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CT Clinical Innovation Center

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

Benefit

Risk (?)

Interconnected

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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

Health

20/10/2001 - Updated 02:21 PM ET

CT scans in children linked to cancer

By Steve Stenberg, 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 more, CT or computed tomography scans given to kids are typically calibrated for adults, so children absorb two to six times the radiation needed to produce clear images, a second study shows. These doses are "way bigger than"

Brenner D, Elliston C, Hall E, Berdon, W. Estimated risks of radiation-induced fatal cancer from pediatric CT. 2001 Feb;176(2):289-96.

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2001

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

Brenner D, Elliston C, Hall E, Berdon, W, Estimated risks of radiation-induced fatal cancer from pediatric CT. 2001 Feb;176(2):289-96.

Health
2010/2001 - Updated 12:21 PM ET
CT scans in children linked to cancer
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History (jumping ahead a little)

- Media attention resurfaces periodically

2004 **CT Scan Radiation Risks?**
RADIATION RISK FROM CT SCANS: A CALL FOR PATIENT-FOCUSED IMAGING
December 1, January 25, 2005

2005 **Radiation Risk From CT Scans: A Call for Patient-Focused Imaging**
December 1, January 25, 2005

2006 **CT Scans: A Radioactive Risk**
VIEWS • DECEMBER 32, 2006

2007 **Report Links Increased Cancer Risk to CT Scans**
THE NEW YORK TIMES

2008 **How Dangerous Are CT Scans?**
TIME

2009 **New Focus on Dangers of CT Scans**
THE WALL STREET JOURNAL

2010 **Radiation Risks Prompt Push to Curb CT Scans**
THE NEW YORK TIMES

2011 **CT Scans Increase Children's Cancer Risk, Study Finds**
THE NEW YORK TIMES

2012 **We Are Giving Ourselves Cancer**
THE NEW YORK TIMES

2013 **To Scan or Not to Scan: Largest Study to Date Links Childhood CTs to Increased Cancer Risk**
TIME

2014 **Consumer Reports: Unnecessary CT scans are far too common in U.S.**
CONSUMER REPORTS

2015 **The cancer risk that lurks in your hospital**
CONSUMER REPORTS

2016 **Could CT scans cause cancer?**
CONSUMER REPORTS

History (jumping ahead a little)

- And this happened too (more on this later)

Doctors 'Shocked' by Radiation Overexposure at Cedars-Sinai
When Elaine Taylor's hair suddenly fell out in a freakish band of her head, he was not the only one worried about his health. His wife, hearing he had a contagious disease, was also worried.

West Virginia Hospital Overradiated Brain Scan Patients, Records Show
By WALT BOGDANSKI
Published March 6, 2017
A patient's radiation exposure was so high that it was a matter of a hospital in



U.S. probing more cases of CT radiation overexposure

FDA Identifies More CT Scan Problems with Dangerous Radiation Levels
Published December 8th, 2009 • No Comments

Huntsville Hospital Responds To Cases Of Radiation Overexposure Through CT Scans
Huntsville, AL— A North Alabama woman is among hundreds of people who have been

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 peds specific techniques
 - Voluntary (pledge, no testing requirements)

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History

- ▶ **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
 - Strict standards of performance and safety
 - 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).

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History


- ▶ **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

*United Healthcare: Very large insurance provider. Covers 45 million individuals worldwide. Q1 2015 revenue: \$32.6 billion.

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History

- **2009 (continued)**
 - NCRP* Report 160: "Ionizing Radiation Exposure of the Population of the United States"
 - Medical exposure one of the largest source of radiation to Americans
 - CT is largest source of medical exposure






***National Council on Radiation Protection and Measurements.**
Chartered by US congress (1964). Collect, analyze, and disseminate information and recommendations on radiation protection.

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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

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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.

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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)

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History (a brief step back)

- **2009-2011 (multiple sites)**



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History (a brief step back)

- **2010**
 - Feb. 26, Congressional Hearing on Medical Radiation
 - AAPM representatives among invited witnesses

MEDICAL RADIATION: AN OVERVIEW OF THE ISSUES

HEARING
BEFORE THE
SUBCOMMITTEE ON HEALTH
OF THE
COMMITTEE ON ENERGY AND
COMMERCE
HOUSE OF REPRESENTATIVES
ONE HUNDRED ELEVENTH CONGRESS
SECOND SESSION
FEBRUARY 26, 2010
Serial No. 111-100



Cynthia McCollough

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History (a brief step back)


- **2010**
 - Feb. 26, Congressional Hearing on Medical Radiation
 - AAPM representatives among invited witnesses

MEDICAL The New York Times
F.D.A. to Increase Oversight of Medical Radiation
By HEAT BUCHANAN and MICHAEL R. WOTZ Feb. 9, 2010

JNCI Journal of the National Cancer Institute Advance Access published April 13, 2010
Federal Oversight of Medical Radiation Is on Horizon as Experts Face Off

USA TODAY
FDA may require safer CT scans to prevent unnecessary radiation
Updated 2/26/2010 7:31 PM | Comments (1) | Recommend (0)

Serial No. 111-100



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History (a brief step back)

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The New York Times
Initiative to Reduce Unnecessary Radiation Exposure from Medical Imaging
February 2010
Center for Devices and Radiological Health
U.S. Food and Drug Administration

FDA **CDRH**

FDA may require safer CT scans to prevent unnecessary radiation
Updated 2/26/2010 7:31 PM | Comments (1) | Recommend (0)



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History (a brief step back)

- **2011**
 - Manufacturers to take action



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History

- **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!**

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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

 **AAPM 2016** JUL 31-AUG 4 COMMUNICATING OUR VALUE. IMPROVING OUR FUTURE. 86th ANNUAL MEETING & EXHIBITION WASHINGTON, DC

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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

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Motivation

Does the question
“Does CT dose **REALLY matter?”**
REALLY matter in the US?

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

CT dose only **REALLY matters if don't want...**

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Motivation

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?

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?

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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

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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

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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?**