# What's HOT in CT?

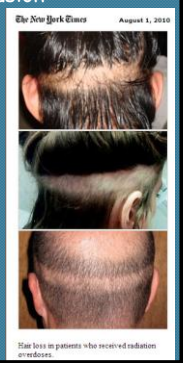
Dianna Cody, Ph.D.
U.T. M.D. Anderson Cancer Center
Houston, TX

## Hot…

- CT Perfusion (still…)
- Protocols online
- AAPM Working Group activities
- CT Dose Check
- Size Specific Dose Estimates (AAPM Rept. 204)

## Still in the news…

- Overexposures due to CT Neuro-Perfusion
  - Cedars-Sinai , CA(Oct. 2009)
  - Huntsville, AL
  - Huntington, WV, March 2011

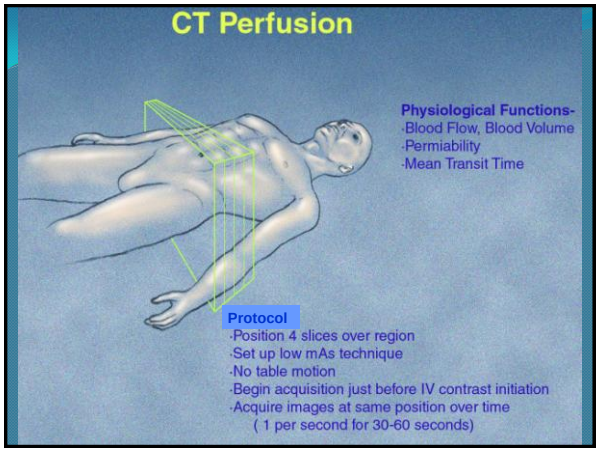


The New York Times August 1, 2010

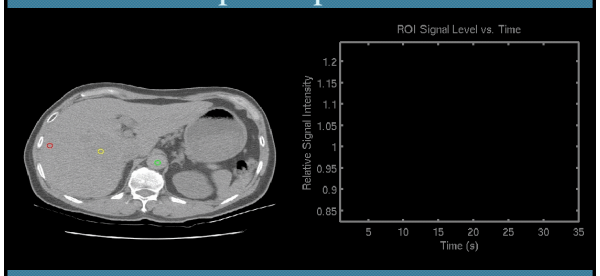
Hair loss in patients who received radiation overdoses.

## What happened at Cedars-Sinai?

- CT perfusion exam
  - Examines blood motion through tissue
    - Stroke (diagnosis)
    - Tumor activity (treatment response)
  - Performed with many rotations of x-ray tube
  - Little or no table motion
  - Small tissue volume receives relatively large amount of radiation



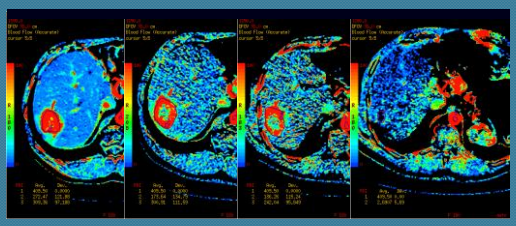

## Example of procedure




**Movie of CT Perfusion acquisition sequence**

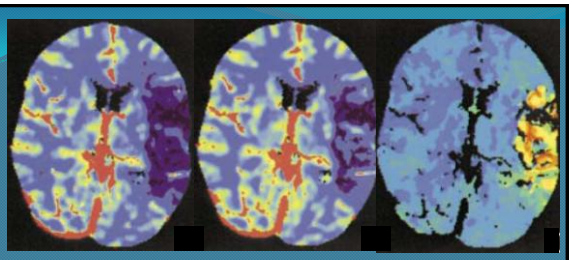
## CT Perfusion

Changes in blood flow after Thalidomide



1/21 272 4/12 173 6/26 136 9/12 2.7

**General Electric CT Perfusion**



Cerebral Blood Flow | Cerebral Blood Volume | Time To Peak Enhancement

CT Perfusion for STROKE
(Siemens)

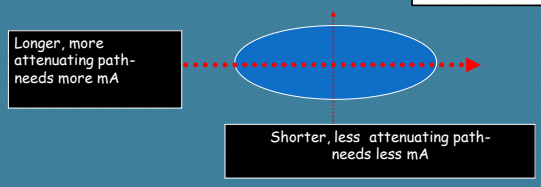
## CT Perfusion Overexposure?

- CT protocol settings were changed
- (No one confessed…)
- Tube current modulation option enabled
- 120 kV (doubles dose relative to 80 kV)
- Noise Index = 2 (?)

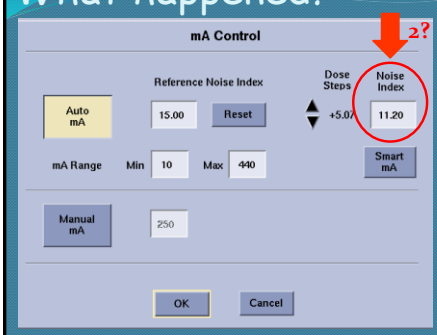
## Tube Current Modulation

- "Right-sizes" technique for body part
- Vary mA as tube rotates around patient to improve x-ray detection through varying attenuation
- Adjusts technique along z-axis

Makes NO sense for head




## What happened?




NI ↓
Noise ↓
Dose ↑

## Lessons to be learned

- Technical review of high-dose CT exams like CT Perfusion is extremely important
- Regular review of these parameters is critical to maintaining patient safety
- Increases pressure to monitor CT protocol parameter adjustments and maintain traceable records

Review and compare to what???

## AAPM Working Group on Standardization of CT Nomenclature and Protocols

Cynthia McCollough
Workgroup Co-Chair

Dianna Cody
Workgroup Co-Chair

## Charge

- Develop consensus protocols for frequently performed CT examinations, summarizing the basic requirements of the exam and giving several model-specific examples of scan and reconstruction parameters.
- Develop a set of standardized terms for use on CT scanners

## Membership

- AAPM
  - Mike McNitt-Gray, Bob Pizzutiello, Jim Kofler
- ACR
  - Mark Armstrong, Penny Butler
- ASRT
  - Kevin Reynolds
- FDA
  - Thalia Mills

## Manufacturers

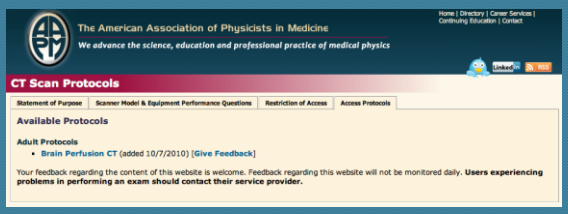
- GE
  - John Jaeckle
- Hitachi
  - Mark Silverman
- Philips
  - Mark Olszewski
- Siemens
  - Christianne Liedecker
- Toshiba
  - Rich Mather
- MITA
  - Stephen Vastagh

## Scanner Protocols

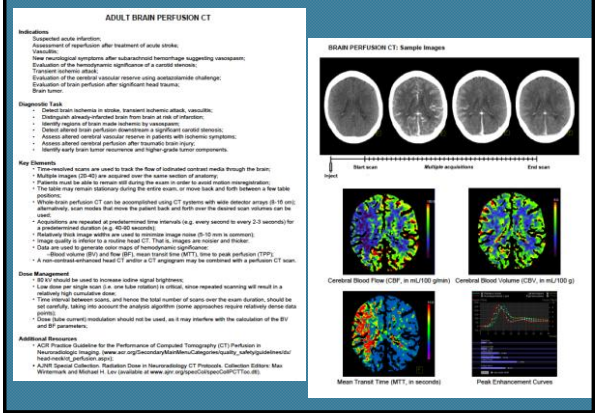
- Peer review process
- Protocol databases for sites to confirm their approach is reasonable

http://www.aapm.org/pubs/CTProtocols/

*American Association of Physicists in Medicine*




*American Association of Physicists in Medicine*



ADULT BRAIN PERFUSION CT

**Indications**

Suspected acute infarction;
Assessment of reperfusion after treatment of acute stroke;
Vasculitis;
New neurological symptoms after subarachnoid hemorrhage suggesting vasospasm;
Evaluation of the hemodynamic significance of a carotid stenosis;
Transient ischemic attack;
Evaluation of the cerebral vascular reserve using acetazolamide challenge;
Evaluation of brain perfusion after significant head trauma;
Brain tumor.

**Diagnostic Task**

- Detect brain ischemia in stroke, transient ischemic attack, vasculitis;
- Distinguish already-infarcted brain from brain at risk of infarction;
- Identify regions of brain made ischemic by vasospasm;
- Detect altered brain perfusion downstream a significant carotid stenosis;
- Assess altered cerebral vascular reserve in patients with ischemic symptoms;
- Assess altered cerebral perfusion after traumatic brain injury;
- Identify early brain tumor recurrence and higher-grade tumor components.

**Key Elements**

- Time-resolved scans are used to track the flow of iodinated contrast media through the brain;
- Multiple images (20-40) are acquired over the same section of anatomy;
- Patients must be able to remain still during the exam in order to avoid motion misregistration;
- The table may remain stationary during the entire exam, or move back and forth between a few table positions;
- Whole-brain perfusion CT can be accomplished using CT systems with wide detector arrays (8-16 cm); alternatively, scan modes that move the patient back and forth over the desired scan volumes can be used;
- Acquisitions are repeated at predetermined time intervals (e.g. every second to every 2-3 seconds) for a predetermined duration (e.g. 45-60 seconds);
- Relatively thick image widths are used to minimize image noise (5-10 mm is common);
- Image quality is inferior to a routine head CT. That is, images are noisier and thicker;
- Data are used to generate color maps of hemodynamic significance:
  - Blood volume (BV) and flow (BF), mean transit time (MTT), time to peak perfusion (TPP);
- A non-contrast-enhanced head CT and/or a CT angiogram may be combined with a perfusion CT scan.

**Dose Management**

- 80 kV should be used to increase iodine signal brightness;
- Low dose per single scan (i.e. one tube rotation) is critical, since repeated scanning will result in a relatively high cumulative dose;
- Time interval between scans, and hence the total number of scans over the exam duration, should be set carefully, taking into account the analysis algorithm (some approaches require relatively dense data points);
- Dose (tube current) modulation should not be used, as it may interfere with the calculation of the BV and BF parameters;

**Additional Resources**

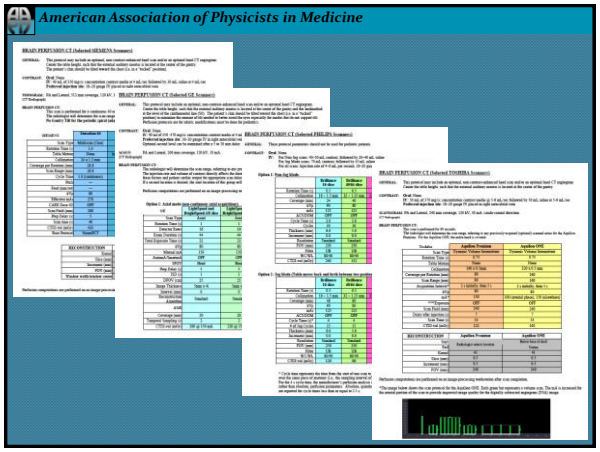
- ACR Practice Guideline for the Performance of Computed Tomography (CT) Perfusion in Neuroradiologic Imaging. (www.acr.org/SecondaryMainMenuCategories/quality_safety/guidelines/ct/head-neck/ct_perfusion.aspx);
- AJNR Special Collection: Radiation Dose in Neuroradiology CT Protocols, Collection Editors: Max Wintermark and Michael H. Lev (available at www.ajnr.org/specCollspecCollPCTToc.dtl).

BRAIN PERFUSION CT: Sample Images

Inject | Start scan | Multiple acquisitions | End scan

Cerebral Blood Flow (CBF, in mL/100 g/min) | Cerebral Blood Volume (CBV, in mL/100 g)

Mean Transit Time (MTT, in seconds) | Peak Enhancement Curves



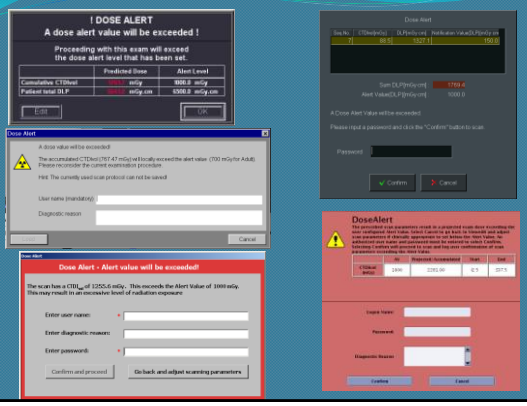

## Work in progress…

- More routine CT exams:
  - Head CT
  - Chest CT
  - Abdomen & Pelvis
  - Chest, Abdomen, Pelvis CT
  - Coronary Calcium Scoring CT

## CT Dose Check Feature

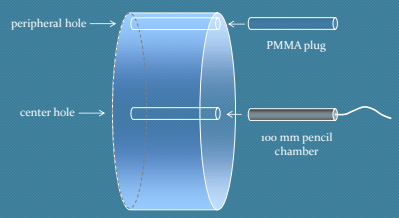
- New MITA Standard
- Intended to serve as safety feature on new scanners
- Two levels of dose checking:
  - Alert: 1 Gy (for entire exam)
  - Notification (for each pass over patient)
- Dose check levels will be adjustable by site
- Scanners to be delivered with initial default values

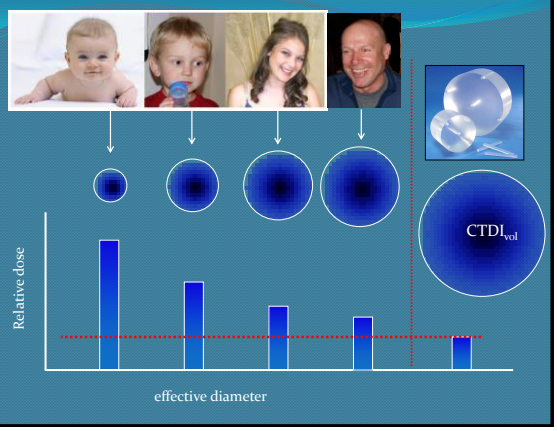
## New Feature – CT Dose Check



# CT dosimetry for the pediatric patient

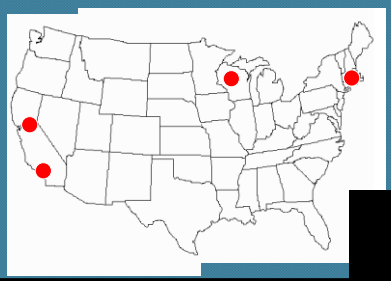
John M. Boone, Ph.D., FAAPM, FSBI, FACR
Professor and Vice Chairman of Radiology
Professor of Biomedical Engineering
University of California at Davis


## *TG-204 Approach*

Combined the size-dependent CT dose data from four independent US research groups

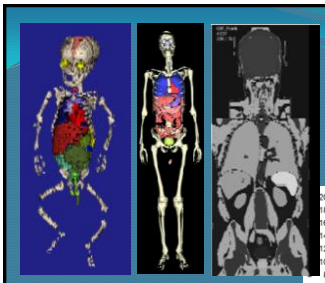


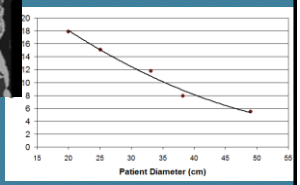
| TOTH DATA | | |
|---|---|---|
| Pediatric Body | | |
| Diameter | A32 | a16 |
| 5 | 2.93 | 1.45 |
| 10 | 2.63 | 1.31 |
| 15 | 2.33 | 1.16 |
| 20 | 2.04 | 1.02 |
| 25 | 1.74 | 0.87 |
| 30 | 1.44 | 0.73 |
| 35 | 1.14 | 0.58 |
| 40 | 0.85 | 0.44 |

standard phantoms
Tom Toth & Keith Strauss

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | sequential) | 4J | | |
| | | | | | | | | | | | ck | 6 oclock | Ave | Normed |
| | | | | | | | | | | | | | Periphery | CTDIvol |
| New Born | 8.9 | 10.6 | 296.3719 | | 1.95227 | 2.24324 | 2.13312 | 1.9466 | 2.12432 | 2.06695 |
| Fat New Born | 11.1 | 10.6 | 369.6398 | | 1.7339 | 2.20184 | 1.94263 | 1.8723 | 2.00559 | 1.91501 |
| 1 Year Old | 11.4 | 14 | 501.3982 | | 1.93582 | 2.35611 | 2.2665 | 1.98857 | 2.20373 | 2.1144 |
| 5 Year Old | 13.9 | 18 | 786.0265 | 15.81771 | 1.70951 | 2.25402 | 2.09577 | 1.91711 | 2.08897 | 1.96246 |
| 10 Year Old | 16 | 20.6 | 1035.469 | 18.15489 | 1.47867 | 2.14852 | 1.95114 | 1.79006 | 1.96324 | 1.8017 |
| 15 Year Old | 18.4 | 24 | 1387.327 | 21.01428 | 1.30908 | 2.12356 | 1.82352 | 1.81047 | 1.91919 | 1.7158 |
| Fat 15 Year Old | 29.3 | 24 | 2209.168 | 26.51792 | 0.95855 | 1.5507 | 1.74695 | 1.20812 | 1.50192 | 1.32079 |
| Small Adult | 22 | 30 | 2073.451 | 25.69047 | 1.02718 | 1.91654 | 1.59608 | 1.62103 | 1.71122 | 1.48319 |
| Medium Adult | 24.9 | 32.4 | 2534.511 | 28.40352 | 0.89616 | 1.77985 | 1.50249 | 1.53992 | 1.60742 | 1.37032 |
| Large Adult | 30.7 | 38.9 | 3751.784 | 34.55763 | 0.58137 | 1.53822 | 1.3692 | 1.32609 | 1.41117 | 1.13456 |
| Fat Large Adult | 40 | 38.9 | 4888.318 | 39.44617 | 0.45024 | 1.0898 | 1.24898 | 1.19403 | 1.1776 | 0.93514 |

Family of physical phantoms
Cynthia McCollough, Mayo Clinic



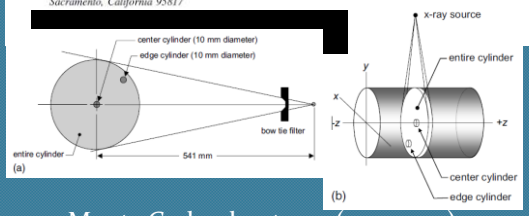



Anthropomorphic Monte Carlo phantoms
Mike McNitt-Gray, UCLA

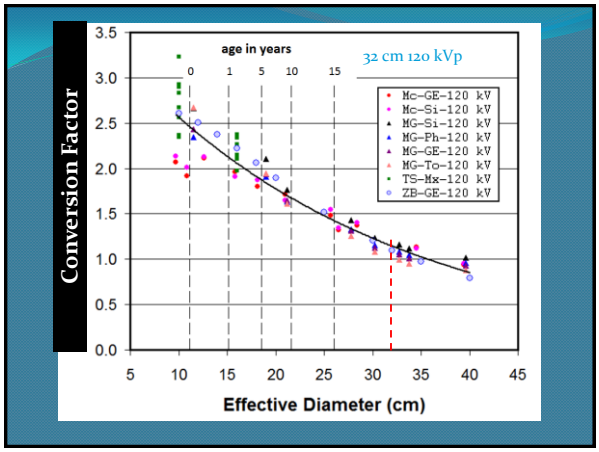
**Monte Carlo evaluation of CTDI$_\infty$ in infinitely long cylinders of water, polyethylene and PMMA with diameters from 10 mm to 500 mm**

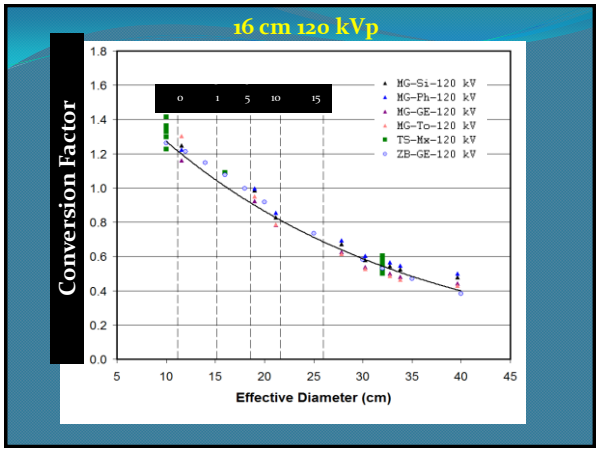
Hong Zhou
*Department of Radiology and Department of Radiation Oncology, University of California, Davis, Sacramento, California 95817*
John M. Boone[a)]
*Department of Radiology and Department of Biomedical Engineering, University of California, Davis, Sacramento, California 95817*

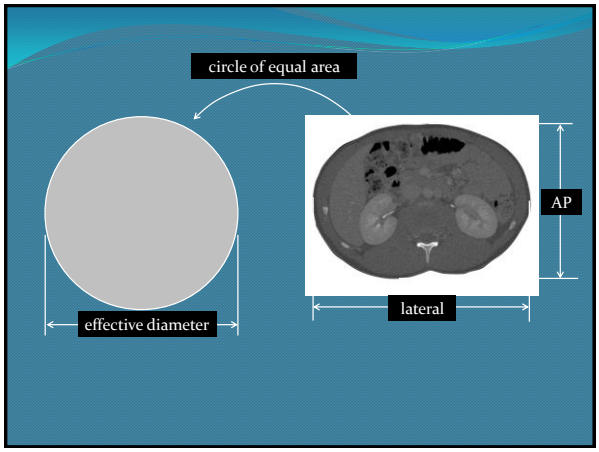
[redacted]

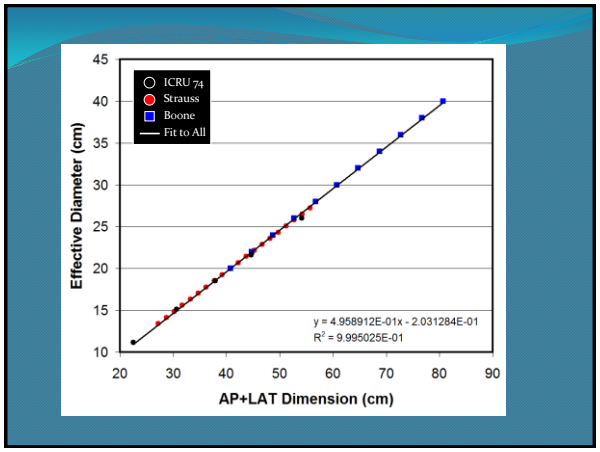



Monte Carlo phantoms (1 – 50 cm)
John M. Boone, UC Davis


Conversion Factor
age in years
0
1
5
10
15
32 cm 120 kVp
Mc-GE-120 kV
Mc-Si-120 kV
MG-Si-120 kV
MG-Ph-120 kV
MG-GE-120 kV
MG-To-120 kV
TS-Mx-120 kV
ZB-GE-120 kV
Effective Diameter (cm)


16 cm 120 kVp
Conversion Factor
0
1
5
10
15
MG-Si-120 kV
MG-Ph-120 kV
MG-GE-120 kV
MG-To-120 kV
TS-Mx-120 kV
ZB-GE-120 kV
Effective Diameter (cm)


circle of equal area
AP
effective diameter
lateral

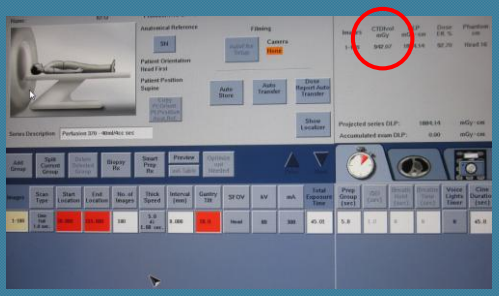

ICRU 74
Strauss
Boone
Fit to All
Effective Diameter (cm)
y = 4.958912E-01x - 2.031284E-01
R² = 9.995025E-01
AP+LAT Dimension (cm)

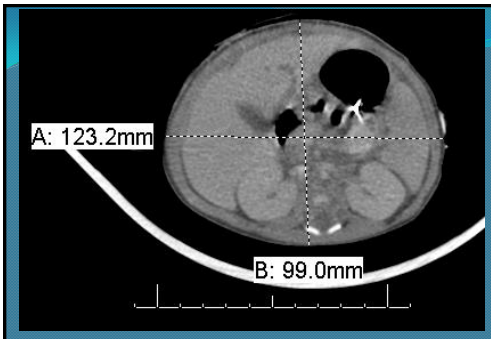
## Practical Implementation during Patient Scanning

CT Radiograph

| Lateral Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 8 | 9.2 | 2.65 |
| 9 | 9.7 | 2.60 |
| 10 | 10.2 | 2.55 |
| 11 | 10.7 | 2.50 |
| 12 | 11.3 | 2.45 |
| 13 | 11.8 | 2.40 |
| 14 | 12.4 | 2.35 |
| 15 | 13.1 | 2.29 |
| 16 | 13.7 | 2.24 |
| 17 | 14.3 | 2.19 |
| 18 | 15.0 | 2.13 |
| 19 | 15.7 | 2.08 |
| 20 | 16.4 | 2.03 |
| ⋮ | | |
| 38 | 32.7 | 1.11 |
| 39 | 33.8 | 1.07 |
| 40 | 34.9 | 1.03 |

## Dose Index value ($CTDI_{vol}$) is on most scanners.....






Lat + AP = 12.3 + 9.9 cm = 22.2 cm

5.40 mGy = $CTDI_{vol}$ (32 cm phantom)

| Lat + AP Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 15 | 7.2 | 2.84 |
| 16 | 7.7 | 2.79 |
| 17 | 8.2 | 2.74 |
| 18 | 8.7 | 2.69 |
| 19 | 9.2 | 2.64 |
| 20 | 9.7 | 2.59 |
| 21 | 10.2 | 2.55 |
| 22 | 10.7 | 2.50 |
| 23 | 11.2 | 2.46 |
| 24 | 11.7 | 2.41 |
| 25 | 12.2 | 2.37 |
| 26 | 12.7 | 2.32 |
| 27 | 13.2 | 2.28 |
| 28 | 13.7 | 2.24 |
| 29 | 14.2 | 2.20 |
| 30 | 14.7 | 2.16 |
| ⋮ | | |
| 48 | 23.6 | 1.56 |
| 49 | 24.1 | 1.53 |
| 50 | 24.6 | 1.50 |
| 51 | 25.1 | 1.47 |
| 52 | 25.6 | 1.45 |
| 53 | 26.1 | 1.42 |

5.40 mGy = $CTDI_{vol}$

Size Specific Dose Estimate

SSDE = 5.4 mGy × 2.5

SSDE = 13.5 mGy

## 16 cm $CTDI_{vol}$ conversion factors

**Table 2A**

| Lat + AP Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 16 | 7.7 | 1.39 |
| 17 | 8.2 | 1.36 |
| 18 | 8.7 | 1.34 |
| 19 | 9.2 | 1.31 |
| 20 | 9.7 | 1.29 |
| 21 | 10.2 | 1.26 |
| 22 | 10.7 | 1.24 |
| 23 | 11.2 | 1.22 |
| 24 | 11.7 | 1.19 |
| 25 | 12.2 | 1.17 |
| 26 | 12.7 | 1.15 |
| 27 | 13.2 | 1.13 |
| 28 | 13.7 | 1.10 |
| 29 | 14.2 | 1.08 |
| 30 | 14.7 | 1.06 |
| 31 | 15.2 | 1.04 |
| 32 | 15.7 | 1.02 |
| 33 | 16.2 | 1.00 |
| 34 | 16.7 | 0.98 |
| 35 | 17.2 | 0.97 |
| 36 | 17.6 | 0.95 |
| 37 | 18.1 | 0.93 |
| 38 | 18.6 | 0.91 |
| 39 | 19.1 | 0.89 |
| 40 | 19.6 | 0.88 |

**Table 2B**

| Lateral Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 8 | 9.2 | 1.32 |
| 9 | 9.7 | 1.29 |
| 10 | 10.2 | 1.26 |
| 11 | 10.7 | 1.24 |
| 12 | 11.3 | 1.21 |
| 13 | 11.8 | 1.19 |
| 14 | 12.4 | 1.16 |
| 15 | 13.1 | 1.13 |
| 16 | 13.7 | 1.10 |
| 17 | 14.3 | 1.08 |
| 18 | 15.0 | 1.05 |
| 19 | 15.7 | 1.02 |
| 20 | 16.4 | 0.99 |
| 21 | 17.2 | 0.96 |
| 22 | 17.9 | 0.94 |
| 23 | 18.7 | 0.91 |
| 24 | 19.5 | 0.88 |
| 25 | 20.3 | 0.85 |
| 26 | 21.1 | 0.83 |
| 27 | 22.0 | 0.80 |
| 28 | 22.9 | 0.77 |
| 29 | 23.8 | 0.75 |
| 30 | 24.7 | 0.72 |
| 31 | 25.6 | 0.70 |
| 32 | 26.6 | 0.67 |

**Table 2C**

| AP Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 8 | 8.8 | 1.33 |
| 9 | 10.2 | 1.26 |
| 10 | 11.6 | 1.19 |
| 11 | 13.0 | 1.13 |
| 12 | 14.4 | 1.07 |
| 13 | 15.7 | 1.02 |
| 14 | 17.0 | 0.97 |
| 15 | 18.3 | 0.92 |
| 16 | [illegible] | [illegible] |
| 17 | [illegible] | [illegible] |
| 18 | [illegible] | [illegible] |
| 19 | [illegible] | [illegible] |
| 20 | [illegible] | [illegible] |
| 21 | [illegible] | [illegible] |
| 22 | [illegible] | [illegible] |
| 23 | [illegible] | [illegible] |
| 24 | [illegible] | [illegible] |
| 25 | [illegible] | [illegible] |
| 26 | [illegible] | [illegible] |
| 27 | [illegible] | [illegible] |
| 28 | [illegible] | [illegible] |
| 29 | [illegible] | [illegible] |
| 30 | [illegible] | [illegible] |
| 31 | [illegible] | [illegible] |
| 32 | [illegible] | [illegible] |

**Table 2D**

| Effective Dia (cm) | Correction Factor |
|---|---|
| 8 | 1.38 |
| 9 | 1.32 |
| 10 | 1.27 |
| 11 | 1.22 |
| 12 | 1.18 |
| 13 | 1.13 |
| 14 | 1.09 |
| 15 | 1.05 |
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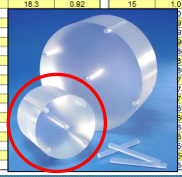

## 32 cm $CTDI_{vol}$ conversion factors

**Table 1A**

| Lat + AP Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 16 | 7.7 | 2.38 |
| 17 | 8.2 | 2.36 |
| 18 | 8.7 | 2.33 |
| 19 | 9.2 | 2.31 |
| 20 | 9.7 | 2.28 |
| 21 | 10.2 | 2.25 |
| 22 | 10.7 | 2.22 |
| 23 | 11.2 | 2.20 |
| 24 | 11.7 | 2.17 |
| 25 | 12.2 | 2.14 |
| 26 | 12.7 | 2.12 |
| 27 | 13.2 | 2.09 |
| 28 | 13.7 | 2.06 |
| 29 | 14.2 | 2.03 |
| 30 | 14.7 | 2.00 |
| 31 | 15.2 | 2.12 |
| 32 | 15.7 | 2.08 |
| 33 | 16.2 | 2.05 |
| 34 | 16.7 | 2.01 |
| 35 | 17.2 | 1.97 |
| 36 | 17.6 | 1.94 |
| 37 | 18.1 | 1.90 |
| 38 | 18.6 | 1.87 |
| 39 | 19.1 | 1.83 |
| 40 | 19.6 | 1.80 |
| 41 | 20.1 | 1.77 |
| 42 | 20.6 | 1.74 |
| 43 | 21.1 | 1.71 |
| 44 | 21.6 | 1.67 |
| 45 | 22.1 | 1.64 |
| 46 | 22.6 | 1.62 |
| 47 | 23.1 | 1.59 |
| 48 | 23.6 | 1.56 |
| 49 | 24.1 | 1.53 |
| 50 | 24.6 | 1.50 |
| 51 | 25.1 | 1.47 |
| 52 | 25.6 | 1.45 |
| 53 | 26.1 | 1.42 |
| 54 | 26.6 | 1.40 |
| 55 | 27.1 | 1.37 |
| 56 | 27.6 | 1.35 |
| 57 | 28.1 | 1.32 |
| 58 | 28.6 | 1.30 |
| 59 | 29.1 | 1.27 |
| 60 | 29.6 | 1.25 |
| 61 | 30.0 | 1.23 |
| 62 | 30.5 | 1.21 |
| 63 | 31.0 | 1.19 |
| 64 | 31.5 | 1.16 |

**Table 1B**

| Lateral Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 8 | 8.3 | 2.74 |
| 9 | 9.0 | 2.65 |
| 10 | 9.7 | 2.60 |
| 11 | 10.3 | 2.53 |
| 12 | 11.1 | 2.45 |
| 13 | 11.8 | 2.40 |
| 14 | 12.4 | 2.35 |
| 15 | 13.1 | 2.29 |
| 16 | 13.7 | 2.24 |
| 17 | 14.3 | 2.19 |
| 18 | 15.0 | 2.13 |
| 19 | 15.7 | 2.08 |
| 20 | 16.4 | 2.03 |
| 21 | 17.2 | 1.97 |
| 22 | 17.9 | 1.92 |
| 23 | 18.7 | 1.86 |
| 24 | 19.5 | 1.81 |
| 25 | 20.3 | 1.76 |
| 26 | 21.1 | 1.70 |
| 27 | 22.0 | 1.65 |
| 28 | 22.9 | 1.60 |
| 29 | 23.8 | 1.55 |
| 30 | 24.7 | 1.50 |
| 31 | 25.6 | 1.45 |
| 32 | 26.6 | 1.40 |
| 33 | 27.6 | 1.35 |
| 34 | 28.6 | 1.30 |
| 35 | 29.6 | 1.25 |
| 36 | 30.6 | 1.20 |
| 37 | 31.7 | 1.16 |
| 38 | 32.7 | 1.11 |
| 39 | 33.8 | 1.07 |
| 40 | 34.9 | 1.03 |
| 41 | 36.1 | 0.98 |
| 42 | 37.2 | 0.94 |
| 43 | 38.4 | 0.90 |
| 44 | 39.6 | 0.87 |
| 45 | 40.8 | 0.83 |
| 46 | 42.1 | 0.79 |
| 47 | 43.3 | 0.76 |
| 48 | 44.6 | 0.72 |
| 49 | 45.9 | 0.69 |
| 50 | 47.2 | 0.65 |
| 51 | 48.5 | 0.62 |
| 52 | 49.9 | 0.59 |
| 53 | 51.3 | 0.56 |
| 54 | 52.7 | 0.54 |
| 55 | 54.1 | 0.51 |

**Table 1C**

| AP Dim (cm) | Effective Dia (cm) | Correction Factor |
|---|---|---|
| 8 | 9.3 | 2.88 |
| 9 | 10.8 | 2.67 |
| 10 | 12.2 | 2.45 |
| 11 | 13.6 | 2.36 |
| 12 | 14.4 | 2.16 |
| 13 | 15.7 | 2.08 |
| 14 | 17.0 | 2.00 |
| 15 | 18.3 | 1.85 |
| 16 | 19.6 | 1.81 |
| 17 | 20.8 | 1.73 |
| 18 | 22.0 | 1.65 |
| 19 | 23.2 | 1.58 |
| 20 | 24.3 | 1.52 |
| 21 | 25.5 | 1.46 |
| 22 | 26.6 | 1.40 |
| 23 | 27.6 | 1.34 |
| 24 | 28.7 | 1.29 |
| 25 | 29.7 | 1.25 |
| 26 | 30.7 | 1.20 |
| 27 | 31.6 | 1.16 |
| 28 | 32.6 | 1.12 |
| 29 | 33.5 | 1.08 |
| 30 | 34.4 | 1.05 |
| 31 | 35.2 | 1.02 |
| 32 | 36.0 | 0.98 |
| 33 | 36.8 | 0.96 |
| 34 | 37.6 | 0.93 |
| 35 | 38.4 | 0.91 |
| 36 | 39.1 | 0.88 |
| 37 | 39.8 | 0.86 |
| 38 | 40.4 | 0.84 |
| 39 | 41.1 | 0.82 |
| 40 | 41.7 | 0.80 |
| 41 | 42.3 | 0.78 |
| 42 | 42.8 | 0.77 |
| 43 | 43.4 | 0.75 |
| 44 | 43.9 | 0.74 |
| 45 | 44.4 | 0.72 |
| 46 | 44.8 | 0.71 |
| 47 | 45.2 | 0.70 |
| 48 | 45.6 | 0.69 |
| 49 | 46.0 | 0.68 |
| 50 | 46.4 | 0.67 |
| 51 | 46.7 | 0.67 |
| 52 | 47.0 | 0.66 |
| 53 | 47.2 | 0.65 |
| 54 | 47.5 | 0.65 |
| 55 | 47.7 | 0.64 |

**Table 1D**

| Effective Dia (cm) | Correction Factor |
|---|---|
| 8 | 2.97 |
| 9 | 2.86 |
| 10 | 2.86 |
| 11 | 2.47 |
| 12 | 2.38 |
| 13 | 2.30 |
| 14 | 2.22 |
| 15 | 2.14 |
| 16 | 2.06 |
| 17 | 1.98 |
| 18 | 1.91 |
| 19 | 1.84 |
| 20 | 1.78 |
| 21 | 1.73 |
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## What does new metric mean?

- Size corrected CTDIvol
- DO NOT apply standard k-factors to this value willy-nilly
  - k-factors based on standard man size
  - Will require some effort to sort out step to effective dose
- May be similar to average organ dose

## 2nd AAPM Summit on CT Dose

Interdisciplinary Program on Scan Parameter Optimization for Radiologists, Technologists and Physicists

**October 6-7, 2011**
**Denver, Colorado**