Good, Bad and Ugly of Patient Exposure and Dose Tracking: Experience at UCLA in dose tracking and implications

Michael McNitt-Gray, PhD, DABR, FAAPM FACR
Professor, Department of Radiology
Director, Physics and Biology in Medicine Graduate Program
David Geffen School of Medicine at UCLA
mmcnittgray@mednet.ucla.edu

Radiation Dose Tracking

In summer of 2011, the State of California passed a law that required all sites performing diagnostic CT.

(a) Commencing July 1, 2012, subject to subdivision (e), a person that uses a computed tomography (CT) X-ray system for human use shall record the dose of radiation on every diagnostic CT study produced during a CT examination in the patient’s record ...

Radiation Dose Tracking

1. The requirements of this section shall be limited to CT systems capable of calculating and displaying the dose.
2. For the purposes of this section, dose of radiation shall be defined as one of the following:
   (1) 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).
   (2) The dose unit as recommended by the American Association of Physicists in Medicine.
Dose Reporting

- To comply, we used Radimetrics to:
  - Send CTDI and DLP information from scanner to Radimetrics server
  - Convert that information to an HL-7 message
  - Import that message into our Radiology reporting system
  - Include that information in all radiology reports

Dose Tracking

- Our primary purpose was to provide tools that allowed us to comply with CA state law
- Radimetrics has MANY more capabilities that we are using and still exploring

- Track doses by protocol and by scanner
- Track individual patient doses
- Organ doses
- Radimetrics is REALLY GOOD at organizing, querying, displaying data (they are outstanding at database issues)
Dashboard

- Personalized overview of doses, # of exams, etc

Patients

- Search option by patient name, all CT examinations performed (Physics testing here)

Query individual patients: Obtain their dose summary
Many Parameters/Fields to Query On

Dose History for an Individual Patient

Even Investigate an Individual Scan

Histogram of doses for each protocol.
Red line shows dose for this scan.
[Indication if this is outlier or not]
Even Investigate an Individual Scan

Interactive Dosimetry (like ImPACT) – can vary parameters

Some Examples and Cautions
- Review Dose distribution for a specific protocol
- Lung Cancer Screening
Some Examples and Cautions

► Review Dose distribution for a specific protocol
► Lung Cancer Screening
► CTDIvol as a function of BMI
► Fujii et al, AJR 2016

Some Examples and Cautions

What happened here?
(you can click to find out)

Some Examples and Cautions

Somehow this patient got a CT Abd AND a low dose lung cancer screening exam
Some Examples and Cautions

Clearly not just a low dose lung cancer screening exam. And Radimetrics seems to add (or at least do a weighted average) of CTDIs to get the one number above (21.8 mGy).

Some Examples and Cautions

Individual Dose History
ACR Dose Index Registry (DIR)

- Activity sponsored by ACR (fee)
- Send Dose Reports (patient dose reports or RDSR) from scanner to ACR
  - Have to provide some mapping from your exam names ("Routine Adult Brain") to standard names

ACR Dose Index Registry (DIR)

- Report back to site: Dose Index Values
  - CTDvol, DLP and SSDE
  - By protocol
  - By age group (adult and several peds categories)
  - Provide comparisons to "similar" practices:
    - By practice type (academic/community/etc.)
    - Geographic Region (Pacific)
    - Location (Urban/Suburban/Rural)

ACR Dose Index Registry (DIR)

- DOES:
  - Allow comparisons to national and regional averages by protocol

- Does NOT:
  - Track individual patient doses
    - Data is anonymized when it is submitted
    - Therefore, NO cumulative doses
  - Allow detailed queries by patient scan
    - Though individual exposure events can be queried
Summary for Tracking Systems

- **Bad/Ugly:**
  - Track patient exposure history for stochastic risks
  - What will you DO with that data? Not perform next exam?
  - Estimates of effective dose are within XX%??
  - No real way to deal with the effects of time except assume risks are linear and cumulative
  - 50 mSv over one week = 50 mSv over 50 years?
  - Non-standard reporting of CTDIvol
  - Weighted average across studies
  - Cute idea, but not standard. Leads to confusion
Summary for Tracking Systems

- **Good/Bad?**
- **Query individual patients’ dose history**
- Great from QC perspective
- Also will be good for tissue effects (effect formerly known as “Deterministic effects”) from fluoro/angiography

Summary for Tracking Systems

- **Good:**
  - Help us comply with Legal Requirements (CA law)
  - Perform internal audits
  - Query individual cases
  - Ability (ACR DIR) to make meaningful comparisons against national, regional and type of practice
  - Ability to do these by protocol