Dose Optimization in CT: Trends and Motivation in the US

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Motivation

▸ Is dose really a concern?
  – Yes, always!

▸ No, is it **REALLY** a concern?
  – Probably not, but if it could be, it is!
  – Does the question **REALLY** matter?

▸ Considerations for public safety policy
  – Perception
  – Politics
  – Money
  – Science
  Interconnected

History

▸ Pre-2000 (ish)
  – CT QC solely by State regulations (if any)
    ▪ Probably included CTDI but no guiding limits
    ▪ CTDI, DLP not displayed on console
  – Adult techniques typically used for pediatric patients

▸ 2001
  – Publication on CT risks get media attention

History

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  - CT QC solely by State regulations (if any)

Each year, about 1.6 million children in the USA get CT scans to the head and abdomen — and about 1,500 of those will die later in life of radiation-induced cancer, according to research out today.

- 2001
  - Publication on CT risks get media attention (lots of attention)


Health

CT scans in children linked to cancer
By Dave Berlinski USA TODAY

Each year, about 1.6 million children in the USA get CT scans to the head and abdomen — and about 1,500 of those will die later in life of radiation-induced cancer, according to research out today.

What's worse, CT or computed tomographic scans given to kids are typically calculated for adults, so children are exposed to up to twice the radiation received by adults. These cases may be too low, and the dangers are greater for children.

History (jumping ahead a little)

- Media attention resurfaces periodically

2004
- Radiation Risk From CT Scans A Call for Patient Focused Imaging

2005
- CT Scans: A Radioactive Risk

2006
- What Are the Dangers of CT?

2007
- Radiation Dose: Peak of Peak of CT scans

2008
- New Federal Rules for CT

2009
- Reducing Radiation Risks from Pediatric CT Scans

2010
- CT Scan, Dose, Fat, and Cancer Risk

2011
- CT Scans, Cancer, and Childhood Radiation

2012
- New Federal Rules for CT

2013
- CT Scans, Dose, Fat, and Cancer Risk

2014
- We Are Giving Ourselves Cancer

2015
- Could CT scans cause cancer?

History (jumping ahead a little)

- And this happened too (more on this later)

Doctors ‘Shocked’ by Radiation Overexposure at Cedars-Sinai

West Virginia Hospital Overradiated Brain Scan Patients, Records Show

U.S. probing more cases of CT radiation overexposure

FDA identifies More CT Scan Problems with Dangerous Radiation Levels

Huntsville Hospital Responds To Cases Of Radiation Overexposure Through CT Scans
History

- **2002**
  - ACR introduces CT accreditation program
    - Voluntary
    - QC and dose measurements with tolerances
      - Adult and pediatric
    - "National" (not state-specific)
    - Not the first modality program (BI, US, MR, NM)

- **2008**
  - Image Gently launched
    - Alliance to improve safe and effective imaging care of children worldwide
    - Promotes ped-specific techniques
    - Voluntary (pledge, no testing requirements)

- **2008 (continued)**
  - Medicare* Improvements for Patients and Providers Act (MIPPA) approved
    - All nonhospital suppliers of CT, NM, MR, and PET services must be accredited
      - Physicians and staff maintain training and education
      - Establish and maintain a QA program
    - Medicare reimbursement of technical component
    - Effective Jan. 1, 2012

*Medicare: A federal health insurance program for people who are 65 or older, certain younger people with disabilities, and people with End-Stage Renal Disease (dialysis or transplant patients).

- **2009**
  - United Healthcare* mandates accreditation
    - Outpatient CT, MR, PET, NM
    - Required for reimbursement of technical component
    - ACR, IAC (Intersocietal Accreditation Commission)
      - ACR has dose limits
      - IAC compares dose to reference (but no limits)
    - Sets stage for other insurers

History

• 2009 (continued)
    • Medical exposure one of the largest source of radiation to Americans
    • CT is largest source of medical exposure


History

• 2010
  – Image Wisely launched
    • Campaign for lowering doses in adult medical imaging

• 2011
  – ACR CT Dose Index Registry opens
    • Dose info from clinical scans
    • 800+ facilities, 10 million exams (2014)

• 2012
  – AAPM posts scan protocols for selected exams
    • Includes reasonable CTDI-vol ranges
    • 7 protocols to date (2016)
    • Other dose educational tools

The Alliance for Quality Computed Tomography

History

• 2012 (continued)
  – CMS* requires CT accreditation for reimbursement
    • MIPPA (2008) takes effect
    • ACR, IAC, and the Joint Commission
      – JC added in 2010
      – Compare doses to reference (no threshold)
    • Other private insurers also begin to mandate accreditation

*Centers for Medicare & Medicaid Services. Manages Medicare, Medicaid (and other programs). 1 in 3 Americans enrolled in one of these programs.
History

• 2012 (continued)
  – California State law (SB 1237) becomes effective
    • Strict CT dose reporting requirements
    • Accreditation mandatory after Jan., 2013
  – Several States have since followed suit
    • Requiring accreditation and/or
    • Stricter dose reporting

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History

• 2013
  – NEMA Standard XR-29 developed
    • DICOM Radiation Dose Structured Report
      – Recording more detailed dose info
    • CT Dose Check (Notifications and Alerts)
    • Automatic Exposure Control (AEC)
    • Pediatric and Adult Reference Protocols
      – Pre-loaded in scanners

*National Electrical Manufacturers Association. "The authoritative representative of the collective interests of the electrical and medical imaging industries." (Vision statement, NEMA.org)

History (a brief step back)

• 2009-2011 (multiple sites)
  – Doctors 'Shocked' by Radiation Overexposure at Cedars-Sinai
  – West Virginia Hospital Overradiated Brain Scan Patients, Records Show
  – U.S. probing more cases of CT radiation overexposure
  – FDA identifies more CT scan problems with dangerous radiation levels
  – Huntsville Hospital Responds to Cases of Radiation Overexposure Through CT Scans
History (a brief step back)

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  - Feb. 26, Congressional Hearing on Medical Radiation
  - AAPM representatives among invited witnesses

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  – Manufacturers to take action

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• 2014
  – Congress passes **Protecting Access to Medicare Act**, among other things, includes...
    ▪ Scanners must meet NEMA Standard XR-29
      – Reduced reimbursement for non-compliance
      - 5% by 2016, 15% by 2017
    – May require scanner upgrade (or new scanner)
      – Not necessarily free or inexpensive
    ▪ Applies to Medicare outpatients **BRILLIANT!**
History

- So here we are...
  - No laws directly related to CT dose
  - Laws affecting reimbursement for government insurance
    - CT scanner dose features
    - CT Accreditation
  - Some states laws require...
    - CT Accreditation
    - Stricter CT dose reporting
  - Private insurance companies mandating CT accreditation
  - Resources and encouragement from many professional organizations for CT dose optimization

One thing to think about...

- State laws
  - Proposals drafted with (hopefully) input from physicists
  - Public vetting/feedback process
  - Can “Shut you down” (warnings, fines, more likely)
- ACR accreditation
  - Rules determined by small committee of mostly physicists
  - No open vetting/feedback process
  - Can’t “shut you down” if you don’t comply but...
    - Other consequences (from insurers and/or State)
- The Joint Commission
  - Consult with physicists (1 physicist now employed)
  - Open feedback period
  - Can’t “shut you down” if you don’t comply

Motivation

Does the question “Does CT dose REALLY matter?”

CT dose only REALLY matters if don’t want...
- Patients to think you don’t care about giving them cancer! (Perception)
- To operate illegally (at least in some states)! (Politics)
- To lose money and go out of business! (Money)

Is this bad?
Motivation

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Is this bad?

Not as long as emphasis is on the importance of a diagnostic CT exam.
Too low of dose is as bad, or worse, than too high of dose!

What happened to the science consideration?
Motivation

What happened to the science consideration?
It’s there, just not as relevant anymore!
• Risks will most likely always be in question
• Public perception not likely to change much (any time soon)
• “Goal” has been defined—less dose

We must be active in all CT dose-related discussions with regulators and accreditors (and others) to maintain a checks-and-balance in the clinical, practical, and safety aspects of any proposals.

US Dose Reduction/Optimization in CT

• Standard List
  – Limit scan range to only what is needed
  – Technique charts (when AEC not available)
  – Automatic Exposure Control (AEC)
    • Different implementations by vendor
      – Some more effective with AEC technique charts
  – Reduce technique in small steps
  – Auto-kV
    • Best with small patients with contrast agent

US Dose Reduction/Optimization in CT

• Standard List (continued)
  – Tailored exams for specific indications
    • e.g. follow-up renal stone
  – Reduced dose phases for multi-phase exams
    • Or eliminate phases if possible
    • Dual Energy virtual non-contrast
  – Iterative Reconstruction
  – De-noising software
  – Other scanner features
    • Dynamic collimation, etc.
Towards the Future

- Continued reduction as US ratchets down doses
  - Practice improvements
    - Continued implementation of standard techniques
  - Technology improvements
    - Detectors, processing, etc.
  - Updating of current dose thresholds/references to reflect decreasing doses
    - Need to be cautious regulations and requirements don’t spiral (or helical?) beyond reason.

- More regulations? Convergence?