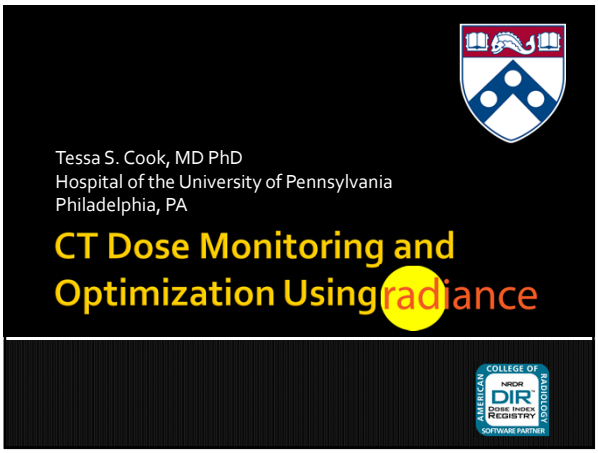


Disclosures

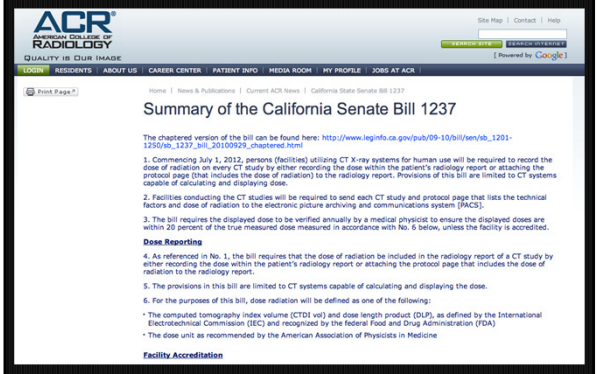
- No financial disclosures
- Principal developer of RADIANCE (http://www.radiancedose.com) - free, open-source dose monitoring tool

Objectives

1. Describe some of the challenges in CT dose monitoring
2. Summarize the development of a dose monitoring/quality assurance program
3. Describe our facility's experience with CT dose monitoring and protocol optimization

Why Monitor Radiation Dose?

- Known effects of exposure to high doses of imaging-related radiation, and potential effects to low doses
- Increased awareness in the scientific community, lay press and federal and state legislatures
- We monitor doses of other substances we administer to patients….
- We'll use CT dose metrics as an example in this talk, but dose monitoring is essential in all modalities



ACR AMERICAN COLLEGE OF RADIOLOGY
QUALITY IS OUR IMAGE

Summary of the California Senate Bill 1237

The chaptered version of the bill can be found here: http://www.leginfo.ca.gov/pub/09-10/bill/sen/sb_1201-1250/sb_1237_bill_20100929_chaptered.html

1. Commencing July 1, 2012, persons (facilities) utilizing CT X-ray systems for human use will be required to record the dose of radiation on every CT study by either recording the dose within the patient's radiology report or attaching the protocol page (that includes the dose of radiation) to the radiology report. Provisions of this bill are limited to CT systems capable of calculating and displaying dose.

2. Facilities conducting the CT studies will be required to send each CT study and protocol page that lists the technical factors and dose of radiation to the electronic picture archiving and communications system (PACS).

3. The bill requires the displayed dose to be verified annually by a medical physicist to ensure the displayed doses are within 20 percent of the true measured dose measured in accordance with No. 6 below, unless the facility is accredited.

Dose Reporting

4. As referenced in No. 1, the bill requires that the dose of radiation be included in the radiology report of a CT study by either recording the dose within the patient's radiology report or attaching the protocol page that includes the dose of radiation to the radiology report.

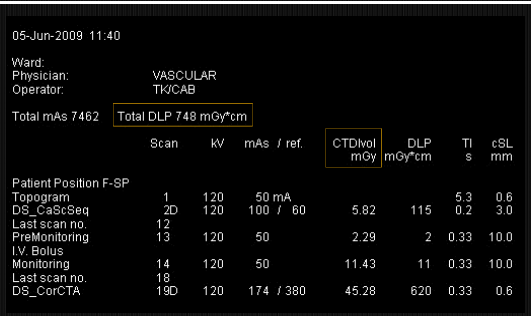
5. The provisions in this bill are limited to CT systems capable of calculating and displaying the dose.

6. For the purposes of this bill, dose radiation will be defined as one of the following:

- The computed tomography index volume (CTDI vol) and dose length product (DLP), as defined by the International Electrotechnical Commission (IEC) and recognized by the federal Food and Drug Administration (FDA)
- The dose unit as recommended by the American Association of Physicists in Medicine

Facility Accreditation

The CT Dose Sheet: (One Place) Where the Data Is



05-Jun-2009 11:40

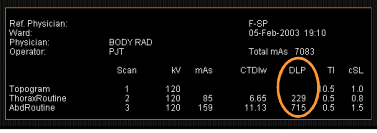
Ward:
Physician: VASCULAR
Operator: TK/CAB

Total mAs 7462 Total DLP 748 mGy*cm

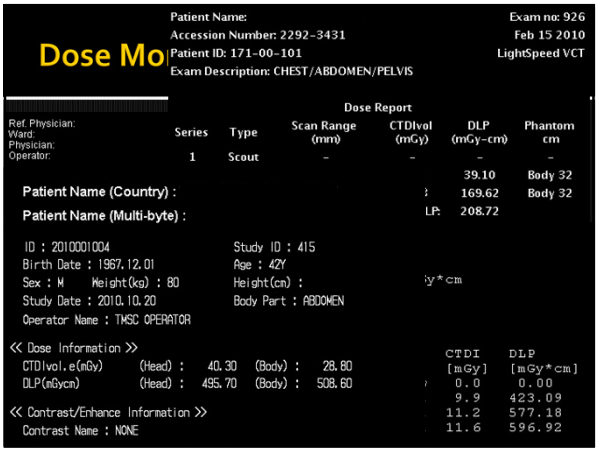
	Scan	kV	mAs / ref.	CTDIvol mGy	DLP mGy*cm	TI s	cSL mm
Patient Position F-SP							
Topogram	1	120	50 mA			5.3	0.6
DS_CaScSeq	2D	120	100 / 60	5.82	115	0.2	3.0
Last scan no.	12						
PreMonitoring	13	120	50	2.29	2	0.33	10.0
I.V. Bolus							
Monitoring	14	120	50	11.43	11	0.33	10.0
Last scan no.	18						
DS_CorCTA	19D	120	174 / 380	45.28	620	0.33	0.6

Dose Monitoring: Challenges

- Dose related parameters stored as pixel data, not structured data
- "Dose indices," which are measured in a standardized phantom and in a standardized fashion
- NOT actual patient doses, but measures of machine energy output



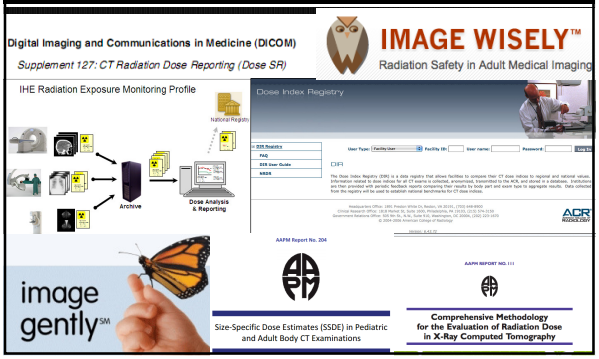
Dose Mo



Dose Monitoring: Even More Challenges

- Actual patient dose depends on
  - Scanner parameters
  - Gender
  - Age
  - Body habitus
  - Anatomy imaged
  - Number of phases of imaging
- We are monitoring the radiation output of our equipment, as that is what the operator has control of and must be configuring properly

Responding to the Challenges



Practical Limitations

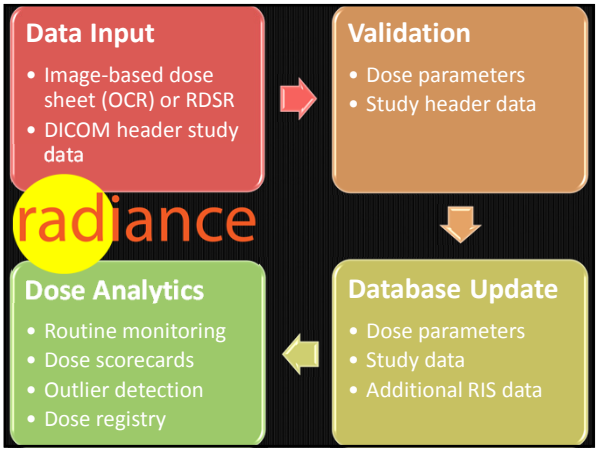
- Not all scanners currently produce RDSR (radiation dose structured reports)
  - Originally the only means of transmitting data to the ACR's Dose Index Registry
- **Large** numbers of CT exams with image-based dose sheets already exist around the world
- How can we monitor dose today?

Dose Monitoring Options

radiance
iMALOGIX
AWARE
DOSEMONITOR®
GROK
PEMNET®
Patient Exposure Management NETwork
EASY DOSE IT
radimetrics

Choosing a Dose Monitoring Solution

- Open-source vs. commercial
- Dose sheet only vs. RDSR only vs. both
- CT only vs. multi-modality
- Dose monitoring only vs. dose/utilization monitoring



Features of radiance

- Automated extraction pipeline
- Compatible with multiple vendors

PHILIPS SIEMENS TOSHIBA NeuroLogica

- Small footprint – standard Windows PC, all open-source components
- Imports from image-based dose sheets or RDSRs
- Built-in reporting tools
- Can send to the ACR Dose Index Registry

Cook et al., JACR 7(11): 871-877, 2010

RADIANCE Reporting Tools

RADIANCE Dashboard

- Built on top of the RADIANCE database
- Analyze dose parameters by
  - Study type
  - Scanner model
  - Performing technologist*
  - Reporting radiologist*
- Identify outliers
- View patient profile

*If RIS integration enabled

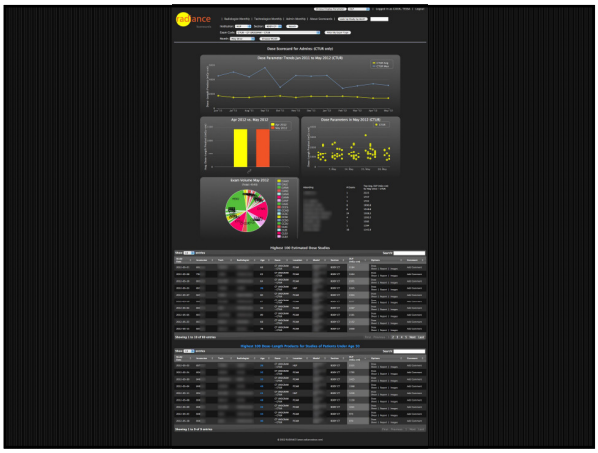
Cook et al., RadioGraphics 31: 1833-1846, 2011

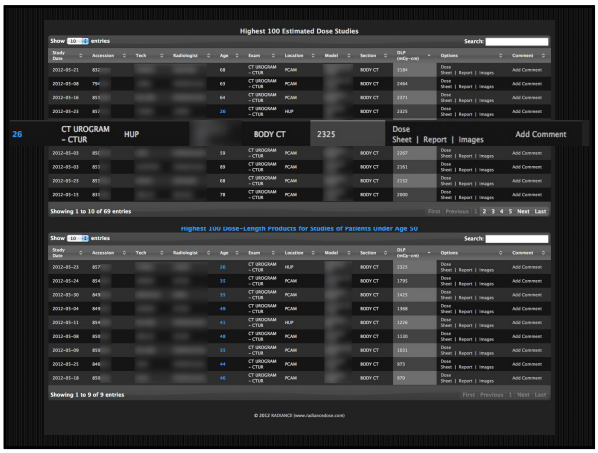
Dashboard: Scanner

RADIANCE Scorecards

- Updated monthly – all radiologists, technologists, physicists, etc.
- Tailored to the role of the recipient
- Facilitate review of dose parameters
- Allow users to leave feedback

Cook et al., RSNA 2012

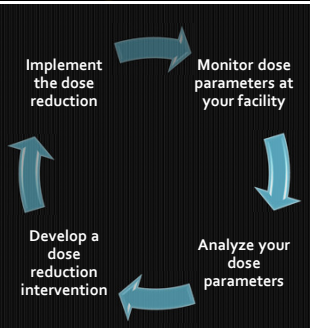




RADIANCE Toolkit

- User interface for customized queries of RADIANCE database
  - Independent & dependent variables
  - Grouping criterion
  - Date range
- Generates charts → image
- Generates tabular data → spreadsheet
- Not required to know query language or deal with complicated database interface

Developing a Dose Quality Assurance Program



What Makes a Dose "High"?

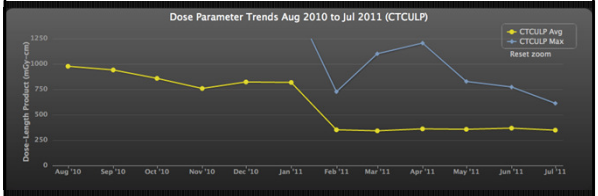
"Optimizing" Protocols

- Test new parameters
  - Diagnostic image quality?
  - Unanticipated problems?
- Important to-dos
  - Note the date of the protocol deployment
  - Give the new protocol a unique name
- Evaluate dose estimates pre- and post-protocol revision
  - Compliance?
  - Educational intervention?
  - Practical factors precluding use of new protocol?

Penn's CT Dose Reduction Efforts

- Thoracic CT
- CT urograms
- Coronary CTA

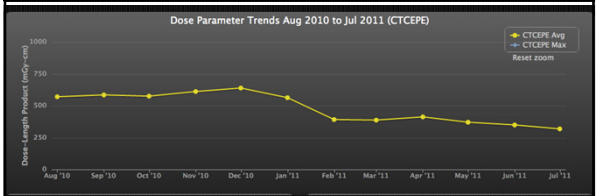
Dose Reduction: High-Resolution Chest CT



- Optional expiratory phase (with very low mAs)
  - Study tailored to clinical question!
- Warren Gefter, MD & Eduardo Barbosa, MD

Cook et al., STR 2011

Dose Reduction: PE Chest CTs



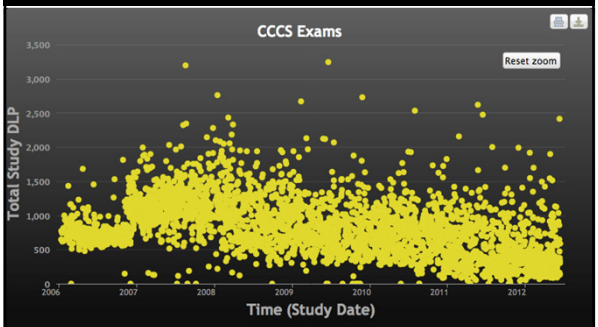
- kVp adjusted for patient size
  - Saves dose to smaller patients who can be imaged with 100 kVp or even 80 kVp
- Warren Gefter, MD & Eduardo Barbosa, MD

Cook et al., STR 2011

Dose Reduction: CT Urograms

- 2 imaging series instead of 3; stricter scan lengths
- Split bolus injection
- Susan Hilton, MD

Dose Reduction: Coronary CTA



radiance Ongoing/Future Work

- Automated alerts
- Patient size estimation
  - Dose normalization to patient size (SSDE)
- Protocol optimization
  - Patient size-specific protocoling
  - Iterative reconstruction
- HL-7 integration
- Customizable reporting tools
- Large-scale RADIANCE validation

Acknowledgments

HUP
- William Boonn, MD
- Woojin Kim, MD
- Thomas Chiang, MBA
- Dan Morton, MSEE
- Brad Moritz
- Scott Steingall, RT
- Harold Litt, MD PhD
- Andrew Maidment, PhD
- R. Nick Bryan, MD PhD
- Michael Bleshman, MD

PixelMed
- David Clunie, MD

PPMC
- Harvey Nisenbaum, MD
- Dongqing Shi

PAH
- Bruce Kneeland, MD
- Donovan Reid
- Kelly Domitrowsky

ACR
- Laura Coombs, PhD
- Mythreyi Chatfield, PhD
- Chao Huang Yen
- Frank Shi

Questions?

radiance

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http://www.radiancedose.com

The Future

Developing a Dose Quality Assurance Program

What Makes a Dose "High"?

- Patient factors
  - Body habitus
  - Ability to tolerate exam (e.g., motion, altered mental status, etc.)
- Technical factors
  - Contrast injection (e.g., extravasation, incorrect triggering, etc.)
  - Additional scans though body region of interest
- Need for protocol optimization

Reviewing Effects of Protocol Optimization

- Evaluate changes in dose estimates pre- and post-protocol optimization
- Verify that new protocols were actually used during the post-optimization time period
  - Compliance?
  - Need for educational intervention?
  - Practical factors precluding use of new protocol?

Food for Thought

- Reporting dose estimates in dictations (CA) – it's happening!
- Payment based on eventual study dose estimate?
- "How much radiation did I get from that CT scan?"