV-minimization-based Reconstruction for Low-dose Dedicated Breast CT

Junguo Bian PhD (Presenter) ; **Kai Yang** PhD ; **Xiao Han** MSc ; **Karen K Lindfors** MD * ; **Erik A Pearson** BS, BEng ; **Emil Y Sidky** PhD ; **John M Boone** PhD * ; **Xiaochuan Pan** PhD *

PURPOSE
Current dedicated breast CT is of low SNR in projection data and high noise in reconstruction images because a small imaging dose is distributed into large number of projections. The small contrast and fine structure of breast tissues, together with low-SNR data has made reconstruction improvement from low-dose breast-CT data very challenging. We have developed and tailored a TV-minimization based reconstruction algorithm for breast CT and performed reconstruction for more than 10 patient cases. In the work, we evaluated the image quality of TV-minimization-based reconstructions against images currently reconstructed by use of FBP algorithm. We demonstrate that image quality can be improved over the currently used FBP-based algorithms for low-dose breast CT.

METHOD AND MATERIALS
The reconstruction is formulated into a constrained-TV-minimization problem. We developed and tailored an ASD-POCS algorithm for solving the problem. Patient data were collected during an ongoing clinical trial performed at UC-Davis. We performed reconstruction of the whole volume for more than 10 patient cases from the low-SNR data. Special attention was paid to minimize the blocky appearances that are typically observed in images reconstructed by use of TV-minimization-based algorithms from low-dose data sets. We use the difference between adjacent slices to quantify quantum noise and use the power-law exponent, Beta, fitted from log-log plot of the image power spectra to quantify anatomical noise. A smaller Beta value for the reconstruction images indicates a better observer performance on lesion detection. We also performed a 2AFC experiment in which the observers were asked their preference between images currently reconstructed by use of FBP and the proposed algorithms.

RESULTS
Visual inspection shows images reconstructed with proposed algorithm have improved contrast and details. The noise variances and beta values are consistently smaller for image reconstructed with the proposed algorithm. The results of 2AFC study also show observers' preference of images reconstructed by use of the proposed algorithm over those currently reconstructed by use of FBP algorithms.

CONCLUSION
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

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QA PR HP

MSRA12 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Douglas E Pfeiffer , MS *

LEARNING OBJECTIVES
This session will include a discussion of current methods and trends toward reducing patient radiation dose with highlihgts 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

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QA GI

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 imgaging 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

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QA GU

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 managment and its imperitive 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

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QA IN

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 pracitce can create and adopt quality metrics to help drive performance improvement. We will use case examples to demonstarte how measuring quality can help improve performce 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

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QA PR LM

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

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QA PH

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

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QA HP MR

RC229 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5

Jeffrey C Weinreb , MD *
Emanuel Kanal , MD *

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

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QA CT

RC251 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5

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.

RC251A • General Image Quality Session: Interactive Discussion on Image Quality Parameters Such As Noise, Contrast, Sharpness, and Artifacts at Different Dose Levels

Mannudeep K Kalra MD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

ABSTRACT
Using CT images acquired at different dose levels, radiologists will learn about general image quality metrics, such as image noise, sharpness, contrast, texture and artifacts. In addition, they will learn from images, how dose and different scan parameters affect these image quality metrics. In order to accomplish this, radiologists will scroll through clinical cases at different dose points in different body regions. Next, the radiologists will learn about the specific effects of dose on lesion detection and appearance. In this section, radiologists will go through multiple series of CT images at different dose levels to assess the effect of changing dose on specific lesion and image appearance for specific lesion types. They will be asked to perform a directed search for structures and lesions, some of which will exist and others will not exist in the provided datasets. At the end of each case, they will get to see the specific example template protocol for at least two scanner vendors. This course will help radiologists understand the need for specific clinical indication and size driven protocols.

RC251B • Lesion Detection: Multi-Dose CT Images with Clinical/Pathology Correlation

Mannudeep K Kalra MD (Presenter) * ; **Donald P Frush** MD (Presenter) ; **Sarabjeet Singh** MD (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

Gastrointestinal Series: Emerging Issues in Abdominal CT

Monday, 08:30 AM - 12:00 PM • N227

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QA CT GI

VSGI21 • *AMA PRA Category 1 Credit* ™:3.25 • ARRT Category A+ Credit:4

Moderator
Giles W Boland , MD
Moderator
Jonathan B Kruskal , MD, PhD *

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 abscess (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.

METHOD 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, patient maximum skin to skin diameters, 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-Philips (n=724). Abdominal CT were performed with several clinical protocols, including routine abdominal CT (n=2963), stone/ hematuria (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),16 GE (n=220, 10.5±3.8 mGy), and 256-Philips (n=144, 8.4±5 mGy). Routine abdominal CT were stratified in 4 weight groups, less than 135lbs (n=683, 6±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 ; **Zhoubo Li** ; **Armando Manduca** PhD * ; **Daniel J Blezek** PhD ; **David M Hough** MD ; **Sudhakar K Venkatesh** MD, FRCR ; **Gregory C Brickner** MD ; **Joseph G Cernigliaro** MD ; **Amy K Hara** 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 (LT's), 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 LT's). Presence of LT's 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 (abd) 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 LT's, with true positives correctly localized and classified. A limit of non-inferiority of -0.1 was defined a priori.

RESULTS
There were 73 LT's 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 ($p < 0.03$ 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.

VSGI21-06 ● 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, $CTDI_{vol}$, 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 345.8, 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
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.

VSGI21-08 ● 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 capabilites.

VSGI21-09 ● 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=33) and fatty liver infiltration (n=13) were accurately detected on MMD-VUE images. The mean HU on MMD-VUE demonstrated good to excellent correlation with TUE values for liver (r=0.85), kidney (r=0.7), muscle(r=0.82) and fat (r=0.9). The mean attenuation difference (HU) between TUE-VUEa, TUE-VUEd and VUEa-VUEd for liver, kidney, muscle and fat was
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.

VSGI21-10 ● 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 from 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, reflect 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 perfusion 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 52-150ml/100ml/min and BV 22-50ml/100ml). Neuroendocrine tumors showed the highest perfusion values (BF 122-260ml/100ml/min and BV 30-40ml/100ml) in comparison to normal pancreas. Cystic pancreatic tumors showed the least perfusion values (BF 0.2-34ml/100ml/min and BV 0.5-15 ml/100ml) followed by adenocarcinoma (BF 2.8-36ml/100ml/min and BV 0.5-18 ml/100ml), 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's correlation test 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/ 100mL/min, BV = 11.80 ml/100mL, AP = 41.86 mL/min/100mL, TLP = 47.24 mL/min/100mL, HPI = 87.88%, PS = 16.03 ml/100mL/min, PP = 5.37 mL/min/100mL, $p < 0.05$). 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

Quantitative assessment of hepatic perfusion using perfusion CT and IVIM-DWI can provide important information about the hepatic perfusion of HCC.

VSGI21-14 ● Panel Discussion

Global Health: Dose Reduction is Our Business (Sponsored by the Associated Sciences Consortium) (An Interactive Session)

Monday, 10:30 AM - 12:00 PM ● S105AB

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QA

MSAS22 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Michael D Ward , PhD

MSAS22A ● Promoting a Radiation Safety Culture in Europe: The Role of European Union Projects

Graciano N Paulo MSC, RT (Presenter)

LEARNING OBJECTIVES
1) To comprehend the importance of European Union (EU) Projects for promoting a Radiation Protection safety culture. 2) To understand the structure of the European Radiation Protection Organizations. 3) To critically analyze the results of some of the EU projects. 4) To know the Role and structure of of European Federation of Radiographer Societies (EFRS). 5) To understand the contribution of EFRS in EU projects.

ABSTRACT
In the past years there have been several European Union (EU) projects dedicated to Radiation Protection area, mostly promoted by the Directorate General of Energy (DG ENER) from the European Commission (EC). The majority of these projects were related to topics from the EURATOM 97/43 Directive (known as the MED), that constitutes an European Law that all Member States are obliged to transpose to their National legislation system. During this presentation a special focus will be given to: (a) Clinical Audit Guidelines (a tool developed to facilitate the implementation of clinical audit programs in medical imaging and radiotherapy departments; (b) EMAN (European Medical ALARA Network - dedicated to optimization in medical field); (c) MEDRAPET (Medical Radiation Protection Education and Training - dedicated to develop guidelines for E&T in RP for Health Professionals); (d) DOSEDATAMED II (dedicated to collect dose distributions from medical radiodiagnostic procedures from EU member states); One of the main relevant point of all these EU projects is the fact that they were made on a multi stakeholders model, based on the contribution of Organizations representing EU regulators, Radiologists, Radiographers, Medical Physicists, Research Centers, amongst others. In conclusion this presentation will give an overview of all these projects, the respective results and the importance that they have in promoting a Radiation Protection Culture in Europe.

MSAS22B ● Promoting Radiation Safety in Imaging Worldwide

Donna E Newman (Presenter)

LEARNING OBJECTIVES
1) You will learn about the ISRRT involvement in global initiatives that promote best radiography practice, education and standards in developing countries. We will review several Partnerships with WHO, PAHO and Local associations that helped facilitate dose reduction this past year at workshop and conferences. 2) You will learn how the ISRRT involvement in global initiatives and international standards serves as the voice for technologists internationally.; The ISRRT cooperates and communicates with international organization that address medical imaging, health care, patient safety, radiation protection. 3) You will learn how the ISRRT participates as a member state in projects relating to radiological protection in medical exposure for the IAEA and WH.

ABSTRACT
Promoting Radiation Safety in the Imaging Worldwide You will learn about the ISRRT involvement in global initiatives help facilitate global dose reduction threw the use of Workshops and conferences in developing countries. Also about the ISRRT's Campaign for safe use of radiation in developing countries through the use of workshops You will learn how the ISRRT promotes radiography practice, education and standards in developing countries to help ensure dose reduction with the use of workshops and conferences. We will review several Partnerships with WHO, PAHO and Local associations that helped facilitate dose reduction in various areas of radiology this past year :Caribbean/ Jamaica/mammography partnership with PAHO, Cameroon/ Partnership with French Local Organization ,Lithuanian partnership with EFRS European organization Malawi/ QA and Pattern Recognition and Zambia/Image interpretation. You will learn how the ISRRT involvement in global initiative and international standards help promote radiation reduction by acting as a stakeholder and the voice for technologists internationally. ISRRT cooperates and communicates with international organization that address medical imaging, health care, patient safety, radiation protection for example, Smart Card/Smart RAD Track and the IAEA WHO/IRQN Referral Guidelines project. You will learn how the ISRRT participates as a member state in projects relating to radiological protection of patient and protection in medical exposure for the IAEA and WHO. We will discuss several of the project and documents that have been developed and review by our organization. Several example of this are the WHO/Radiation risk communication in pediatric imaging IAEA's Training material on Radiation protection in diagnostic and interventional radiology , digital Radiology Annals Reports of the ICRP, Basic Safety Standards Review and Safety guides and
Justification of medical exposures IAEA Technical meeting.

Physics (CT-Dose Modulation)

Monday, 10:30 AM - 12:00 PM ● S403A

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QA PH CT

SSC13 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Michael F McNitt-Gray , PhD *
Moderator
James T Dobbins , PhD *

SSC13-01 ● Experimental Validation of Shaped Filter Design with Variable Source-to-Filter Distance for Breast CT with Respect to Image Quality and Dose

Ferdinand Lueck 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 but 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 patients 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 diaphragms 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 (SD) and minimum and maximum mA values.

METHOD AND MATERIALS
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.

SSC13-05 ● Towards Accurate Monte Carlo Simulations of Tube Current Modulation CT Dosimetry: Model Validation and Technical Considerations

Kyle McMillan (Presenter) * ; **Maryam Khatonabadi** * ; **Christopher H Cagnon** PhD ; **John J Demarco** PhD ; **Michael F McNitt-Gray** PhD *

PURPOSE
The purpose of this study is to establish the appropriate level of detail needed within Monte Carlo models to accurately simulate dose from tube current modulation (TCM) CT scans of patients.

METHOD AND MATERIALS
A Monte Carlo model was developed in MCNPX for use in CT dose quantification. In order to validate the suitability of this model to accurately simulate patient dose from a TCM CT scan, a two-part validation scheme was devised. In the first phase, relatively simple geometries requiring varying levels of x-, y- and z-modulation were explored, including a cylindrical CTDI phantom, an elliptical body phantom and a rectangular water equivalent phantom. In the next phase, a more complex anthropomorphic phantom was investigated. Each phantom was scanned in a Siemens Sensation 64 scanner under the conditions of fixed tube current (FTC) and TCM. Dose measurements were made at various surface and depth positions within each phantom. Simulations using each phantom were performed for FTC, full x-y-z TCM and z-axis (along patient length) only TCM, and dose was tallied at the same locations where measurements were obtained.

RESULTS
For simple geometries, the average absolute difference between the FTC measurements and simulations was 4.6%. The difference between TCM measurements and full TCM and z-axis only TCM simulations was 4.1% and 9.7%, respectively. Dose differences in the water equivalent phantom, whose rectangular shape contains considerably more x-y modulation than the other phantoms, were as high as 37.2% when z-axis only TCM was simulated. For the anthropomorphic phantom, the difference between TCM measurements and full TCM and z-axis only TCM simulations was 1.2% and 8.9%, respectively. For FTC measurements and simulations, the difference was 1.6%.

CONCLUSION
This work exhibited good agreement between measured and simulated values under both simple and complex geometries including an anthropomorphic phantom. This work also showed the increased dose differences for z-axis only TCM simulations, which demonstrates the importance of using full TCM data for Monte Carlo simulations.

CLINICAL RELEVANCE/APPLICATION
Results from this investigation highlight details that need to be included in Monte Carlo simulations of TCM CT scans in order to yield accurate, clinically viable assessments of patient dosimetry.

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.

SSC13-07 ● Realistic Dose Distribution in Helical Abdominal/Pelvis Scans - Fixed mA vs. Z-directional and Angular mA

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 luminance 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's, 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 * ; **Xinming 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 Radiosensitive 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 radiosensitive 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 (
RESULTS
Thought the total mAs delivered per 360° is unchanged with organ-based TCM patient dose was reduced respect to the standard protocol, with a decreasing trend in function of increasing patient size (R2= 95%, range 25% to 4% dose reduction). The dose to the breasts, lungs, heart and thyroid was also decreased, due to the lower dose to the anterior respect to the posterior side of the patients and showed an increasing trend with patient size, (R2= 92, range 23%-36% for breasts, R2= 84, range 0% to 6% for lungs , R2= 92, range 11% to 48% for the heart and R2= 85, range 0% to 21% for the thyroid). Noise was not significantly increased (p>0.05) with organ-based TCM.

CONCLUSION
Organ-based TCM allows for reduction of organ doses (breasts, lungs, heart and thyroid) and the reduction increases with patient size. Indeed the higher tube current in the posterior views is contributing to the organ doses more in small (less attenuating) patients. Patient dose is also reduced but the effect is smaller for larger patients, possibly because dose to the spine and bone marrow increases.

CLINICAL RELEVANCE/APPLICATION
Compared with routine chest CT examination, CT with organ-based TCM reduces dose to radiosensitive organs in the thorax and the reduction increases with patient size. Image quality was not affected.

Reducing CT Dose (Sponsored by the Associated Sciences Consortium) (An Interactive Session)

Monday, 01:30 PM - 03:00 PM ● S105AB

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QA CT

MSAS23 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Ellen Lipman , MS, RT

MSAS23A • Going Beyond the Protocol: A Comprehensive Approach to Optimizing CT Dose and Quality

Phuong-Anh T Duong MD (Presenter)

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 dose 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

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QA PH

SPPH21 • *AMA PRA Category 1 Credit* ™:1.25 • ARRT Category A+ Credit:1.5
Moderator
Douglas E Pfeiffer , MS *
Eric L Gingold , PhD
Charles E Willis , PhD

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 limiations of exposure indicators.
ABSTRACT
URL

Physics Symposium: Uncertainties in Radiation Therapy 2

Monday, 01:30 PM - 05:45 PM • S102C

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QA PH RO

SPPH22 • *AMA PRA Category 1 Credit* ™:4 • ARRT Category A+ Credit:4.5

LEARNING OBJECTIVES
1) Describe the limitations of traditional QA/QM programs in radiation oncology. 2) Understand the rationale for establishing risk-based QA/QM programs in radiation oncology. 3) Learn how to apply FMEA methodology in radiation oncology.

SPPH22A • New Paradigms of QA/QM

Jatinder R Palta PhD (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

ABSTRACT
The increasing complexity, functionality, and site-to-site variability of modern radiation therapy planning and delivery techniques challenge the traditional prescriptive quality assurance/quality management (QA/QM) programs that ensure safety and reliability of treatment planning and delivery systems under all clinical scenarios. The manufacturing industry has historically relied on extensive testing and use of techniques such as probabilistic reliability modeling for developing and maintaining new products. Among the most widely used method 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

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QA CT GI

SSE07 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Moderator
Meghan G Lubner , MD
Moderator
Rizwan Aslam , MBBCh *

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 (17/35), 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, patient off centering and repeats are avoidable factors. Scanning with arms by the side 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 30 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 (iDose^4) 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-, iDose^4-, 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 iDose^4 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±0.9) and B (8.9±0.8) didn't show significant difference with conventional scan. In the large BMI group, the CTDI of protocol A were significant lower than 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 duel 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 (CTDIvol). 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 CTDIvol 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.

SSE07-05 ● 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 suspicious 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 observer's 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
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.

Special Interest Session: Image Wisely®: Update on Issues in Adult Radiation Protection

Monday, 04:30 PM - 06:00 PM ● E351

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QA

SPSI21 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
James A Brink , MD
Moderator
Richard L Morin , PhD

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.

SPSI21A ● Image Wisely® Update

James A Brink MD (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

SPSI21B ● Dose Registries: Rationale and Implementation

Richard L Morin PhD (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

SPSI21C ● What Patients Want to Know before Their Radiologic Exams

Andrew T Trout MD (Presenter) ; **Jay K Pahade** MD (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

SPSI21D ● Working with Payers on Radiation Protection Programs

Christoph Wald MD, PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

SPSI21E ● CT Dose Issues: State Regulations, Accreditation, and Real-life Scenarios

Robert K Zeman MD (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

Special Interest Session: Getting Radiologist Peer Review Right

Monday, 04:30 PM - 06:00 PM ● N229

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QA

SPSI22 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Joseph R Steele , MD *

SPSI22A ● Options for Radiologist Peer Review

David B Larson MD (Presenter) *

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

SPSI22B ● Peer Review of Procedural Radiologists

Joseph R Steele MD (Presenter) *

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

SPSI22C ● Peer Review as your PQI Project

Bettina Siewert MD (Presenter)

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 neccessary 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 neccessary documentation.

URL

Quality Improvement: Safety at Work

Tuesday, 08:30 AM - 10:00 AM ● S406B

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QA

MSQI31 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Co-Director
Jonathan B Kruskal , MD, PhD *
Co-Director
James V Rawson , MD
Moderator
Lane F Donnelly , MD *

LEARNING OBJECTIVES
1) To understand multiple aspects of safety in radiology including the importance of an effective daily management system, staff safety, and risk management.
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.

MSQI31A ● The Daily Management Huddle - A Paradigm for Safe Practice

Lane F Donnelly MD (Presenter) *

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.

MSQI31B ● 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 sticks resulting in exposure to body fluids. Strategies to mitigate or prevent such risks include ergonomics initiatives for radiologists and technologists, appointment of a radiation safety officer to ensure compliance with radiation dose guidelines and policies, and use of equipment that prevents exposure to body fluids. In addition, there are regulations and guidelines from various government bodies on occupational radiation dose limits, handling of isotopes and chemotherapy agents, contact with patients with airborne infections, 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 adminstrative 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 essenve, risk management deals with 'identification if legal risk, prioritization of identified risk, determination of proper organizational response to risk, management of recongized risk causes with the goal of minimzing 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

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QA PH

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

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. 2) Provide a wider dynamic range of patient thickness and reduce the patient exposure at the same time. 3) And, to identify there is a need to establish a hospital wide radiation monitoring and tracking system (HWRM).

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.

RC323C ● CR and DR Dose Reduction and Clinical Management

Charles E Willis PhD (Presenter)

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.

HCC Diagnosis Using LI-RADS (An Interactive Session)

Tuesday, 08:30 AM - 10:00 AM ● E353B

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QA MR GI

RC329 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5

RC329A ● MRI features

Benjamin M Yeh MD (Presenter) *

LEARNING OBJECTIVES
1) Review underlying clinical scenarios that predispose patients to develop hepatocellular carcinoma. 2) Understand typical imaging appearances at MR imaging such that when characteristic imaging features are seen in the correct clinical setting, we can be certain that the diagnosis is hepatocellular carcinoma. 3) Describe variant features and secondary signs that are either suggestive of, or argue against, the diagnosis of hepatocellular carcinoma.

ABSTRACT

RC329B ● LI-RADS Principles

Cynthia S Santillan MD (Presenter)

LEARNING OBJECTIVES
1) To familiarize radiologists with the Liver Imaging Reporting and Data System (LI-RADS) and its associated lexicon, atlas, and reporting recommendations. 2) To review the categories for liver observations in LI-RADS. 3) To demonstrate how to access and use the algorithm for determining the category of a liver observation.

ABSTRACT

RC329C ● LI-RADS Cases

Reena C Jha MD (Presenter) *

LEARNING OBJECTIVES
We will review LI-RADS categories, and criteria for classification by means of clinical cases. Classic and atypical cases will be presented with audience participation to reinforce the LI-RADS algorithm.

ABSTRACT

RC329D ● Reporting LI-RADS Results

Mustafa R Bashir MD (Presenter) *

LEARNING OBJECTIVES
1) To discuss standards for liver lesion reporting, using the Liver Imaging Reporting and Data System (LI-RADS).

ABSTRACT
The Liver Imaging Reporting and Data System (LI-RADS) includes a reporting template for contrast-enhanced CT and MRI, and minimum reporting standards. This talk will discuss those reporting standards and provide tips for clear and concise reporting.

Quality Improvement: Keeping our Customers Satisfied

Tuesday, 10:30 AM - 12:00 PM ● S406B

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QA

MSQI32 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Co-Director
Jonathan B Kruskal , MD, PhD *
Co-Director
James V Rawson , MD
Moderator
Jonathan B Kruskal , MD, PhD *

MSQI32A ● Creating a Comprehensive Customer Service Program in Radiology

Alex Towbin MD (Presenter) *

LEARNING OBJECTIVES
1) Describe the needs of the different types of customers a radiology department serves. 2) Describe a customer service program that meets the needs of the different customers a radiology department serves. 3) Describe metrics used to evaluate the quality of customer service.

MSQI32B ● Achieving Almost Perfect Service Excellence: The Specifics
Ella A Kazerooni MD (Presenter)

MSQI32C ● Branding and Marketing Your Imaging Services
Giles W Boland MD (Presenter)

Quality Improvement: Strategies for Improving Patient Safety: Root Cause Analysis

Tuesday, 01:30 PM - 03:00 PM • S406B

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QA

MSQI33 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Co-Director
Jonathan B Kruskal , MD, PhD *
Co-Director
James V Rawson , MD
Moderator
James V Rawson , MD

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

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QA PH

SSJ22 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Moderator
Mitchell M Goodsitt , PhD *
Moderator
Dianna D Cody , PhD *

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 predominately 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

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.

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**

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 [0.73mSv (interquartile range, 0.55-1.18) vs. 1.53mSv (1.15-2.42), p
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

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.

Background
Deviation Index (DI) expresses the deviation in image receptor dose utilized for a digital radiograph relative to a target value. The AAPM Report 116 recommends a desirable operating range of the DI to be between ±0.5. The goal of this work was to quantify the spread in the DI for radiographs under real-world clinical conditions.

Evaluation
IRB exemption was obtained. The DI values were evaluated for radiographs obtained using storage phosphor and flat-panel digital radiography systems at a tertiary medical center and an affiliated community hospital (Jan-2012 to Mar-2013). Descriptive statistics for the DI and percent cases within ranges listed in AAPM Report 116 were computed as a function of exam location and type.

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±2.5; amongst these, radiographs of the chest were most frequent (58%) with a mean±SD for the DI of 0.9±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.

Vascular/Interventional (CTA: Dose and Contrast Reduction)

Tuesday, 03:00 PM - 04:00 PM • N230

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QA IR CT VA

SSJ27 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Moderator
Dominik Fleischmann , MD *
Moderator
Geoffrey D Rubin , MD *

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 ($CTDI_{vol}$), the effective dose (ED)] 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),(pvol and ED for group A (15.89mGy and 0.24mSv) were significantly lower than those in group B (28.25mGy and 0.42mSv), (both p
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

BMI=25.

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). $?t_{>200HU}$ 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 CT_{max} 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 mgI/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 signficant higher in optimal contrast than simulated 120 kVp group (AA: 358.4 ± 35.9 vs. 276.7 ± 34.9 HU, $p < 0.001$; DA: 325.8 ± 41.1 vs. 258.1 ± 31.2 HU, $p < 0.001$; 350.7 ± 44.3 vs. 271.5 ± 29.5 HU, $p < 0.001$). The noise of optimal contrast was signficant higher than the simulated 120 kVp images in the aorta, but not on the muscles. The SNR was signficantly different between two groups. The CNR of optimal contrast was signficantly higher than simulated 120 kVp images (AA: 12.4 ± 1.8 vs. 7.0 ± 1.5, $p < 0.001$; DA: 11.1 ± 2.1 vs. 6.5 ± 1.5, $p < 0.001$; 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

An authentic low-dose simulation from actual CT examinations opens up important opportunity with regard to staff education, protocol optimization and introduction of new reconstruction techniques.

SSJ27-05 • Reduced Iodine Dose Single Source Dual-energy CT Angiography of Abdomen for Assessment of Aorto-Iliac 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 reduce 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 (Iodixinol, 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. Readers also 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 ; **Toshiharu 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^2/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 with 240-80 group (7.8-15.3) were greater for the abdomen ($P < .05$) 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

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QA MR

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 managing 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 BS, RT (Presenter) *

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 lean 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 over1419 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.
3. Schedule MR exam.
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

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QA MR

SPSC40 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Moderator
Thomas M Grist , MD *
Jeffrey C Weinreb , MD *
Martin R Prince , MD, PhD *

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
URL

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

Wednesday, 08:30 AM - 10:00 AM • N226

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QA PH

RC523 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Director
J. Anthony Seibert , PhD

URL's
www.imp.uni-erlangen.de/RSNA2012

RC523A • 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

RC523B • The European Perspective

Willi A Kalender PhD (Presenter) *

LEARNING OBJECTIVES
1) Understand that CTDI is merely a technical concept for scanner acceptance and constancy testing, but not a measure for patient dose. 2) Learn about concepts for patient- and scanner-specific patient dose estimates. 3) Learn about the concept of diagnostic reference levels and its strengths and weaknesses.

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

reference levels (DRL). DRLs for radiological examinations in the European Union were demanded by law already in 2000.
Patient dose assessment relies predominantly on pre-tabulated values generated for anthropomorphic and voxel phantoms. Efforts are underway to provide more patient-specific dose estimates (PSDE) independent of CTDI phantom measurements.
The lecture will review the above concepts and will point to both strengths and weaknesses.

RC523C ● Informatics Tools for Recording/Tracking Dose

Kevin O'Donnell (Presenter) *

LEARNING OBJECTIVES
1) Understand how DICOM Radiation Dose SR (RDSR) captures procedure dose information, the modalities and details covered. 2) Understand how the IHE Radiation Exposure Monitoring Profile (REM) coordinates the capture and management of RDSR objects and how it can be applied in a radiology practice. 3) Understand how 'CT dose screens' from legacy scanners can be ported into RDSR. 4) Understand how to apply the pre-scan dose pop-ups on the CT console specified in the MITA CT Dose Check (XR-25) standard. 5) Understand how to specify the above standards and features when purchasing and integrating radiology systems.

Using RADIANCE for Dose Monitoring and Quality Assurance: A Hands-on Course

Wednesday, 08:30 AM - 10:00 AM ● S401AB

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QA IN

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 packaged 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 (CTDIvol) 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

Next Generation IT Requirements for Improving Quality and Safety for Radiology

Wednesday, 10:30 AM - 12:00 PM ● S501ABC

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QA IN

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 improving 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

Luciano M Prevedello MD,MPH (Presenter)

LEARNING OBJECTIVES
View learning objectives under main course title.

ISP: Health Service, Policy and Research (Quality and Reporting)

Wednesday, 10:30 AM - 12:00 PM • S102D

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QA HP

SSK10 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:0.5
Moderator
Edward Y Lee , MD, MPH
Moderator
Jeffrey G Jarvik , MD, MPH *

SSK10-01 • Health Service, Policy and Research Keynote Speaker: Pragmatic Trials-Real World Research for Real World Problems
Jeffrey G Jarvik MD, MPH (Presenter) *

SSK10-02 • Structured Reporting of Incidentally Detected Hepatic Steatosis in Abdominal CTs: Impact on Physician Practices and Patient Management

Surabhi Bajpai MBBS, DMRD (Presenter) ; **Andrew P Wright** MD ; **Kathleen Corey** MD ; **Debra A Gervais** MD * ; **Dushyant V Sahani** MD

PURPOSE
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 to 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 documentation rates, and 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.

SSK10-03 • Assessing Competence of Non-physician Providers Trained in Point-of-Care Obstetrical Ultrasound in Under-resourced Settings of Western Kenya

H. B Harvey MD, JD (Presenter) ; **Daniel Price** MD ; **Roy Ahn** MPH ; **Garry Choy** MD, MS ; **Giles W Boland** MD ; **Thomas Burke** MD *

PURPOSE
Hand-held ultrasound machines have the potential to positively impact infant and maternal mortality in the developing world by identifying patients with high risk conditions that should deliver in a hospital setting. However, due to the paucity of radiologists in the developing world, training of non-radiologist clinicians in point-of-care ultrasound is essential. We trained a select group of nurse midwives in resource-limited areas of Western Kenya and empowered them to implement antenatal ultrasound screening programs in their hospitals and clinics. At least six months after training, we evaluated their retained obstetrical ultrasound skills.

METHOD AND MATERIALS
From February 2011 through August 2012, nine nurse midwives underwent an intensive one-week training course to perform and interpret point-of-care ultrasound examinations followed by a few weeks of supervised on-the-job training. Approximately six months after completion of training, fellowship trained sonographers subjected the providers to an objective structured clinical examination (OSCE) on two patients. The OSCE graded their ability to assess gestational number, gestational age, fetal heart rate, fetal position, placental position, and amniotic fluid index on a 3 point scale (0 = inadequate, 1 = adequate, 2 = excellent). The maximum score for the OSCE was 12.

RESULTS
The ultrasound screening programs were set up in three hospitals and six clinics. The average age of the providers was 36.9 yrs (28-60yrs, stdev 12.9 yrs). The providers performed an average of 9.3 scans per month (4-15, stdev 4.6) in their home clinics and hospitals. All of the providers achieved at least a score of 1 (adequate) on all the assessed OSCE measures with an average per skill score of 1.6. The average total OSCE score per provider was 9.9 (8-12, stdev 1.3).

CONCLUSION
The findings suggest that non-physician clinical providers retain basic skills in point-of-care maternal ultrasound after one week of intensive training. Confident with the quality of the service provided, we next hope to begin the process of evaluating the potential longitudinal impact of these maternal ultrasound screening programs on patient management and maternal and infant outcomes.

CLINICAL RELEVANCE/APPLICATION
Non-physician clinical providers can be trained to reliably perform and interpret point-of-care obstetrical ultrasound examinations in resource-limited areas of the developing world.

SSK10-04 • Radiologist Compliance with Institutional Guidelines for Use of Non-routine Communication of the Results of Radiologic Examinations

H. B Harvey MD, JD (Presenter) ; **Tarik K Alkasab** MD, PhD ; **Gloria M Salazar** MD ; **Daniel I Rosenthal** MD ; **G. Scott Gazelle** MD, PhD *

PURPOSE
Failure to appropriately communicate the results of radiologic examinations in urgent or non-routine clinical situations is a common source of medical malpractice liability in radiology. In 2009, the Departments of Radiology across our large integrated health system came together and developed guidelines for non-routine communication of diagnostic imaging findings based on the urgency of the findings and in view of existing guidelines and requirements. We study radiologist compliance with the guidelines nearly three years after implementation.

METHOD AND MATERIALS
From July 2012 through March 2013, 6,716 randomly selected radiology reports with images across all sections were reviewed in a peer-review conference format by at least three radiologists. The reviewing radiologists were asked to reach a consensus on two questions relating to non-routine communication: (1) "Does the report describe a finding which requires non-routine communication to the patient's physicians?" and (2) if so, "Were departmental guidelines for non-routine communication followed?" Consensus judgments were subsequently aggregated and analyzed based on section, level of acuity per the guidelines (i.e. Level 1, 2 or 3), and type of communication employed.

RESULTS
Of the 6,716 studies reviewed, 718 (10.7%) were deemed to require non-routine communication of results and 17 (0.3%) resulted in no consensus as to whether non-routine communication was required. Out of the 718 studies deemed to require non-routine communication, 20 cases (3%) resulted in a consensus that the guidelines were not followed: 4 of these were level 1 findings, 4 were level 2 findings, and 12 were level 3 findings. Neurological imaging accounted for the majority of the failures of non-routine communication with 60% of the cases and all of the cases involving level 1 findings (e.g. new ventricular entrapment, new subarachnoid hemorrhage, and new acute cortical infarction). Cases in which no consensus could be reached primarily involved Level 3 findings.

CONCLUSION
Guidelines for non-routine communication are appropriately applied in the vast majority of clinical cases at our large academic medical institution years out from their introduction.

CLINICAL RELEVANCE/APPLICATION
Non-routine communication of radiologic results is an important aspect of the radiology quality and safety landscape and efforts to ensure that it occurs consistently and effectively remain essential.

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 differencein detection; 3, clinically unimportant differencein 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 conventional 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 from1999-2010 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 255-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) comprised of 539,210,581 images (CT=339,830,947; MRI=199,379,634) 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
CONCLUSION
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.
The pre-test probability of obstructive CAD in the base case was determined by the model of Diamond and Forrester that uses age, sex and nature of chest pain.
The gatekeeper tests included exercise ECG, stress echocardiogram, stress MRI, SPECT, cardiac CT and PET.
The test characteristics, equivocal test rate and mean radiation dose were abstracted from the literature.
It was assumed that desired quality was the minimization of both radiation dose and proportion of negative catheter angiograms.

RESULTS
The typical patient in the cohort is a 55 year old female with atypical 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
CONCLUSION
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 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 by clinical significance and potential change in patient management. Rates of change in diagnosis were analyzed 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

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QA IN CT

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 Baghai 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
One in 14 radiology reports contain comments or disclaimers related to TUIQ with US and CT having relatively higher rates than CR. 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 residence areas are necessary.

Background
It is important to assess the effect of radiation from fallout after accident of Nuclear Powe Plant to keep our health. This is to report the current radiation dose rate(RDR) in various sites in Fukushima Prefecture after severe accident(Level 7) of Fukushima Nuclear Power Plant(FNPP), and also to report the effort to eradicate radiation in soil and trees contaminated by fallout.

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 30.5 ?Sv/hr in the northwet areas within 20km from FNPP even in March, 2013. It measured 0.24 to 1.11?Sv/hr in Fukushima City(ca,70km from FNPP) on 3-8-13, whereas it measured 11 to 15.0 ?Sv/hr on 5-25-11. The RDR at measuring posts on the ground of FNPP measured 3.1 to 6.7?Sv/hr on 3-3-13. 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 ^{131}I and some influence was due to ^{134}Cs (HL: 2.06 years) and washing effect of rains. The rate of decrease of RDR was exceeding the half life of ^{137}Cs(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

de-identification profiles and how the configuration could be customized.

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
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
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

Yuying 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 iDose4in lesion sharpness and low contrast detectability (P0.05; 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 (P0.05

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 Szczykutowicz PhD (Presenter) * ; **Frank N Ranallo** PhD ; **Walter W Peppler** PhD * ; **Richard J Bruce** MD * ; **Myron A Pozniak** 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 aide 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.

Meaningful Use: Experience from Radiology Practices in Hospitals and Health Systems

Wednesday, 12:30 PM - 02:00 PM • S501ABC

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QA IN

ICII42 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Ramin Khorasani , MD *
Curtis P Langlotz , MD, PhD *

LEARNING OBJECTIVES
1) Understand the meaningful use program. 2) Learn how hospitals and health systems have achieved meaningful use for their radiologists. 3) Decide how your practice should respond to the program.

Vascular/Interventional (Radiation Safety and Ergonomics)

Wednesday, 03:00 PM - 04:00 PM • E352

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QA IR

SSM23 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1

Moderator
Sarah B White , MD
Moderator
James R Duncan , MD, PhD

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.

SSM23-02 ● Removal of the Grid during Routine Biliary Interventional Procedures Performed in a Flat Panel Interventional Suite: Preliminary Data on Image Quality and Patient Radiation Exposure

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 grill 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 – 10 mm) and 24 tubular objects (TUO; 6 diameters, range 1.2 – 7mm) with four different densities (10, 20, 40 and 60?HU) 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, $I_{qualref}$ = 210mAs; 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, Goteborg 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 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 suggest 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 phantom (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 antropomorphical 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.
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

ASRT@RSNA 2013: The Role of the Radiologic Technologist in Patient Safety (HCIAC)

Wednesday, 03:40 PM - 04:40 PM ● N230

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QA

MSRT43 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Kim M Mullan *
Lynn Bordlee-Rupp *
Donna L Long , RT
Liana M Watson , RT

LEARNING OBJECTIVES
1) Understand the need for and development of the white papers. 2) Appreciate the need for appropriate workplace staffing. 3) Comprehend the need for a workplace culture that improves the process of reporting errors and near misses. 4) Embraces a personal skills assessment and opportunities for continuous learning. 5) Recognize the value of collaborative applications training environment. 6) Develop processes from the recommendations and actions of the white paper.
ABSTRACT
Radiologic technologists are at the forefront of patient safety and quality. The tremendous growth in medical imaging has improved patient care in the United States and around the world. However, some risks and drawbacks have accompanied that growth. As researchers and regulatory, advocacy and clinical organizations continue to explore the issue of safety in medical imaging, they consider the delicate balance of effective diagnosis and treatment of disease with the required exposure to radiation or other potential hazards. Among strategies to improve radiation safety are justification, education and optimization of images and technique. The American Society of Radiologic Technologists and its partners recognize the critical role of the radiologic technologist in all aspects of medical imaging patient safety. This presentation will provide an overview of recommendations from the ASRT Foundation's Health Care Industry Advisory Council's Subcommittee on Patient Safety and Quality Medical Imaging with the primary focus on quality and safety in CT, computed radiography/digital radiography, along with all medical imaging specialties. Specific topics addressed will include the current state of medical imaging as well as challenges associated with providing consistently high-quality care and education on equipment and new and emerging technologies.The panel will also discuss the desired state for radiologic technologist workplaces to ensure consistent quality in patient care and to maximize education and understanding of equipment and new technology.

Controversy Session: CT Radiation and Risk: How Certain Are We of the Uncertainties?

Wednesday, 04:30 PM - 06:00 PM ● N228

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QA CT

SPSC42 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Donald P Frush , MD
Rebecca Smith-Bindman , MD
William R Hendee , PhD

LEARNING OBJECTIVES
1) To understand the source of data that have been used to assess the association between medical radiation exposure and cancer risk. 2) To understand the work that has been done to quantify risk and the uncertainty in those estimates.
ABSTRACT
URL
http://www.radiology.ucsf.edu/research/labs/radiology-outcomes-research

ASRT@RSNA 2013: The Patient Experience - Our Shared Journey

Wednesday, 05:00 PM - 06:00 PM ● N230

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QA GN

MSRT44 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1
Kevin Rush

LEARNING OBJECTIVES
1) Discussion of the six I's: A. Setting the goal B. Building the process through the six I's: a. Intentional b. Individual c. Interactive d. Interpret e. Inspirational f. Institute. 2) The Patient Profile a. Gathering the information b. Understanding the goal c. Assuming our role 3) On-Stage, Off-stage a. Barriers to implementation b. Remembering our role and our goal. 4) The Patient's Story a. Each individual has a story b. Journeys made.
ABSTRACT
It is assumed by most people that those individuals providing healthcare services do so because they have a desire to care for others. The vast majority of us in imaging and radiation therapy joined the field for that very reason. While that is our goal, many of us are often lost amidst the maze of technology and advanced techniques. We have aspirations of doing more for our patients and their families but we are somewhat stifled as to how we can provide care in a more personal or meaningful way. We seek to provide an atmosphere of technical excellence as well as caring and support. Each of us recognizes and understands that our patients do not make their journey through our departments alone. This presentation will discuss this journey and provide the methods we can implement to serve as our patients' guides through the system.

ASRT@RSNA 2013: Moving Towards Best Practice: Developing National Guidelines through a Collaborative Approach

Thursday, 08:00 AM - 09:00 AM ● N230

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QA LM HP

MSRT51 • *AMA PRA Category 1 Credit* ™:1 • ARRT Category A+ Credit:1

Mark Given , MRT, RT

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

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QA PH IR

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, intraprocedure 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

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QA CT CA

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 Lehnert** 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 (p0.05), 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 (CCTA) 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 HDxt 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 CCTA were 95%, 61%, 61%, and 95%, respectively, those by using SP-DECT were 92%, 72%, 68%, and 94%, respectively, and those by using CCTA/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 CCTA/SP-DECT compared with CCTA.

CONCLUSION
SP-DECT can play a complimentary role to enhance the accuracy of CCTA 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 myocardiac perfusion in the assessment of coronary artery disease, and shows value in follow up of coronary stent inplantation.

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/m^2. 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 (710.32 +/- 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 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 techiques, 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 mainchallenge 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 Deviggiano** 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 score and then a contrast enhanced DE-CCTA. First the non contrast CCS scan was evaluated with a dedicated special software (Smart score; GE Medical Systems) in order to quantify the calcium score of each patient. Additionally, mass and volume of burden 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 Leipsic** MD * ; **Brett Heilbron** MD, FRCPC ; **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

CONCLUSION
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.

CLINICAL RELEVANCE/APPLICATION
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**

PURPOSE
To investigate the utility of low concentration contrast medium in coronary CT angiography with dual energy spectral imaging mode for overweight patient.

METHOD AND MATERIALS

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 (LAD (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 Frolkis 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 correlative CT images. Primary findings were coronary artery calcification (CAC), valvular calcification (both mitral and aortic), Mitral annual 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 74.4yrs. 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 (CAV) 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 (96)%, respectively, and those by using rest-DECT were 29 (47)%, 89 (80)%, 54 (59)%, and 74 (72)%, respectively. There was moderate (?=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

Alexia Rossi MD (Presenter) ; **Andrew Wragg** ; **Ernst Klotz** DiplPhys * ; **Maria A Cova** MD ; **Steffen E Petersen** ; **Francesca Pugliese** MD, PhD

PURPOSE
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
Fourty-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 g/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
CONCLUSION
CT-derived hyperaemic MBF and myocardial flow reserve are inversely and non-linearly related to stenosis severity as defined by ICA and FFR. In intermediate lesions, hyperaemic MBF can discriminate IFS from INFS coronary stenoses.

CLINICAL RELEVANCE/APPLICATION
CT-derived measurements of 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)

PURPOSE
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

PURPOSE
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. Computed tomography angiography (CTA) 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 who underwent 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
CONCLUSION
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.

Chest (Radiation Dose Reduction)

QA CT CH

SSQ04 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5

Moderator
Prachi P Agarwal , MD
Moderator
Mannudeep K Kalra , MD *

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-milli Sievert 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; p0.05). 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 ; **Kazuro 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 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
CONCLUSION
AIDR 3D method has better potential for radiation dose reduction of chest perfusion ADCT than FBP method in routine clinical practice.

CLINICAL RELEVANCE/APPLICATION
When compared with FBP method, AIDR 3D method has better potential for radiation dose reduction of perfusion ADCT for lung and nodule perfusion assessments in routine clinical practice.

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

shielding, compared to 33.0% at 100 kVp (p=0.009). Noise increase within the 2 deepest ROIs was less with shielding (19.0% vs 32.1%, p For 1cm- breast thickness, breast dose was reduced by 46.5% and 29.7% (p=0.01) and in-depth noise increased by 19.5 % and 33.9 % (p=0.01) with shielding or at 100 kV, respectively. For 2cm- breast thickness, breast dose was reduced by 38.5% and 30.1 %, (p=0.02) and in-depth noise increased by 16.5% and 33.5% (p=0.001) with shielding or at 100 kV, respectively. For 4cm- breast thickness, breast dose was reduced by 40.6% and 40.5% (p=0.95) and in-depth noise increased by 20.7% and 29.2% (p=0.02) (with shielding or at 100 kV, respectively).

CONCLUSION
For small breast thicknesses, breast dose reduction is greater with shielding. Shielding systematically provides less in-depth noise increase.

CLINICAL RELEVANCE/APPLICATION
For an equivalent or greater breast dose reduction, shielding provides less in-depth noise increase than the 100kVp option for CT acquisitions performed on GE equipments.

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 HD) 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.

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, major fissures, and subsegmental 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.

SSQ04-05 • 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-Il 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 40 mAs at 120 keV. LDCT scan parameters were as follows: pitch=1.2, 0.5 seconds gantry rotation time and other parameters were same as HP-LDCT parameters. Objective image noise was measured in five regions such as air, lung parenchyma, infraspinatus muscle, aorta, subcutaneous fat layer. Two blind radiologists independently assessed the subjective image quality of noise, artifact, sharpness and overall diagnostic acceptability with 5-point scale. Independent sample t-test, Mann-Whitney U test and kappa anlaysis were used for the statistical analyses.

RESULTS
BMI between the HP-LDCT group (24.5 ± 2.9 kg/m^2) and LDCT group (23.2 ± 3.0 kg/m^2) was no significant difference (p=0.073). The DLPs for HP-LDCT and LDCT were 90.22 ± 4.34 mGycm and 106.14 ± 6.48 mGycm, respectively ($p$ppp
CONCLUSION
HP-LDCT was achieved approximately 22% reduction of mean radiation dose with improvement of the suppression of cardiac pulsation and preserving image quality.

CLINICAL RELEVANCE/APPLICATION
High-pitch low dose chest CT reduced mean radiation dose from 1.5mSv to 1.2mSv and showed similar image noise but more motion-free images compared with standard low dose chest CT.

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 Notohamiprodjo** 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 procentual level of noise in a water phantom in virtual slices of varying thickness (VS in mm); raw data were reconstructed in soft tissue kernel using ASIR 50%). These baseline raw data were also reconstructed with MBIR (D0).

Additionally, each cadaver was scanned with varying dose levels D1-D5 by changing NI and VS (D1: NI=35, VS=2.5; D2: NI=70, VS=0.625; D3: NI=35, VS=5; D4: NI=70, VS=2.5; D5: NI=70, VS=5; all reconstructed with MBIR). Except for NI, VS and MBIR, all other parameters were identical to the FBR, all series reformatted in 3mm axial, coronal and sagittal slices. Two radiologists, blinded to the dose level, independently compared IQ for soft tissue evaluation of D0-D5 to the full-dose FBR (IQ: -2:diagnostically inferior, -1:inferior, 0:equal, +1:superior, +2:diagnostically superior; respectively). For statistical analysis ICC and Wilcoxon's test were used.

RESULTS
Mean values were (CTDIvol 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±0.2, 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 significant 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 comprised of 8 nodules ranging 5-12 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 otherwise 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
AIDR 3D allowed volumetry of synthetic lung nodules with reduced absolute biases on low- and ultra-low-dose CT and reduced inter-scan variability on ultra-low-dose CT.

CLINICAL RELEVANCE/APPLICATION
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), Aquillion 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 craniocaudal 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, craniocaudal 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;P
CONCLUSION

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.

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

Thursday, 10:30 AM - 12:00 PM • E353B

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QA GU

SSQ09 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Richard C Semelka , MD
Moderator
Aart J Van Der Molen , MD

SSQ09-01 • Genitourinary Keynote Speaker
Richard C Semelka MD (Presenter)

SSQ09-02 • Safety of Gadobutrol in Renally Impaired Patients: Interim Results from a Prospective International Multicenter Trial after End of Recruitment

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 observatory study (GRIP-gadovist in renally impaird 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/m² 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 occured after administration of 0.1mmol/kg gadobutrol in this prospective study in renally imparied patients so far.

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
CONCLUSION
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.

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

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. Percents 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 dysfuction (eGFR
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 safety 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, 0.487–0.538; p< 0.01) and the cortical R2* of 16 echoes and medullary ADCs had a weak correlation (correlation coefficient, 0.317–0.365; 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 correlated with GFR values using linear regression.
Contrast-to-noise ratio graphs were also constructed for each patient to determine the optimum KeV for viewing. Statistical analysis was performed using SPSS software. Mean values and standard deviation of each group were calculated and compared using 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 impairement

Pediatrics (Radiation Dose Reduction)

Thursday, 10:30 AM - 12:00 PM ● S102C

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QA PD CT

SSQ18 • AMA :1.5 • ARRT:1.5
Moderator
Donald P Frush , MD
Moderator
Bernard F Laya , DO

SSQ18-01 ● Patient-Specific CT Dose Maps (CTDM) and Patient-Specific Dose Estimates (PSDE) for Pediatric CT: Preliminary Results in Comparison with the CTDIvol and Size Specific Dose Estimate (SSDE)

Dianna M Bardo MD (Presenter) * ; **Jeffrey H Yanof** PhD ; **Donna M Stevens** MS ; **Efrat Shefer** PhD * ; **Galit Kafri** PhD * ; **Jens Wiegert** PhD *

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.

METHOD AND MATERIALS
IRB approval was granted to review 15 pediatric CT and CTA exams, 8 male, 7 female, ages 6 days to 15 years. HU of each image voxel was used to categorize tissues into 6 material classes based on physical composition and chemical stoichiometry. PSDEs were computed from voxelized CTDMs using the Monte-Carlo method, integrating dose or energy in individual patients, taking into account tissue density. A Student's paired T-test was used to compare the mean values of CTDIvol-normalized PSDE and SSDE for chest and abdomen regions. Display of radiation dose in CTDMs is designed to visually indicate areas of greater and lesser dose on a color scale, with scatter dose displayed separately and in total.

RESULTS
CTDMs show that dose generally increases with decreasing patient size. The general trend of average normalized dose vs. patient size tends to agree with the SSDE. The calculated PSDE dose profile is greater in smaller diameter patients. Patient specific dose profiles of PSDE vary along the z-axis indicating variation of dose throughout the irradiated volume which depends on effective diameter, tissue type and position within the irradiation field. PSDE values for infant chest/cardiac CTA exams were greater than CTDI-normalized SSDE. In older/larger patients, increased diameter, which increases attenuation of x-rays, skews the PSDE less than the SSDE.

CONCLUSION
PSDE provides an accurate and individualized measure of radiation dose imparted during CT scan. CTDMs depict dose distribution within each slice. CTDMs and PSDE enable understanding of dose in different tissues, using varied scan protocols and are especially important in understanding imparted CT dose in infants.

CLINICAL RELEVANCE/APPLICATION
The importance of accurate, patient specific dose estimation and reporting in the youngest and smallest patients is most vital. In children, the accurate estimation and calculation of dose in clinica

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) ; **Jenifer W Siegelman** MD, MPH ; **Choonsik Lee** PhD ; **Elizabeth C Jones** MD ; **Mahadevappa Mahesh** MS, PhD * ; **Les R Folio** 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 ($CTDI_{vol}$, 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. Radiologists and ordering physicians monitored studies for clinically relevant (subjective) reductions in quality. Repeat rate due to inadequate quality was collected.

RESULTS
Comparing 2012 with 2010 as baseline, $CTDI_{vol}$, DLP, and SSDE in 2012 were 22% (p=0.082), 20% (p=0.2982), and 26% (p=0.012) lower on average. Organ doses in 2012 were on average 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 additonal 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, 60.7months) 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) ; **Khoschy Schawkat** MD ; **Daniel Ott** MD ; **Stefan Puig** MD, MSc

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 thoracal, 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=0.02). This was obviously mainly 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 (n_C=204; n_{AP}=340; M:F= 309:235) were assessed with a web based dose monitoring software (Exposure, Radimetrics) 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; n_C=6,000; n_{AP} =8,000) for comparison. Analysis of variance (ANOVA) was used to evaluate differences in ED across above variables. P
RESULTS
Mean EED (ICRP-103) in pediatric cohort was 6.9±6.5 (EED_C: 4.7±5.3; EED_{AP}: 8.1±6.8; mean age:12.0±5.0 years). Compared to adults mean EED was 7.4±4.1 (EED_C: 4.6±2.7; EED_{AP}: 10.2±5.5). Mean EED for pediatric abdominal CT was significantly low compared corresponding adult dose (p
CONCLUSION
Mean ED varies considerably across CT scanners, body regions and with BW in pediatric patients. Mean ED 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 Buchmann 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 = 0.54). Size-Specific Dose Estimates (SSDE) were calculated for each study. Image noise was used as a proxy for image quality. Three 1.0 cm^2 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 = 0.58). 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 = 0.09) 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 = 0.18). A 7% reduction in pelvis image noise by wide-detector technique was significant (p = 0.04).

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 HU). The field-of-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 to1.9, 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 reductionsns 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 angiography. 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 $CTDI_{vol}$ 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 evaluate the radiation dose and image quality (IQ) of an iterative reconstruction (AIDR 3D) in combination with SureExposure^{3D} on a 640-slice CT and determine the optimal dose reduction 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. SureExposure^{3D} 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
CONCLUSION
Using AIDR 3D technique, 80kvp with SureExposure^{3D} (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.

Minicourse: Recording and Reporting Radiation Dose: CT

Thursday, 04:30 PM - 06:00 PM ● E351

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QA PH CT

RC723 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Director
J. Anthony Seibert , PhD

RC723A • Measurements and Indices in CT Dose

John M Boone PhD (Presenter) *

LEARNING OBJECTIVES
1) The audience will be able to identify and discuss the standard parameters used for reporting dose in computed tomography, including the volume CTDI, DLP, and effective dose using the k-coefficients. 2) The audience will be able to identify and discuss parameters which influence the radiation dose to the patient, including patient size, dose modulation protocols, and scan length. 3) Participants will be able to identify the limitations of using effective dose in describing radiation dose levels to individual patients.

ABSTRACT
Computed tomography has experienced rapid growth in utilization over the past 10 years, due in part to the dramatic increase in image quality and decrease in scan time that helical and multi-slice CT scanners have allowed. This increased utilization has raised legitimate concerns about the radiation dose levels in CT. Traditional dose metrics such as the volume computed tomography index (CTDIvol) and the dose length product (DLP) will be discussed. The limitations of these metrics in the context of individual patient dosimetry will also be explained. In recent years, a number of new CT dose concepts have been introduced in the peer-reviewed literature, in task group reports, and in other documents. A number of these new dose metrics will be discussed, including the rise-to-equilibrium-dose, H(L), and the site-specific dose estimate (SSDE). CT dosimetry has historically been performed used integrating ion chambers. In light of the dynamic scanning capabilities of modern CT scanners, the utility of a real-time radiation meter will be discussed. Real-time dose meters can substantially reduce the time required by the physicist in the CT scanner suite, while increasing the quantity and quality of the dose information that is measured. Niche applications include the rapid assessment of beam quality (half value layer) and the characterization of the beam shaping filters used in CT. In summary, this presentation will discuss existing CT dose parameters, and will then review a number of proposed new CT dose parameters which will likely be useful for CT dose assessment in the future. The recent growth of CT technology has outgrown the simple dose metrics of the past, and there is a need for the CT community to embrace new and more accurate CT dose metrics.

RC723B • Estimating Patient Dose

Dianna D Cody PhD (Presenter) *

LEARNING OBJECTIVES
1) Recognize the limitations of current approaches to estimate CT patient dose. 2) Understand several methods available for estimating CT patient dose. 3) Understand potential future options for patient CT dose estimations.

RC723C • Initial Experience with California Law on Reporting Dose from CT

J. Anthony Seibert PhD (Presenter)

LEARNING OBJECTIVES
1) Describe the provisions of the California State law on dose reporting for computed tomography (CT) scanners. 2) Demonstrate ways in which the required elements volume Computed Tomography Dose Index ($CTDI_{vol}$) and Dose Length Product (DLP) can be placed into the radiology report. 3) Discuss discrepancies regarding the relationship between $CTDI_{vol}$ and patient dose, and issues in accumulating dose indices for CT scans in a multi-series exam and for individual exams over time. 4) Report on the status of compliance with the statutes of the law.

ABSTRACT
Radiation over-exposure for computed tomography (CT) perfusion studies occurring in the 2008-2009 timeframe resulted in California Senate Bill 1237, legislation that was authored by Senator Padilla in response to these incidents. The legislation was signed by the Governor in September 2010. The law contains three parts: (1) Recording CT dose indices for each patient, placing these values in the radiology report, and verifying accuracy of the volume Computed Tomography Dose Index ($CTDI_{vol}$); (2) Requiring accreditation for all CT scanners performing diagnostic exams that are under the authority of the California Department of Public Health; (3) Reporting of radiation exposures that exceed specified limits to organs, cause unanticipated erythema or hair loss, or inappropriate irradiation to body parts not ordered by a physician. Part 1 of the law commenced on July 1, 2012, and the other two parts are to commence on July 1, 2013. This presentation describes the steps taken to comply specifically with Part 1 of the law. To ensure compliance, an *automated* extraction and delivery of the $CTDI_{vol}$ and DLP indices to the radiology report were implemented. However, the legislation *does not* provide guidance on how to: (1) adjust $CTDI_{vol}$ for patient size; (2) deal with CT exams having multiple different series, each with individual dose indices; (3) sum $CTDI_{vol}$ and DLP for the same or different body areas scanned (if appropriate). The consequence is variable reporting at the initial implementation of the law, which requires standardized reporting metrics. Recommendations by the University of California Dose Optimization and Standardization Endeavor (UC DOSE) is discussed in this context, with relevant solutions described and specific examples demonstrated. To conclude, an update from the users perspective of compliance, as well as reporting of the status from the State of California Department of Public Health office is provided.

Using RADIANCE for CT Dose Monitoring and Quality Assurance: A Hands-on Course

Thursday, 04:30 PM - 06:00 PM • S401AB

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QA IN

RC754 • *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 packaged 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 (CTDIvol) 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

Minicourse: Recording and Reporting Radiation Dose: Nuclear Medicine

Friday, 08:30 AM - 10:00 AM ● S403B

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QA PH NM

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.
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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 computat

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

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QA IN

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

Rasu 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, innovations and developments that are rapidly taking place to address radiation dose reduction in CT - both on the vendor as well as on the private and academic communities. A through and 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.

RC830C ● 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

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QA IR

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 three 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

Mattijs Elschot MSc ; **Jip F Prince** MSc (Presenter) ; **Maarten L Smits** ; **Marnix G Lam** MD ; **Johannes F Nijsen** PhD ; **Bernard 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 ^{99m}Tc-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 ^{99m}Tc-MAA lung shunt calculations

METHOD AND MATERIALS
Fourteen patients were treated with radioembolization using holmium-166-loaded microspheres (^{166}Ho). These particles can be quantified with SPECT and can be used for scout dose and treatment. During preparatory angiography, ^{99m}Tc-MAA (150 MBq) was injected, followed by (planar) scintigraphy and SPECT-CT. At the day of treatment, a scout dose of ^{166}Ho-microspheres (250 MBq) was first injected, followed by SPECT-CT imaging. Subsequently, a treatment dose of ^{166}Ho-microspheres was injected and imaged with SPECT-CT. Lung shunting was calculated on ^{99m}Tc-MAA scintigraphy. Mean lung doses were calculated on quantitative SPECT images for all three procedures and also on scintigraphy for ^{99m}Tc-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 ^{99m}Tc-MAA scintigraphy was 4.1% (range 2.2 – 11.3%). The median lung dose after ^{166}Ho-radioembolization was 0.2 Gy (range 0 – 0.7 Gy), based on quantitative SPECT. This lung dose was significantly overestimated by ^{99m}Tc-MAA scintigraphy (median difference (?) 5.1 Gy, range 1.4 – 17.1 Gy, $p < 0.001$) and by ^{99m}Tc-MAA SPECT (? 2.3 Gy, range 0.5 – 11.8 Gy, $p < 0.001$). The estimations on SPECT images of the ^{166}Ho-scout dose did not differ significantly from treatment (? 0.0 Gy, range -0.7 – 0.3 Gy, $p = 0.542$).

CONCLUSION
^{99m}Tc-MAA lung shunt calculations significantly overestimate the mean lung dose after radioembolization with ^{166}Ho microspheres. In contrast, a scout dose of ^{166}Ho-microspheres accurately predicts the mean lung dose after treatment.

CLINICAL RELEVANCE/APPLICATION
The mean absorbed dose to lung parenchyma of patients treated with ^{166}Ho radioembolization is significantly overestimated by ^{99m}Tc-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 patient 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=16). 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 3.1% (+/- 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.

CONCLUSION
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.

CLINICAL RELEVANCE/APPLICATION
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.

VSIR61-11 ● Combination Therapy Cxs

Thuong G Van Ha MD (Presenter) *

LEARNING OBJECTIVES
View learning objective under main course title.

ABSTRACT
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.

VSIR61-12 ● Debate: Interventional Oncology - A Distinct Specialty/Interventional Oncology - We Are Radiologists, Not Oncologists

Daniel B Brown MD (Presenter) * ; **Charles E Ray** MD, PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

VSIR61-13 ● Literature Review: The Most Important IO Papers from 2012-13

Charles E Ray MD, PhD (Presenter) *

LEARNING OBJECTIVES
View learning objectives under main course title.

VSIR61-14 ● Panel Discussion: Unknown Case Presentation

LEARNING OBJECTIVES
View learning objectives under main course title.

VSIR61-15 ● Wrap Up and Discussion

LEARNING OBJECTIVES
View learning objectives under main course title.

Physics (CT-Dose Optimization)

Friday, 10:30 AM - 12:00 PM ● S403B

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QA PH CT

SST14 • *AMA PRA Category 1 Credit* ™:1.5 • ARRT Category A+ Credit:1.5
Moderator
Cynthia H McCollough , PhD *
Moderator
Robert G Gould , DSc

SST14-01 ● ACRIN PA 4006: Effect of Device Technical Factors on Patient Dose in a Prospective Digital Breast Tomosynthesis Screening Trial

Mathew Thomas BS (Presenter) ; **Yohei Matsutani** ; **Emily F Conant** MD * ; **Andrew D Maidment** PhD *

PURPOSE
To characterize the effect of kVp, mAs, and filter-anode combinations on mean glandular dose (MGD) in digital mammography (DM) and digital breast tomosynthesis (DBT).

METHOD AND MATERIALS
A prospective multi-site trial was conducted to compare the recall rates of DM and DBT. The DBT image set consisted of 2D and 3D images obtained at approximately a 15% reduced dose effected by using a phototimer setting of -1; the DM images were acquired without modification of dose. All image data were stored in a centralized DICOM server and the image metadata were automatically extracted from the DICOM headers. These data included breast laterality, image orientation, kilovoltage (kV), exposure (mAs), target and filter materials, entrance surface dose and mean glandular dose (MGD). Regression analysis was performed to ascertain the influence of the various acquisition parameters on MGD.

RESULTS
The 2D component of the combined-DM/DBT acquisition was on average 18.5% less than (p
CONCLUSION
For both DM and DMT, the key determining factor of MGD is mAs. The kVp of DM and 2D DBT images is significantly lower than the kVp of 3D DBT images for breast thicknesses in the range of 70-100mm due to filter change in DM.

CLINICAL RELEVANCE/APPLICATION
This paper characterizes the key technical parameters that determine the cumulative dose exposure for patients during digital breast tomosynthesis screening.

SST14-02 ● Assessment of Patient Dose from CT Localizer Radiographs

Natalia Saltybaeva (Presenter) ; **Bernhard Schmidt** PhD * ; **Daniel Kolditz** PhD * ; **Willi A Kalender** PhD *

PURPOSE
CT localizer 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.

METHOD AND MATERIALS
Four anthropomorphic phantoms representing 2 adults (male and female, Rando-Alderson Research Laboratories, New York, USA) and 2 children (5 and 1 y.o., CIRS, Norfolk, VA, USA), equipped with 30-60 TLD chips, underwent LR scans (SOMATOM Definition Flash, Siemens AG, Forchheim, Germany). Three different body regions (head, thorax, and abdomen-pelvis) and three positions of the X-ray tube (AP, PA and lateral) were considered. We simulated 3D dose distribution for each setup using a validated Monte Carlo tool (ImpactMC, CT Imaging GmbH, Erlangen, Germany) and compared simulated and measured dose values point by point. Organ and effective doses for the different LRs were calculated and compared to typical dose values in CT examinations.

RESULTS
The differences between measured and simulated dose values for all projections (AP, PA and lateral) were below 15% on average. Organ doses varied significantly depending on the tube position; the largest differences were observed for breast dose in female chest LR (AP: 2.4 mSv vs. PA: 0.5 mSv). Overall effective dose values per LR ranged from 0.04 mSv for adult head to 0.7 mSv for 1 y.o. child abdomen. This adds from 5% to 42% to effective dose of typical low-dose CT exams.

CONCLUSION
MC simulations provide accurate estimates of LR dose distributions. Localizer radiographs may contribute substantially to organ and effective dose of the total CT examination. Organ doses from LRs can be significantly reduced by choosing the appropriate projection angle.

CLINICAL RELEVANCE/APPLICATION
Dose from localizer radiographs should be taken into account. LR parameter optimizations should be performed in order to decrease total dose of CT examinations.

SST14-03 ● CT Radiation Dose Optimization of Coronary Calcium Scanning: Comparing Different Image Reconstruction Methods at 100kVp and 120kVp

Joerg Blobel PhD (Presenter) * ; **Jurgen Mews** * ; **Joanne Schuijf** * ; **Willem Overlaet** *

PURPOSE
The effects of tube voltage reduction and different reconstruction methods on coronary calcium scoring remain largely unknown. We performed a quantitative phantom study to determine the lowest applicable volume CTDI thresholds ($CTDI_{vol}$) at 100kVp versus 120kVp while controlling Agatston and volume score accuracy.

METHOD AND MATERIALS
ECG-gated volume scans of an anthropomorphic thoracic phantom with calcium calibration inserts, containing 200, 400 and 800mg HA/cm^3 calcium mass spheres of 1, 3 and 5mm diameter (QRM GmbH, Germany), were performed on 320-row CT (Aquilion ONE, Toshiba Medical Systems, Japan). Using 100kVp and 120kVp with 10-580mA variations in 32 steps, each acquisition was reconstructed with Filtered Back-Projection (FBP), Quantum Denoising Software (QDS) and Adaptive Iterative Dose Reduction (AIDR 3D). To determine the minimum $CTDI_{vol}$ thresholds for the six groups a statistical 2S-outlier test (WinStat 2007.1 software) was performed on the semi-automatically detected Agatston and volume scores. The Kruskal-Wallis-Test was used to evaluate statistical differences between the three reconstructions and both kVp scan series.

RESULTS
At equal kVp settings, there were no significant differences in average scores between the three reconstruction methods (p>0.21). The use of 100kVp, as compared to 120kVp, resulted in a 3% lower Agatston score average (672 vs. 694, p3, pvol thresholds were reduced from 5.98mGy to 2.37mGy (120kVp, QDS), 1.86mGy (120kVp, AIDR 3D), 4.13mGy (100kVp, FBP), 1.94mGy (100kVp, QDS) and 1.12mGy (100kVp, AIDR 3D) (Fig.). The averages of 10 repeated scans at low dose level (1.12 mGy, AIDR3D, 100kVp) showed no significant difference with the reference group (12 dose steps, FBP, 120kVp) for both Agatston (p=1.00) and volume (p=0.75) score.

CONCLUSION
Mean dose reductions of 37% using 100kVp instead of 120kVp and 71% using the novel iterative reconstruction AIDR 3D instead of FBP can be achieved for coronary calcium scanning. Combining 100kVp with AIDR 3D resulted in an 81% lower $CTDI_{vol}$ threshold compared to a standard scan protocol (120kVp, FBP).

CLINICAL RELEVANCE/APPLICATION
Considerable radiation dose reduction can be achieved for coronary calcium scanning using AIDR 3D at 100kVp. Low dose coronary calcium scanning is possible with good accuracy and reproducibility.

SST14-04 ● Synthetic Cone-beam CT for Determining Patient- and Task-specific Minimum-dose Techniques in Repeat Scans

Adam S Wang PhD (Presenter) * ; **Joseph W Stayman** PhD * ; **Yoshito Otake** * ; **Jeffrey H Siewerdsen** PhD *

PURPOSE
To evaluate a newly developed method (Synthetic Cone-Beam CT) for accurately determining the impact of lower-dose techniques in C-arm CBCT, allowing identification of minimum-dose protocols suitable to a given imaging task in scenarios that require repeat scans.

METHOD AND MATERIALS
An initial CBCT acquired at nominal scan protocol at the beginning of a procedure provides a patient-specific basis for synthetic CBCT. To accurately simulate lower-dose techniques, noise of the proper magnitude and correlation is added to the projections, accounting for object-dependent noise levels and correlations introduced by the detector. The resulting noisy projections are then reconstructed to yield synthetic CBCT images accurately portraying the image quality in lower-dose scans. Validation studies were conducted on a mobile C-arm using a 16 cm acrylic phantom to first assess the detector signal-variance relationship and correlations. Synthetic CBCT was then applied to a head phantom (100 kVp, 320 mAs initial scan), synthesizing projections across a range of lower-dose techniques (160, 80, 40, and 20 mAs). Real CBCT scans were also obtained at each technique for image quality comparison.

RESULTS
Comparison of synthetic and real CBCT images across the full range of techniques demonstrated accurate noise magnitude (within ~3%) and correlation (matching noise-power spectrum, NPS). Other image quality characteristics (e.g., spatial resolution, contrast, beam hardening, and scatter) remain intact and are realistically presented in synthetic CBCT. Generating synthetic CBCT for a broad range of protocols gives a useful method to select minimum-dose techniques that accounts for complex factors of imaging task, patient-specific anatomy, artifacts, and physician preference.

CONCLUSION
Synthetic CBCT accurately portrays the increased noise in lower-dose protocols while preserving other image quality characteristics, providing a method to define minimum-dose, task-specific protocols in repeat CBCT. Ongoing work includes translation to clinical studies and application to iterative reconstruction, where potential dose reduction is even greater and synthetic CBCT accurately portrays low-dose limits that are difficult to predict.

CLINICAL RELEVANCE/APPLICATION
Selection of minimum-dose, task-specific techniques for intraoperative C-arm cone-beam CT is enabled by synthesizing patient-specific images that accurately reflect image quality at lower dose.

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 *

PURPOSE
Intrascan Motion-artifact-correction in C-arm-based flat-detector CT (FD-CT) is an important issue in interventional imaging because of longer scan times as compared to Multi-Slice CT. Our aim was the development and evaluation of an online image-content-based motion-correction technique without using any kind of markers or external motion knowledge.

METHOD AND MATERIALS
The correction method is based on a gradient descent method, minimizing a gray-value entropy criterion optimizing the underlying acquistion trajectory parameters. It is formed as a multistep approach, including a global, local and projection wise optimization. We are using a locally rigid variation of the systems trajectory parameters like detector- or source-translation or a detector rotation to compensate patient motion. The retrospective evaluation of 30 arbitrary (with weak and strong motion, without motion artifacts) patient head scans included 5s 3D angiography and 20s soft-tissue protocols. All scans were performed on an Artis Q System (Siemens AG). For each dataset three volumes were computed: 1) original reconstruction using the system$\diamond$s geometry calibration (OR), 2) motion corrected reconstruction without any system information (MCR) and 3) motion corrected reconstruction using the system$\diamond$s geometry calibration as initialization (MCR+). Two neuroradiology experts performed a visual evaluation according to a 5-point grading scale with respect to general image quality, motion-artifact-content and spatial resolution of the structures of interest, e.g. 3D vessels.

RESULTS
The average scores for OR, MCR and MCR+ were 2.75, 3.0 and 3.15, respectively. The combined compensation of unknown trajectories and unknown patient motion (MCR) can lead to comparable results to OR. Both experts confirmed a distinct reduction of artifacts by the motion correction algorithm (MCR+) , e.g. blurring and streaks. Especially for 3D angiography even small distal vessels were depicted clearly. MCR+ application on soft-tissue protocols illustrated a constantly better delineation of bone und soft-tissue in the border zones.

CONCLUSION
Image-based motion correction is possible without a-priori knowledge of the motion pattern and can improve interventional FD-CT imaging.

CLINICAL RELEVANCE/APPLICATION
Using the proposed algorithm enables good image quality even for unsteady patients and can be helpful for longer FD-CT acquisitions in cases where anaesthesia is contraindicated.

SST14-06 ● Supervised Conversion of Ultra-low-Dose to Higher-dose CT Images by Using Pixel-based Machine Learning: Phantom and Initial Patient Studies

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 $\diamond$virtual$\diamond$ 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 $\diamond$teaching$\diamond$ 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 produces 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 120kVp, 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 120kVp 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
CONCLUSION
With our supervised MTANN dose-reduction technique, the image quality of 0.1 mSv ULDCT 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.

SST14-07 ● 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 Szczykutowicz 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 region 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.

SST14-08 ● Radiation Dose in Dual-energy Computed Tomography: Axial Dose Distributions in Specific Thoracic and Abdominal

Regions

Kosuke Matsubara PhD (Presenter) ; **Haruka Koshida** ; **Keita Sakuta** RT ; **Tadanori Takata** ; **Kichiro Koshida** PhD ; **Yukihiro Matsuura** RT ; **Toshifumi Gabata** MD

PURPOSE
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.

METHOD AND MATERIALS
A 128-section dual-source CT device (SOMATOM Definition Flash; Siemens Healthcare, Erlangen, Germany), an anthropomorphic female phantom (RAN-110; Phantom Laboratory, Salem, NY, USA), and calibrated radiophotoluminescent glass dosimeters (RPLDs) (GD-302M; Chiyoda Technol, Tokyo, Japan) were used to acquire axial absorbed dose distributions in specific regions of the thorax and abdomen that were imaged using CT with one SE (120 kVp) and three DE (100 and Sn/140 kVp, 80 and Sn/140 kVp, and 140 and 80 kVp) modes. The energy modes were in accordance with the standard clinical protocols for thoracic and abdominal CT, and the tube current was adjusted so that the displayed volumetric CT dose indices (CTDIvol) were equivalent among the four energy modes. Axial absorbed dose distributions in the thoracic and abdominal regions were acquired by placing RPLDs within all holes of one thoracic or abdominal section and pasting them around the section.

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 Estimation 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%, 32.2%, 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
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.

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