Tracking Radiation Exposure From Medical Diagnostic Procedures: Siemens Perspectives

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Dose related measures and standards (e.g. CTDI$_{vol}$ and DLP, DICOM SR) are typically defined by IEC, FDA and/or other country specific governing bodies.

- Further standard/recommendations are given by organizations such as ACR or AAPM

- Siemens complies with standards

- Vendors contribute constructively to dose awareness efforts/campaigns via MITA (e.g. MITA CT DOSE CHECK INITIATIVE)
Dose Measures and Standardization

Example I: DICOM SR (Dose Report)

Note: Some parts of this DICOM SR Document cannot be displayed with the current stylesheet. They will not be lost or modified while editing, saving or exporting the DICOM SR Document.
Dose Measures and Standardization
Example IIa: Dose Check MITA XR-25
Dose Measures and Standardization
Example IIb: Dose Check MITA XR-25
Variations in Reported Dose for Same Exam
Example: Cardiac CTA

The Protection1 Study*
- Multi-center multi-vendor trial, 50 sites, 1965 coronary CTAs
- Mean radiation dose: 5.7 mSv – 36.5 mSv
Variations in Reported Dose for Same Protocols
Dose Monitoring – CARE Analytics

- Assessment of DICOM SR (all vendors) incl. statistics
- DICOM node or offline use
Variations in Reported Dose for Same Protocols

BUT ....

- Impact on patient individual dose at SAME parameters (equivalent CTDIvol for small and large patients) is not considered

- Impact of dose reduction tools is considered (e.g. CAREDose4D) via CTDIvol and DLP
Equipment Features to Reduce Exposures

Overview

- **UFC**
- **DICOM SR**
- **SureView**
- **CARE Dose4D**
- **Real-time Imaging**
- **Adaptive ECG-Pulsing**
- **4D Noise Reduction**

- **Dose Alert & Notification**
- **Hand CARE**
- **CARE Analytics**
- **Adaptive Cardio Sequence**
- **Selective Photon Shield**
- **CARE Dashboard**
- **IRIS**

- **X-CARE**
- **Adaptive Dose Shield**
- **Flash Spiral**
- **Sub-mSv heart**
- **Pediatric 70 kV Protocols**
- **CARE kV**
- **SAFIRE*”
Equipment Features to Reduce Exposures
High-Pitch Spiral on DSCT Systems for Cardiac Scanning

Conventional CTA

- 135 - 175 ms temporal resolution
- 2-10 s scan time
- Low Pitch + Overlap = Robustness
- Up to 30 mSv dose

1, J Hausleiter, et al., “PROTECTION” I multicenter, multivendor trial, JAMA, 2009; 301(5):500-507
13 month old boy, NO SEDATION
Suspected congenital heart defect
Tried to get up during scan

- Flash Spiral w/o breath hold
- Non compliant
- 0.57 mSv eff. dose
Equipment Features to Reduce Exposures
CARE kV: Automated, exam-specific kV setting

Source: Internal data evaluation based on anonymous assessment on SRS connected scanners.
Equipment Features to Reduce Exposures
SAFIRE: Up to 60% Dose Reduction*

Without SAFIRE
\[ \text{CTDI}_{\text{vol}} = 12.30 \text{ mGy} \]

With SAFIRE
\[ \text{CTDI}_{\text{vol}} = 4.07 \text{ mGy} \]

* In clinical practice, the use of SAFIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task. The following test method was used to determine a 54 to 60% dose reduction when using the SAFIRE reconstruction software. Noise, CT numbers, homogeneity, low-contrast resolution and high contrast resolution were assessed in a Gammex 438 phantom. Low dose data reconstructed with SAFIRE showed the same image quality compared to full dose data based on this test. Data on file.
Training for Users

- **Scanner Specific Training:**
  - 48h On-site Applications Training
  - Application-specific default protocols using dose reduction feature (e.g. SAFIRE, CAREkV, 70kV)
  - Workflow assistant: Practical tips, default protocols incl. dose values for the different body parts

- **Additional Material:**
  - Education PPT’s that describe dose reduction features
  - CARE Dose 4D Training CD’s for customers
  - Siemens Medical Academy – e-learning 5 dose presentations
  - 4 class room courses at Siemens Training Center (dose is one of the major focus of each of the courses)
  - Training presentation developed for Image Gently
  - Siemens Innovation Meeting – Dose main focus of meeting (90%)
  - “How to…” Flyers
  - Scientific White Papers
Training for Users
Training outline – user specific

Life Training Guideline - Data Selection
Scanner
Workplace
SOMATOM Definition Flash

Update Training
System Training

Life Training Guideline - SOMATOM Definition Flash
syngo CT 2010A

Select The Engines:
- Acute CARE CT
- Adaptive Interventional Suite
- Cardiac CT
- Neuro CT
- Oncology CT
- syngo Dual Energy Advanced

Select The Options:
- 4D Adaptive Spiral
- Adaptive 3D Intervention

Introduction to Siemens MSCT Technology
CT Basics
MSCT Technology
Sure View Concept

Introduction to Dual Source CT
Two Detectors and Two Tubes
Size of the Two Detectors
Up to 75 mSec Temporal Resolution Through Dual Source CT
Double Tube Output Through Dual Source CT for Obese Patient Scanning
Introduction to Dual Energy Technique
Advantages over Single Source CT

System Hardware
Scan Unit
Training for Users
“How to…” Flyers for optimizing dose reduction & White Papers

How to scan children with FAST CARE
For all SOMATOM Scanners equipped with FAST CARE syngo CT 2011
By C. Leitner and T. Fieder
www.siemens.com/healthcare

How to scan with CARE kV
For all SOMATOM Scanners equipped with FAST CARE syngo CT 2011
By E. Schenkt, R. Rauch and T. Fieder
www.siemens.com/healthcare

How to scan with CARE Dose4D
For all SOMATOM Scanners equipped with FAST CARE syngo CT 2011
By T. Ainemiediger, R. Rauch and T. Fieder
www.siemens.com/healthcare
Training for Users
Teaching Website about Dose and Dose Reduction
Which Dose Values Need to be Reported

Differentiate between System Specific and Patient Specific Dose Values

- $\text{CTDI}_{\text{vol}}$, phantom size and DLP per IEC

- Additional measure about the patient might be helpful to extract specific dose information (e.g. to assess differences between sites)
  - weight / attenuation
  - Size Specific Dose Equivalent (SSDE)

- Organ dose values desired, but
  - no agreement on method how to derive values
  - no consensus yet on a practical, routine approach
  - amount of information might overwhelm physicians

- Effective dose values
  - physics community mixed feelings reg. individual values per patient (aim of effective dose)
  - DICOM SR prepared for effective dose values (can be filled by users)
  - Further discussion required between MITA, AAPM, ACR, FDA ...
Integration of Radiation Dose into Reports

- Radiation dose automatically becomes part of radiology reports and EMR → We currently send Patient Protocol to PACS
- Most Siemens scanners currently generate DICOMSR
  - DICOMSR can be sent to PACS and/or DICOM node
- Unfortunately the DICOM committee has removed dose information from the Modality Performed Procedure Step (MPPS) standard.
  - We do not deviate from this standard: we send dose information in the comment field of the MPPS data for most software versions

Data format Example: (found in Dose Log also)
RangeName: kV=120 mAs=430 CTDIvol=7.20 DLP=48
PhantomType=16cm

- Partnership with a third party vendor to get dose information from the PACS to the EMR