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

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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

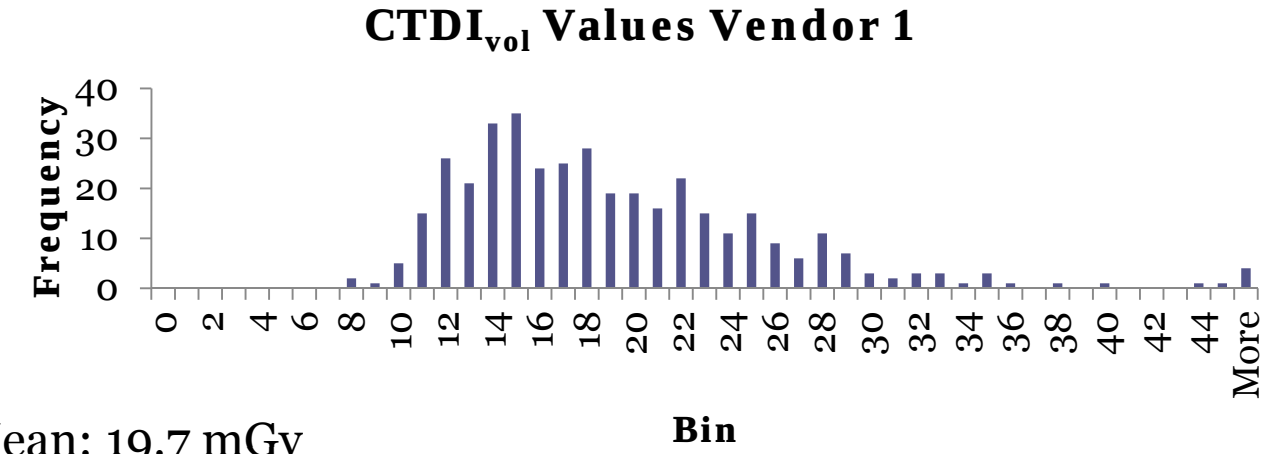
Tools Used

- 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

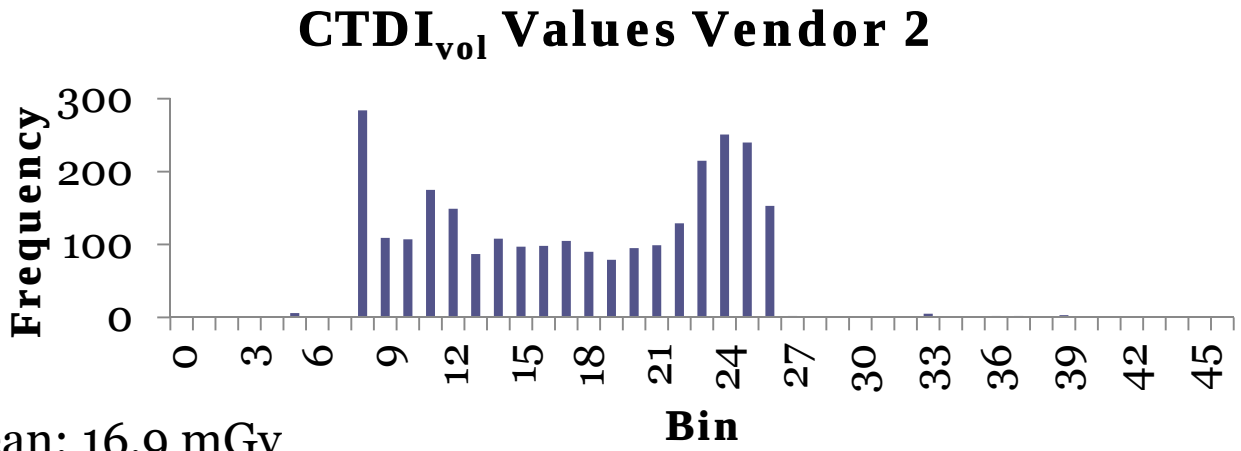
- Institutional dose metrics and scan information collected by eXposure™ from 7/2011 through present including
  - $CTDI_{vol}$
  - SSDE
  - Master Scan Protocol
- Participation in DIR from 1/2012 through present
- Protocols on scanners from same vendor all equivalent
- Image thickness within 0.25 mm 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



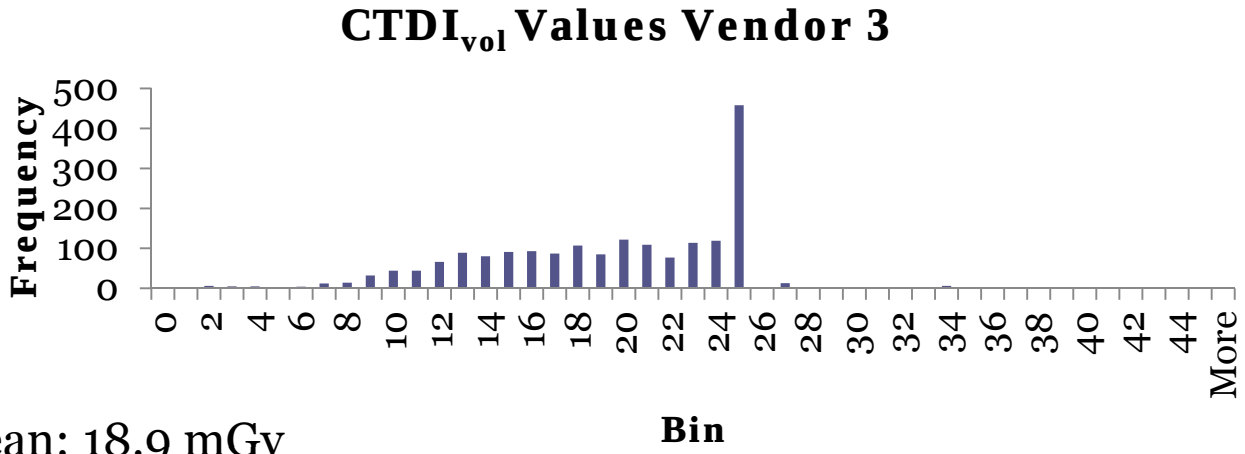
$CTDI_{vol}$ Mean: 19.7 mGy
$CTDI_{vol}$ Median: 17.3 mGy
SSDE Mean: 21.7 mGy
SSDE Median: 20.4 mGy
N=389

Vendor 2 Baseline Data



$CTDI_{vol}$ Mean: 16.9 mGy
$CTDI_{vol}$ Median: 17.2 mGy
SSDE Mean: 19.3 mGy
SSDE Median: 20.1 mGy
N=2565

Vendor 3 Baseline Data



$CTDI_{vol}$ Mean: 18.9 mGy
$CTDI_{vol}$ 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 $CTDI_{vol}$ 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 $CTDI_{vol}$ being higher than ACR DIR median value
  - Highest median $CTDI_{vol}$ of the vendors
  - Scans from Vendor 3 were nearly half of all scans
- Reducing the median $CTDI_{vol}$ 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)

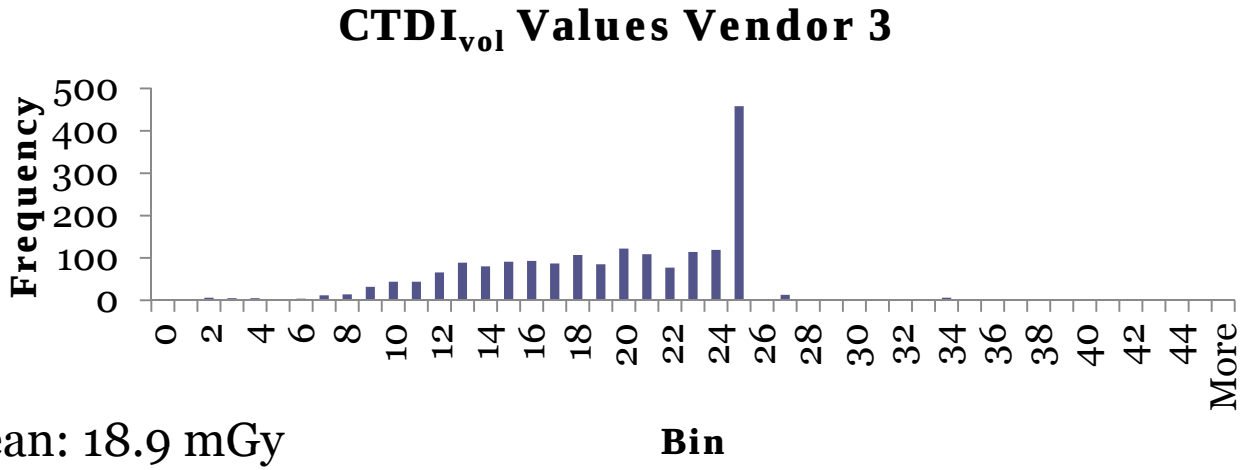
Intervention

- 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

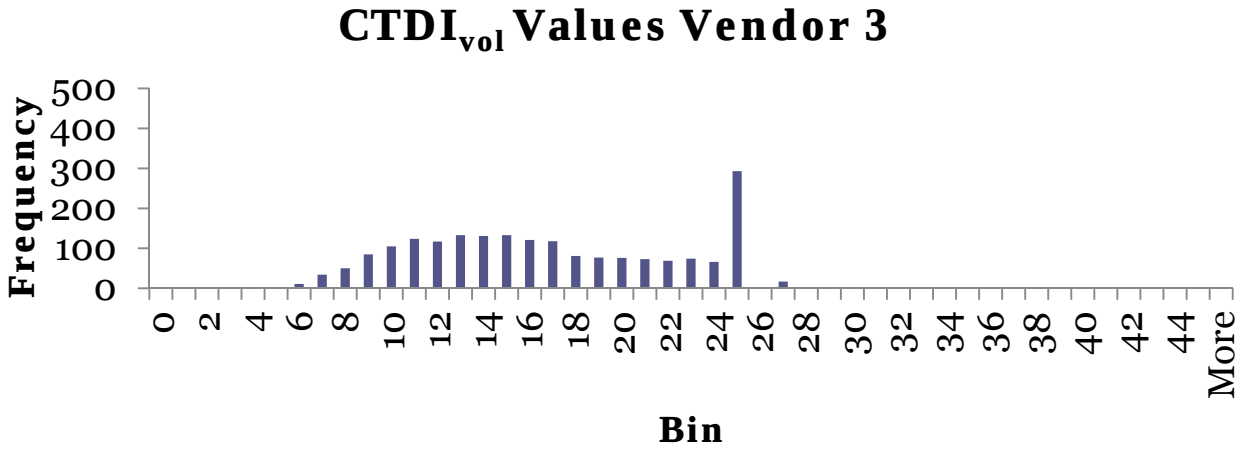
- Following the intervention data was collected over a 3 month period to compare to the 3 months of data used as the baseline
- The use of the new image quality reference parameter resulted in a statistically significant reduction in radiation dose
- Median value decreased by 3.9 mGy
- Median value across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

Vendor 3 Baseline Data



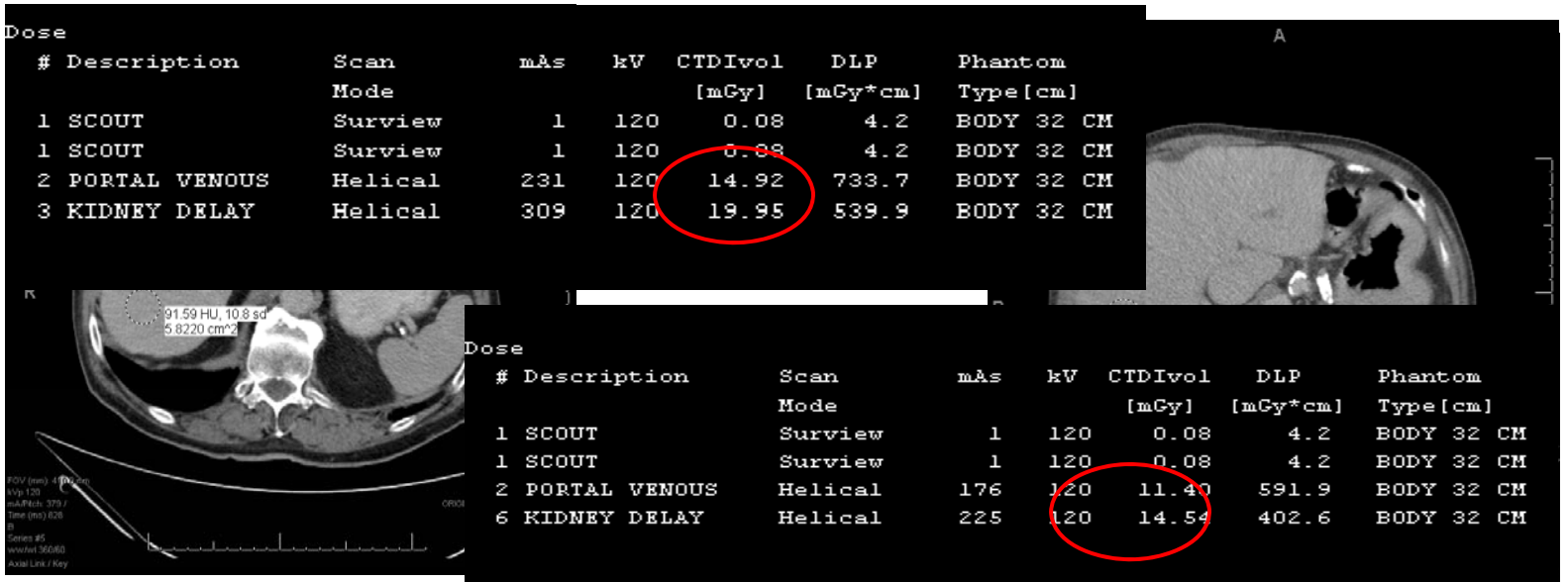
$CTDI_{vol}$ Mean: 18.9 mGy
$CTDI_{vol}$ Median: 19.5 mGy
SSDE Mean: 21.6 mGy
SSDE Median: 21.9 mGy
N=2160

Vendor 3 Post Intervention Data



$CTDI_{vol}$ 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



Dose

#	Description	Scan Mode	mAs	kV	CTDIvol [mGy]	DLP [mGy*cm]	Phantom Type[cm]
1	SCOUT	Surview	1	120	0.08	4.2	BODY 32 CM
1	SCOUT	Surview	1	120	0.08	4.2	BODY 32 CM
2	PORTAL VENOUS	Helical	231	120	14.92	733.7	BODY 32 CM
3	KIDNEY DELAY	Helical	309	120	19.95	539.9	BODY 32 CM

Dose

#	Description	Scan Mode	mAs	kV	CTDIvol [mGy]	DLP [mGy*cm]	Phantom Type[cm]
1	SCOUT	Surview	1	120	0.08	4.2	BODY 32 CM
1	SCOUT	Surview	1	120	0.08	4.2	BODY 32 CM
2	PORTAL VENOUS	Helical	176	120	11.40	591.9	BODY 32 CM
6	KIDNEY DELAY	Helical	225	120	14.54	402.6	BODY 32 CM

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?

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