Reducing Radiation Dose in Abdominal CT Studies: ACR Dose Index Registry Data as an Impetus for Quality Improvement

Mark P. Supanich, Ph.D.¹
Nicholas Bevins, Ph.D.²
Daniel Myers, MD²
¹Rush University Medical Center - Chicago, IL
²Henry Ford Health System - Detroit, MI
Contact: mark_supanich@rush.edu
Disclosures

- Nothing to disclose
Background

• The Radiology division of the Henry Ford Medical covers imaging for 3 hospitals and a number of outpatient centers
• CT scanners include systems from 3 major vendors (n=13)
• Only data from scanners with the ability to reconstruct 64 slices were included in this study
  ▫ Vendor 1, n=1
  ▫ Vendor 2, n=2
  ▫ Vendor 3, n=5
• No scanners employed iterative reconstruction
Motivation

• Continuous quality improvement is a priority in the Radiology department
• Matching radiation dose and image quality for the same protocol across all scanners was identified as a goal by the radiologists and medical physicists
Tools Used

• eXposure™ software from Bayer Healthcare used to collect dose and protocol information
• Institutional participation in American College of Radiology (ACR) CT Dose Index Registry (DIR)
  ▫ Semi-annual reports of institutional dose metrics broken down by orderable
  ▫ Summary of dose metrics from 300+ participating institutions included
Collection of Baseline Data

- Institutional dose metrics and scan information collected by eXposure™ from 7/2011 through present including
  - CTDI\textsubscript{vol}
  - SSDE
  - Master Scan Protocol
- Participation in DIR from 1/2012 through present
- Protocols on scanners from same vendor all equivalent
- Image thickness within 0.25 mm on all scanners
- CT Abdomen Pelvis (with or without contrast) exams analyzed
  - Image quality reference parameter on multiphase exams are equal
Vendor 1 Baseline Data

CTDI\textsubscript{vol} Mean: 19.7 mGy
CTDI\textsubscript{vol} Median: 17.3 mGy
SSDE Mean: 21.7 mGy
SSDE Median: 20.4 mGy
N=389
Vendor 2 Baseline Data

CTDI\textsubscript{vol} Mean: 16.9 mGy
CTDI\textsubscript{vol} Median: 17.2 mGy
SSDE Mean: 19.3 mGy
SSDE Median: 20.1 mGy
N=2565
Vendor 3 Baseline Data

**CTDI\textsubscript{vol} Values Vendor 3**

CTDI\textsubscript{vol} Mean: 18.9 mGy
CTDI\textsubscript{vol} Median: 19.5 mGy
SSDE Mean: 21.6 mGy
SSDE Median: 21.9 mGy
N=2160
Notes on Histograms

- Vendor 2 offered a maximum tube current setting which was utilized resulting in a maximum CTDIvol of ~26 mGy for the standard acquisition.
- The output of Vendor 3’s systems were tube current limited to outputs of ~25 mGy for standard acquisition technique.
Identification of Area for Improvement

- Median $\text{CTDI}_{\text{vol}}$ for CT Abdomen/Pelvis protocol from all scanners was determined to be above the median value reported by the ACR DIR.
- Studies from one vendor (Vendor 3) scanner were identified as the main contributor to the median $\text{CTDI}_{\text{vol}}$ being higher than ACR DIR median value.
  - Highest median $\text{CTDI}_{\text{vol}}$ of the vendors
  - Scans from Vendor 3 were nearly half of all scans
- Reducing the median $\text{CTDI}_{\text{vol}}$ of the CT Abdomen/Pelvis studies from Vendor 3 scanners was identified as the area of desired improvement.
**Intervention**

- The image quality reference parameter used for the studies was identified (400 mAs/slice)
- The body imaging division head and two medical physicists collaborated on a plan to iteratively reduce the image quality reference parameter
  - On one scanner and one protocol
  - Without informing other radiologists
  - With continuous monitoring of image quality (particularly for patients of different body habitus)
Intervention

- The image quality reference parameter was reduced by 10% to 360 mAs/slice for 1 week
  - The image quality was deemed sufficient and no image quality complaints were registered
- The image quality reference parameter was reduced another 10% to 325 mAs/slice for 1 week
  - The image quality was deemed sufficient and no image quality complaints were registered
- The image quality was reduced to 300 mAs/slice for 1 week
  - The image quality was deemed JUST SUFFICIENT and no further modifications were made
- The new image quality reference parameter of 300 mAs/slice was applied across all Vendor 3 scanners and abdomen/pelvis protocols
Analysis

- Following the intervention data was collected over a 3 month period to compare to the 3 months of data used as the baseline.
- The use of the new image quality reference parameter resulted in a statistically significant reduction in radiation dose.
- Median value decreased by 3.9 mGy.
- Median value across all scanners decreased to below DIR benchmark.
Vendor 3 Baseline Data

CTDI\textsubscript{vol} Mean: 18.9 mGy
CTDI\textsubscript{vol} Median: 19.5 mGy
SSDE Mean: 21.6 mGy
SSDE Median: 21.9 mGy
N=2160
Vendor 3 Post Intervention Data

CTDI$_{vol}$ Values Vendor 3

CTDI$_{vol}$ Mean: 16.3 mGy
CTDI$_{vol}$ Median: 15.6 mGy
SSDE Mean: 18.2 mGy
SSDE Median: 18.2 mGy
N=2002
Example Case - same patient pre and post intervention

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<th>kV</th>
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Pre-Intervention

Post Intervention
Notes on experience

• The iterative decrease of the image quality reference parameter was a useful way to adjust image quality and dose in a controlled manner

• Examining the image quality of patients with different body habitus was important
  ▫ The image quality on the thinnest patients was affected more than on the largest

• Radiation dose and image quality were more closely matched between Vendors 2 and 3 after the intervention

• A decrease in the number of cases with a “maxed out” tube current was noted
Conclusion

- Participation in the ACR DIR provides valuable data to institutions
- Semi-annual reports allow departments to perform an “apples to apples” comparison of their dose metrics for exams to those from peer institutions and data aggregated from all participating institutions
- Detailed exam specific data in the reports allows identification of protocols for potential radiation dose reduction
Thank you

Questions?

E-mail: mark_supanich@rush.edu