Moving Forward – What does this mean for the Medical Physicist and the Imaging Community?

John M. Boone, Ph.D., FAAPM, FACP  
Professor and Vice Chairman of Radiology  
University of California Davis Medical Center  
Chairman, AAPM Science Council  
Chairman, ICRU* committee on CT Image Quality & Dose

*International Commission on Radiological Units and Measurement
Moving Forward:

- National / International Activities
- Education and Training
- Clinical: What can we really do?
- Regulations, Accreditation, Certification
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Science Council

Imaging Physics Committee

CT subcommittee

TG-111

TG-200

TG-xxx

Therapy Physics Committee

Research Committee

Technology Assessment Committee
Comprehensive Methodology for the Evaluation of Radiation Dose in X-Ray Computed Tomography

A New Measurement Paradigm Based on a Unified Theory for Axial, Helical, Fan-Beam, and Cone-Beam Scanning With or Without Longitudinal Translation of the Patient Table

Report of AAPM Task Group 111: The Future of CT Dosimetry

February 2010

Robert L. Dixon, Ph.D., Chair of TG-111
CT dose measurement techniques have not kept pace with CT technology

**TG-111**

\[ CTDI_{100} = \frac{1}{nT} \int_{-50mm}^{50mm} D(z) \, dz \]
CT phantoms have not kept pace with CT applications or acquisition modes

TG-200 Phantoms for CT

Length Diameter Composition Shape

(C₅O₂H₈)ₙ
(C₂H₄)ₙ
H₂O

Phantom images courtesy of various web sites, Dr. Cynthia McCollough, and Dr. Robert Dixon
TG-xxx
Pediatric CTDI_w
ICRU

Patient Dose Assessment and Image Quality in Computed Tomography
ICRU CT phantom and analyses

- **Contrast**
- **Spatial resolution (MTF)**
- **Dosimetry**
- **Contrast resolution (NPS)**

*Graphs showing MTF and NPS for different conditions.*
ICRU CT phantom evaluation

<table>
<thead>
<tr>
<th></th>
<th>Old Era</th>
<th>New Era</th>
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<tbody>
<tr>
<td>phantom</td>
<td>complicated</td>
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<tr>
<td>analysis</td>
<td>simple</td>
<td>complicated</td>
</tr>
<tr>
<td>results</td>
<td>perfunctory</td>
<td>useful &amp; quantitative</td>
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</table>
Historical CT dose evaluation
ICRU CT beam evaluation
National / International Activities

Dose Reporting (ACR, etc)
Reference Doses (NCRP)
Dose Information in DICOM header
Moving Forward:

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Technology Assessment Institute: Summit on CT Dose

Traditional Books

Walter Huda

Leidholdt  Bushberg  Seibert  Boone

Bill Hendee  Russ Ritenour
Medical Physicists must take the lead in CT and CT Dose Education

Radiologists and Technologists don’t design CT scanners, MP’s do

76% of you are Medical Physicists
Medical Physics

Industry

Radiologists

Technologists
Radiation-induced temporary hair loss as a radiation damage only occurring in patients who had the combination of MDCT and DSA.


The dose information was there on the CT scanner.
Technology Assessment Institute: Summit on CT Dose

- GE VCT (1)
- GE VCT (2)
- GE Lightspeed 16
- Toshiba Aquilion
- Siemens Definition
- GE Discovery
- Ceretom
- Siemens Sensation 64
- Siemens AS+

UC Davis Medical Center Main Hospital

Placer Center for Health
Ellison Ambulatory Care Center

9 CT scanners
only two are the same model
The parameters selected will result in a CT dose that is above the 75 percentile for this examination.

Do you want to proceed?
Patient: Ann Smith  
DOB: 4-29-1940  
Accession Number: ABCDEF  
Referring Physician: Dr. Alan Jones  
Technologist: Alison Omega-Hansley

This scan

Typical scan

Abdomen-Pelvis

kVp: 120  
mA: 600  
Rotation time: 0.50 sec  
Pitch: 0.95  
CTDvol: 23 mGy  
Length: 32.5 cm  
DLP: 715 mGy-cm

RECON FILTER: xxx  
64 x 1.00 mm  
Delivery: PACS-1
Training Modules: MITA
Medical Imaging and Technology Alliance
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Technology Assessment Institute: Summit on CT Dose

University of California Davis Medical Center, Department of Radiology, Sacramento, California

John M. Boone, Ph.D.  J. Anthony Seibert, Ph.D.

Dr. Ramit Lamba – CT doc
Chief of Computed Tomography
CT Protocol Development at UC Davis
(on limited budget with few participants)

Department of Radiology
Radiation Use Committee
Health Physics Program
Monitoring local CT utilization

CT use 1997-2005
by age and gender

N = 282,530

Age (Years)

CT Scans

Women
Men
Monitor CT scans *per patient*

- Median: 4
- 80th percentile: 9
- 95th percentile: 20

Mean: 2.88
Physicist Evaluation of CT Perfusion Protocols

1. Meet with Neuroradiologists – techs – administrators
2. Identify all scanners used for CT perfusion
3. Check CT perfusion protocols and evaluate dose (<500 mGy)
4. Lock down scanner security (passwords)
5. Heighten awareness of high dose CT techniques to techs
6. Scrutinize all CT Angiography protocols
7. Evaluate CT technologist training / CT certification (52% CT)
1. Verify that CT techs are using the pediatric dose protocols (manual protocols)
Optimize CT protocols for all scanners

CT protocol book
(Lightspeed 16)

- GE VCT
- Siemens Definition
- Siemens Sensation 64
- Siemens AS+
- Toshiba Aquilion
<table>
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<tr>
<th>kVp</th>
<th>Sub-group</th>
<th>Scanner</th>
<th>CTDI (Head, mGy/100mAs)</th>
<th>CTDI (Body, mGy/100mAs)</th>
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\[
CTDI_w = 0.333 \ CTDI_{100}^{\text{CENTER}} + 0.666 \ CTDI_{100}^{\text{EDGE}}
\]
### mAs values to match CTDI$_{w}$ of GE 16 at 100 mAs

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Other Considerations:

Collimation Width
Gantry Rotation Time
Table Speed (ie. Pitch)
Timing for Contrast Bolus
Reconstruction Filters
Window / Level Settings
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Update from Sacramento

New Bill on Radiation Exposure Prevention

Over the past year there have been several incidents in California hospitals where patients received (Padilla) is new legislation sponsored by the Consumer Attorneys of California which attempts to SB 1237 would require that on all imaging procedures involving ionizing radiation the provider be warned of patient’s risk.

The CRS has met with the author and sponsor to indicate concerns with the bill as drafted since many cases the specific radiation dose is a range that varies based upon the physical aspects of the exam and the patient’s anatomy. The CRS is also concerned that the bill does not require the use of imaging protocols to reduce the effective dose. The bill will be heard this week in Senate Health Committee and major amendments are likely to advocated the inclusion of a delayed mandate for accreditation of CT units in both hospital and in beginning in 2012. We will keep you informed of the progress of this legislation.

Regulations

FDA Preliminary Public Health Notification: Possible Malfunction of Electronic Medical Devices Caused by Computed Tomography (CT) Scanning

Date: July 14, 2008

Dear Healthcare Professional:

This is to alert you to the possibility that the x-rays used during CT examinations may cause some implants and external electronic medical devices to malfunction, and to provide recommendations to reduce the potential risk.

Safety Investigation of CT Brain Perfusion Scans: Update

12/8/2009

Date Issued: December 8, 2009
SB 1237

“…would require that on all imaging procedures involving ionizing radiation the provider would be required to indicate or note the specific radiation dose on the patient’s film.”

“CRS has also advocated the inclusion of a delayed mandate for accreditation of CT units in both hospital and freestanding settings that would parallel the Medicare requirement beginning in 2012.”

Regulations
American College of Radiology
Computed Tomography Services of
U.C. Davis Medical Center
Sacramento, CA

were surveyed by the
Committee on Computed Tomography Accreditation
of the Commission on Quality and Safety

The following unit was approved
General Electric Medical Systems  CT LIGHTSPEED 16  2003
For
Adult & Pediatric Patients

Accredited from:
June 15, 2009 through June 15, 2012

Accreditation
Radiologist  ABR Certified

Medical Physicist  ABR Certified

CT Technologist  ARRT (CT) Certified
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