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

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
CT Perfusion

Protocol
- Position 4 slices over region
- Set up low mA technique
- No table motion
- Begin acquisition just before IV contrast initiation
- Acquire images at same position over time
  (1 per second for 30-60 seconds)

Physiological Functions:
-Blood Flow, Blood Volume
-Permeability
-Mean Transit Time

Example of procedure

CT Perfusion
Changes in blood flow after Thalidomide

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

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

**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/
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
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
standard phantoms
Tom Toth & Keith Strauss

Family of physical phantoms
Cynthia McCollough, Mayo Clinic

Anthropomorphic Monte Carlo phantoms
Mike McNitt-Gray, UCLA

Monte Carlo evaluation of CTDI<sub>100</sub> 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 95617

John M. Boone
Department of Radiology and Department of Biomedical Engineering, University of California, Davis, Sacramento, California 95617

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

32 cm 120 kVp

age in years

Conversion Factor

16 cm 120 kVp

circle of equal area

effective diameter

Lateral

AP

ICRU 74

Strauss

Boone

Fit to All

ICRU 74

Strauss

Boone

Fit to All

$y = 4.9589x - 2.03124x - 0.1$
Practical Implementation during Patient Scanning

CT Radiograph

Dose Index value (CTDI\textsubscript{vol}) is on most scanners.....

Lat + AP = 12.3 + 9.9 cm = 22.2 cm

5.40 mGy = CTDI\textsubscript{vol} (32 cm phantom)

5.40 mGy = CTDI\textsubscript{vol}

Size Specific Dose Estimate

SSDE = 5.4 mGy × 2.5

SSDE = 13.5 mGy
What does new metric mean?
- Size corrected CTDI\textsubscript{vol}
- 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