(CT) Radiation Safety: The Current State

SCBT 2015

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No Disclosures
CT Radiation Safety

- Continues to be a public concern
- Continues to be misunderstood/debated
- We have not been successful stewards
- Dose monitoring
  - commercial products
  - accreditation
  - reimbursement
- Growing international efforts
  - EuroSafe, AfroSafe … AsiaSafe and LatinoSafe??
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Radiology MD: “As many as 1 in 300 children who get a CT scan of the abdomen, chest or spine will eventually develop a tumor as a result of the radiation...”

http://www.huffingtonpost.com/entry/childrens-hospitals-ct-scans-study_55df8791e4b0c818f6175b69
ALARA, Image Gently and CT-induced cancer

Mervyn D. Cohen

Introduction

The term As Low As Reasonably Achievable (ALARA) goes back to articles in 1980, 1986 and 1999 [1–3]. In 2001, a group of inspired pediatric radiologists introduced the ALARA concept into routine clinical radiology practice [4–7]. The ALARA and the Image Gently campaigns have been very successful in achieving their goals of reducing unnecessary imaging and radiation exposure, inspiring the development of new technology, and expanding our understanding of measuring radiation dose in humans [6–15]. ALARA and Image Gently evolved from a belief that even incidence from the survivors of the atom can be extrapolated back in a linear fashion cancer risk from tiny radiation doses, threshold exists for cancer risk from radiation linear no threshold theory. With new data, survivors, this linear no threshold theory is challenged [16–20]. Finally, I will discuss technological studies that have linked CT to cancer and must be interpreted with great caution. Pediatric radiologists with information resources in these studies that they can share with parents and referring physicians.
September 11th, 2011

“I am contacting you to ask about the radiation exposure my son has had when having a CT angiogram ... Can I make the radiation exposure request or does his physician need to? Here is my son’s information and the date of his CT angiogram. I am wanting to get his radiation exposure in a file for his health history. Thank you for your time.”
January 20\textsuperscript{th}, 2012

Abdominal Pain

X-ray ABD Comp/W PA Chest
CT ABD and pelvis with IV contrast (dosage \textit{amt} 4.6 msv)
X-ray abdominal

Diagnostics resulting from Hair aine fracture right leg

X-ray right foot
X-ray foot and ankle
X-ray right foot 3 views
nuclear medicine bone imaging 3 phrase. anterior and posterior images of right and lower extremities below the knee were obtained in blood flow, perfusion, and delayed findings.
X-ray bone survey under 2 yrs old. Included frontal and lateral views upper and lower extremities, chest and abdominal, skull and cervical spine. PA and lateral views of feet, skull region, and head CT (dosage \textit{amt} 0.6 msv)
Lower extremity x-rays done by orthopedic to diagnose fracture and prior to and after cast was removed. Not sure how many series.

Head injury secondary to fall
X-ray skull

Pneumonia and bronchitis related X-rays
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• We don’t know if there is a risk
• Overemphasis on risk…under emphasis on the basics?
• Overemphasis on risk…under emphasis on benefit
No significant difference in dose estimates between children’s hospital and community setting, but

40% (138/344 outside CTs) suboptimal technique:

- 50 (15%): delayed phase only
- 44 (13%): dual phase
- 8 (2%): triple phase
- 36 (10%): no iodinated contrast
  - 16 enteral contrast only
  - 20 no contrast at all
Really? Benefit Risk *Balance*?
But we really don’t know if there is a cancer risk with low level exposures…

....true, but doesn’t matter.
If we don’t control this, someone will for us

We have a responsibility to know individual and cumulative (CT) dose, and what this does or doesn’t signify…

patients
colleagues
regulatory organizations
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June 30, 2011

To: Jane Doe
335 Main Street
Anywhere, NC 12345

Dear Ms. Doe,

This letter is to inform you that you had 10 or more CT scans in 2010. This is more than most people get in a year. Medicaid records show that you went through a CT scanner ___ times in 2010.

CT scans, sometimes called CAT scans, expose you to radiation while taking a picture of what is inside your body. Too much radiation can be bad for your health. It can increase your chances of getting some kinds of cancer.

Sometimes CT scans are important for doctors to see what is going on when you are sick or hurt. But sometimes there may be other ways to figure out what is wrong.

If a doctor treating you does not know you well or have your medical records, that doctor will not know how many CT scans you have had. It is important for you to remind them of this information. Showing your doctors this letter will help them treat you as safely as possible. Please take this letter with you when you go to the emergency department or doctor’s office.

Call 1-800-662-7030 if you have any questions.

Please call [enrollment office number] for help finding a primary care doctor in your town.

Wishing you the best of health.
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<th>Date</th>
<th>Exam</th>
<th>Facility Where Exam Performed</th>
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My Medical Imaging History

Use this handy record to track your imaging history.

Before undergoing any X-ray exam or treatment procedure, remember to ask your doctor:
- Why do I need this exam?
- How will having this exam improve my health care?
- Are there alternatives that do not use radiation and which are equally as good?

Remember:
- Be sure to tell the doctor or technologist if you are, or might be, pregnant before having an X-ray.
- Don’t insist on an imaging exam if the doctor explains there is no need for it.
- Read, don’t refuse an imaging exam if there’s a clear need for it and the clinical benefit outweighs the small radiation risk.

For more information, go to www.ImageWisely.org and www.fda.gov/ForConsumers/ConsumerUpdates/ucm395505.htm

Co-Sponsored by Image Wisely and the US Food and Drug Administration.

http://www.imagewisely.org/~media/ImageWisely%20Files/7678_Medical%20Imaging%20History.pdf
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  – States
  – The Joint Commission
  – The Environmental Protection Agency
  – NEMA
  – CMS
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  - States (no federal regulation)
  - The Joint Commission
  - The Environmental Protection Agency
  - NEMA
  - CMS
What was the Impact of California Senate Bill 1237 on Radiology Practices?
California SB 1237 Survey Results

How are the CT dose reporting requirements mandated by SB 1237 integrated into your radiology report?

- Dictated and transcribed: 38.64%
- Template used on voice recognition: 44.32%
- Automatically integrated into report: 17.05%
California SB 1237 Survey Results

- Delayed workflow? No: 70%
- Raised awareness? Yes: 45%
- Changed protocols? No: 78%
May 2013 Texas
CT and fluoro
Establish committees
CT Radiation Safety

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  – The Environmental Protection Agency
  – NEMA
  – CMS
July 2015, TJC mandates that:

1. “The [hospital/practice] documents the radiation dose ($\text{CTDI}_{\text{vol}}$ or DLP) on every study produced during a computed tomography (CT) examination. The radiation dose must be exam specific, summarized by series or anatomic area, and documented in a retrievable format.”,

2. “The [hospital/practice] reviews and analyzes incidents where the radiation dose ($\text{CTDI}_{\text{vol}}$ or DLP) emitted by the computed tomography (CT) imaging system during diagnostic CT exams exceeded expected dose ranges identified in imaging protocols.”
NEMA Standard Attributes on CT Equipment Related to Dose Optimization and Management (XR-29)

- DICOM structured dose reporting,
- A CT Dose Check feature for dose alerts and notifications,
- Automatic Exposure Control (AEC) to help manage radiation dose and image quality, and
- Reference Adult and Pediatric Protocols “pre-loaded”

Not Meeting Guidelines:
January 2016: 5% reimbursement reduction
January 2017: 15% reimbursement reduction
Radiation Protection Guidance for Diagnostic and Interventional X-Ray Procedures

Federal Guidance Report No. 14

CT: pages 58-64

Memorandum Summary

Updated Guidance for Hospital Services: The Centers for Medicare & Medicaid Services (CMS) has updated the interpretive guidelines for the hospital Conditions of Participation (CoPs) for the below to reflect current accepted standards of practice.

- Radiologic Services at 42 CFR 482.26, and
- Nuclear Medicine Services at 42 CFR 482.53

Background

Radiologic and nuclear medicine services have improved the ability to detect and treat a wide range of conditions.

… “updated the interpretive guidelines for the hospital Conditions of Participation (CoPs) for the below to reflect current accepted standards of practice”
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Program Considerations

- Dose monitoring preferred over “tracking”
- Dose estimations
- Program elements:
  - recording
  - monitoring/auditing
  - reporting
- All imaging experts are accountable
- Need to begin to monitor both dose & quality
- Parents/patients should not be responsible
Cumulative Dose Program: Fundamental Elements

- Defined dose metrology
- Individual patient \textit{and} institutional dose
- Recording process
- Monitoring process
- Defined reports/triggers
- Measures taken (including reporting)
Dose Monitoring Program

- **Benefits to the patients**
  - Awareness
  - Appropriate radiation exposure
  - Accountability for radiation protection by healthcare providers
  - Opportunity for informed discussions between patients, caregivers, and medical healthcare providers

- **Benefits to the healthcare providers referring patients**
  - Awareness
  - Point-of-care information for decision support
  - Justification for and optimization of resource utilization
Dose Monitoring Program

• **Benefits to the healthcare providers delivering medical imaging or intervention**
  – Awareness
  – Justification for and optimization of resource utilization
  – Development of facility DRLs
  – Comparison of the practice/facility exposures with national DRLs
  – Compliance with regulatory requirements
  – Protocol optimization and quality improvement
    » identification of under- and over-exposure cases
    » identification and correction of protocol inconsistencies
    » identification and correction of equipment inconsistencies
    » trend analyses across systems and time
$\text{CTDI}_{\text{vol}}$ as the metric of dose. The dashed lines represent the 95th percentiles. Dividing the patients into four size groups, the minimum and maximum target levels can be established based on the state of practice. Note that in this example, the dose is defined based not on targeted image quality rather based on existing dose ranges in the facility.
A comparison of actual versus expected dose across scanners for the orbits protocol. A recent protocol review of the orbits CT protocol for CT system 2 revealed that the median CTDI was 36 mGy, whereas the expected CTDI based on the documented protocol definition was 26 mGy. The protocol on the
Dose Monitoring Program

• **Benefits to the policymakers**
  – Awareness
  – **Quantitative tools to assess and optimize public health and safety**
  – **Improved quantitative approach to radiation safety policymaking**
  – Managing medical imaging utilization

• **Benefits to the regulators**
  – Awareness
  – **Encouragement of the facilities to implement the diagnostic reference level process**
  – **Improved data to assist the facilities to conduct reliable self-audits**
Dose Monitoring Program

• **Benefits to the researchers**
  – Providing radiation dose and imaging use data
  – Incorporate patient-specific radiation metrics into research studies
  – Providing a quantitative basis for the development of best practices, guidelines, and appropriateness criteria

• **Benefits to the industry**
  – Providing and promoting partnership with other stakeholders in establishing radiation exposure monitoring technology
CT Dose Monitoring Program
Best Practices

• **Access**: Connection and collection of dose-relevant data
• **Integrity**: Data quality and accuracy
• **Metrology**: Meaningful quantities to monitor
• **Analytics**: From data to knowledge
• **Informatics**: Dose monitoring as a secure, integrated solution
CT Dose Monitoring Program: The Horizon

• Standardized analytics
• Improved dose metrology
• Enhanced data management
• All modalities
• Beyond radiation dose
  – Include quality metrics
Conclusions

- Dose (and risk) continue to be relevant
- While strategies are important…
- “Guidance” (aka regulation) is growing
References

• **EPA:** [http://www.epa.gov/radiation/federalfgr-14.html](http://www.epa.gov/radiation/federalfgr-14.html)


• **NEMA XR-29 and HR 4302:** [http://www.gpo.gov/fdsys/pkg/BILLS-113hr4302enr/pdf/BILLS-113hr4302enr.pdf](http://www.gpo.gov/fdsys/pkg/BILLS-113hr4302enr/pdf/BILLS-113hr4302enr.pdf)


• **The Joint Commission:** [http://www.jointcommission.org/prepublication_standards_diagnostic_imaging_services_requirements/](http://www.jointcommission.org/prepublication_standards_diagnostic_imaging_services_requirements/)