A continuous quality improvement process to reduce excessive CT radiation dose events across a large, multi-institutional academic center

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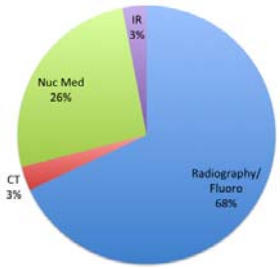
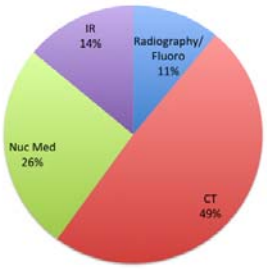
Background

- Medical radiation is the greatest source of radiation exposure in the US and has increased 600% from 1980s to 2006.
- Computed tomography (CT) is the greatest source of medical radiation (49%) prompting greater scrutiny and increased focus on CT dose in the last several years.



Early 1980s

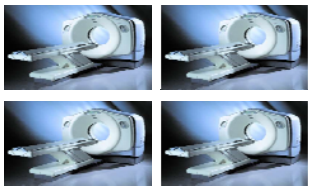


2006

National Council for Radiation Protection, report 160

Background: optimizing CT dose in a large healthcare system

- Emory Healthcare is a large multi-institutional system with 26 scanners spread across 13 inpatient and outpatient locations.
- Over 150 subspecialty protocols are used across the system.
- Systematically optimizing protocols and standardizing them across a system with 3 scanner platforms is a major challenge.



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Background: New Regulations

- The Joint Commission Requirements (effective July 1, 2015):
  - "The organization documents the radiation dose index on every study produced during a diagnostic CT examination"
  - "Diagnostic CT imaging protocols are reviewed and kept current with input from interpreting radiologist, medical physicist and lead technologist…"
  - "The organization reviews and analyzes incidents where the radiation dose index from diagnostic CT exams exceeded expected dose ranges identified in the imaging protocols. These incidents are then compared to external benchmarks"

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Aims

- To develop a process to identify excessive CT radiation exposures and continuously refine and optimize CT protocols to reduce overall computed tomography (CT) radiation dose by 5% by July 2016.
- To engage technologists in the process of recognizing and identifying solutions for excessive dose events.

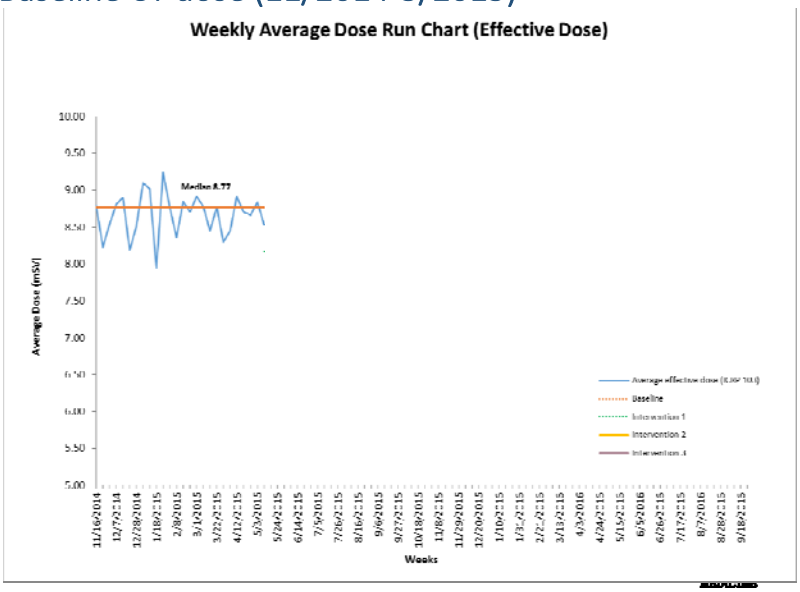
Baseline State

- Department of Radiology and Imaging Sciences installed radiation dose tracking software in November 2014 (Radimetrics, Bayer Healthcare, Whippany NJ).
- 26 inpatient and outpatient CT scanners at all EHC sites were configured to send dose reports to Radimetrics server after 11/2014.
- On average, 10,556 exams were performed monthly generating 59.6 dose alerts.
- Dose thresholds were established for over 150 protocols using benchmark data from American College of Radiology Dose Index Registry (ACR DIR).
- Alerts for examinations exceeding the threshold were sent to the site QC technologist and a radiologist.

Project Team

The CT Quality and Safety Committee organized and led the effort. This multidisciplinary team includes physicists, radiologists, and technologists from each imaging site (13 locations).

Baseline CT dose (11/2014-5/2015)

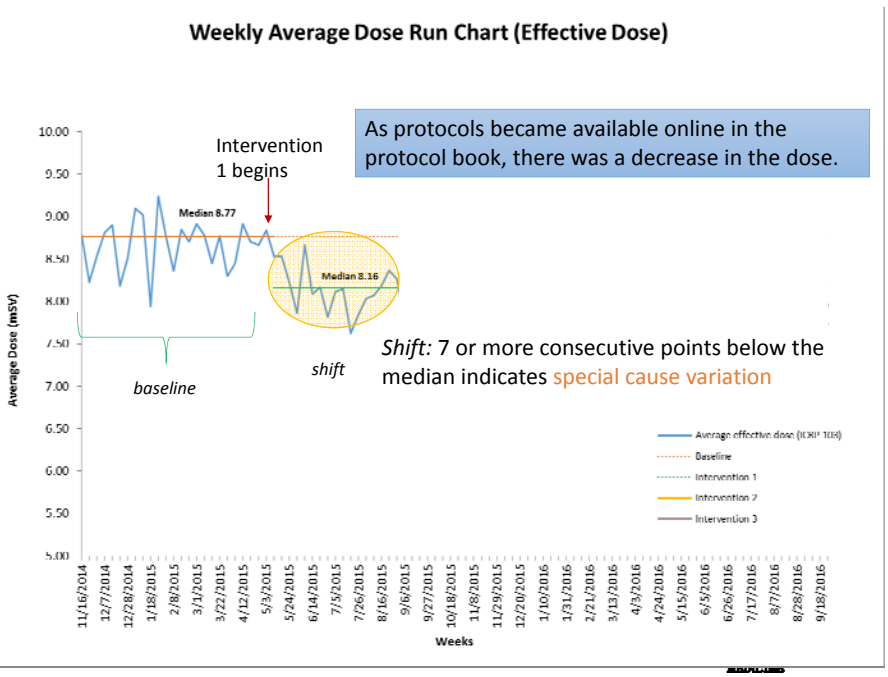


Intervention 1: Update protocols (May 2015-ongoing)

- Technologists were trained to compare scanner protocols to an approved protocol repository in Radimetrics.
- Result:
  - Some improvement in dose and protocols but many discrepancies were still found.
  - Partnered with technologists to encourage review of protocols on scanner.

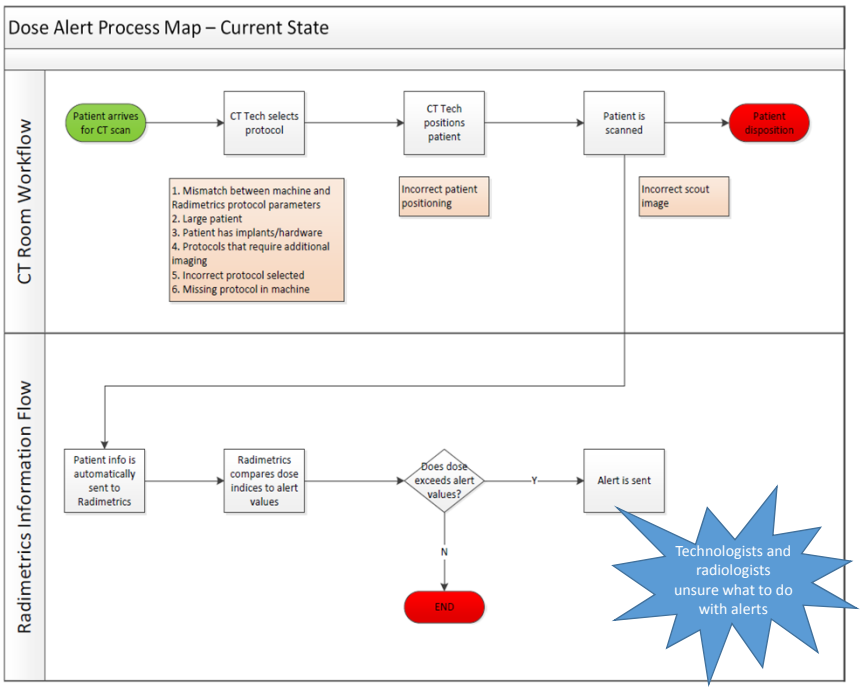
CHG_CHST_W_PE

LightSpeed VCT	
Localizer: AP	
Start Location	S0
End Location	I350
kV	120.0
mA	10.0
Comments: Tube Position 0 degrees; Second Scout	
Localizer: LATERAL	
Start Location	S0
End Location	I350
kV	120.0
mA	10.0
Series 1 : ax	**Scan:** lung bases to Lung Apices
Scan Mode	Helical
Start Location	I160
End Location	I50
Tube Rotation	0.6
Thickness	1.25
Interval	1.25
kV	120.0
Pitch	0.984
Speed	39.375
Gantry Tilt	S0.0
Noise Index	29
Total Collimation	40
Number of Detectors	64
SFOV	LargeBody
Auto mA	Yes
Comments: mA range of 100-500	
Recon 1: ax	
DFOV	36
Algorithm	Standard
Recont Opt.	Plus
Iterative Reconstruction	SS30:Slice
Comments: Send. Use for ax MIPS (7mm thickness at 2.5 mm intervals) and Sag and Cor 2.5 mm MPRs.	



Intervention 2: dose alerts

- Dose alert levels were selected for over 150 protocols
- Alerts were set up to be e-mailed to the quality lead technologists, responsible radiologist, and physicist



DP1

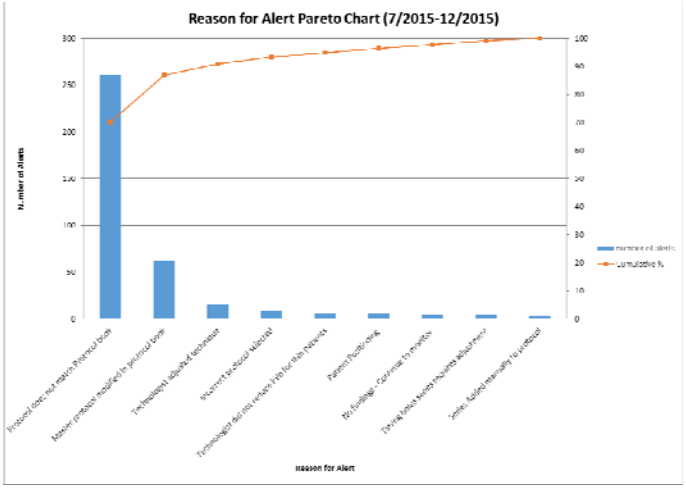
Intervention 2: Physicist reviewed dose alert results from first six months with technologists

- Reviewed the 6/2015-12/2015 dose alerts with technologists one-on-one at every site and discussed how to identify, respond, and mitigate dose alerts.
- Some sites were able to respond quickly to alerts and two sites subsequently decreased alerts to 0 in the next period.

Reasons for dose alerts

Dose alerts from July 2015 to December 2015 were reviewed and categorized.

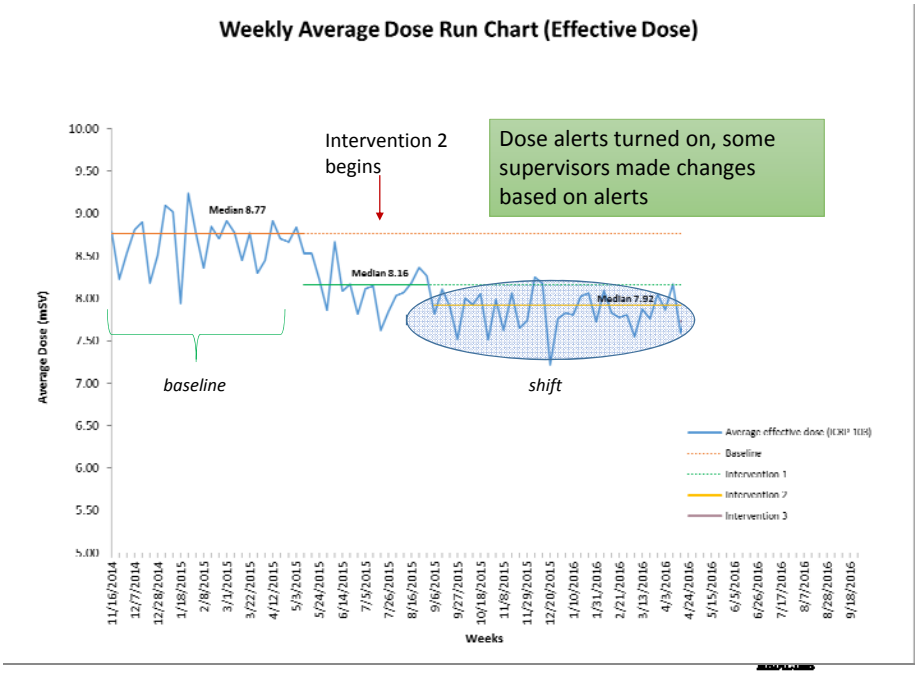
Majority of alerts were triggered due to scanner protocols not matching the master protocols



Slide 13

DP1 Will will

Duong, Phuong-Anh, 10/10/2016



Intervention 2: results and reflection

- Dose alerts alone were insufficient.
- A standard process was not established for resolving dose alerts and preventing future alerts.
- Staff were reluctant to make changes and use new protocols that were available in Radimetrics.
- A survey of technologists revealed that older protocols were still used because, "I know it works."

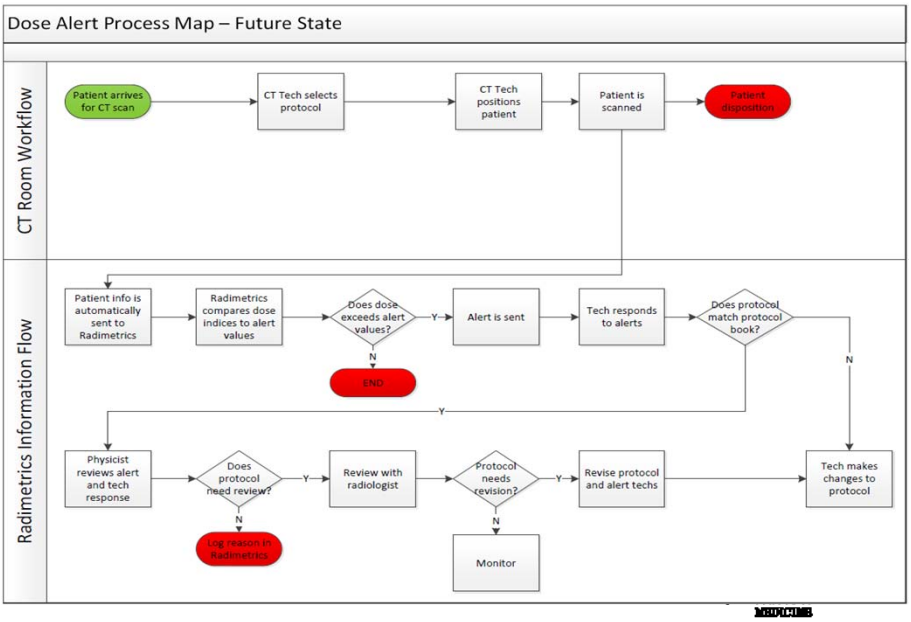
Intervention 3

- Step 1: Multi-step process created to address dose alerts
- Step 2: Reviewed dose alert data with managers to get additional support for implementing process
- Step 3: Implemented protocol-of-the-week program

Step 1: process created for responding to alerts

- After an initial 6 month review of dose alerts, it became clear that a process was needed to guide team members in responding to dose alerts.
  - Technologists were trained how to investigate the apparent cause.
  - Protocols that continued to have dose alerts were reviewed by a radiologist and physicist.
  - Some protocols were amended to reduce the rate of excessive dose.
  - All protocol changes were logged and documented in Radimetrics.

Step 1: Create new process



Technologist apparent cause analysis

- To review dose alerts, we developed a checklist for technologists to use when first evaluating dose alerts.
- Results were documented using the form below and sent by e-mail or added directly to the dose alert comments in Radimetrics.

REASON FOR DOSE ALERT. SELECT ALL THAT APPLY	
☐	Incorrect protocol selected
☐	Protocol modified to add additional series
☐	Large Body Habitus
☐	Positioning
☐	Series repeated due to Movement
☐	Series repeated and scan parameters adjusted
☐	Protocol parameters did not match Radimetrics protocol book
☐	Other:

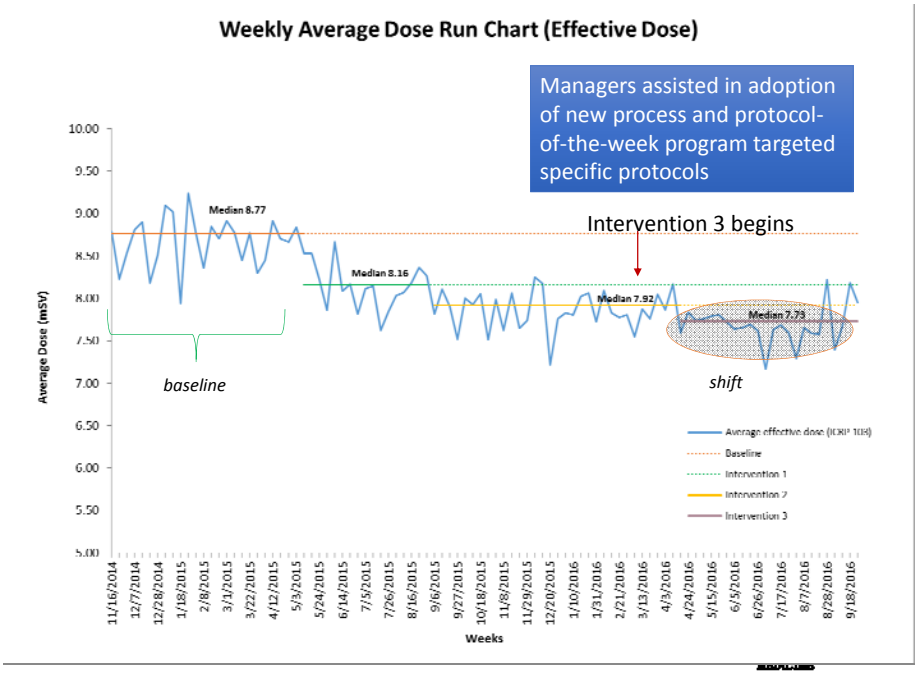
Step 2: Reviewing dose alerts with managers (May 2016)

- Continued to have persistent non-response to alerts at some locations.
- Managers were included in the dose alert review and trained on how to help with intervention.

Step 3: Protocol-of-the-week (June 2016)

- High yield protocols are selected for update and review.
- A radiologist reviews the protocol for best practices and optimal parameters.
- The medical physicist distributes the master protocol.
- Technologists provide feedback and, if necessary, update the CT scanner using the master protocol

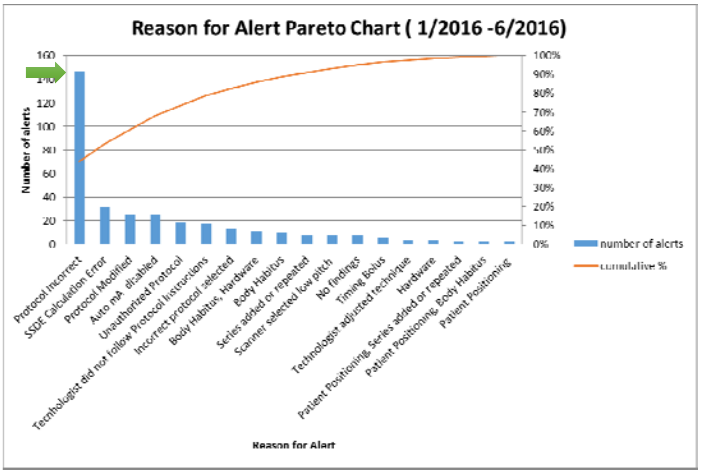
Protocol of the Week:	VN4A & VN4C			
Due Date:	10/7/2016			
Site	Scanner	Checked Scanner with Protocol Book?	Description of Changes Made	Protocol Feedback Given
EUHM	Brightspeed			
EUHM	Emotion 16			
EUHM	Flash			
ESJH	Definition AS			
ESJH	Sensation 64			



Dose alert analysis 2nd period: 1/2016-6/2016

Total number of alerts decreased from 372 to 335 (10% reduction)

Most common reason is still incorrect protocol



Results

- Median exam doses decreased from 8.77 mSv to 7.73 mSv, an 12% drop in an health system with over 100,000 CT examinations per year.
- Dose alerts decreased by 10% as well from 373 to 335.
- The percentage of alerts due to protocol deviation from protocol book dropped from 70% to 44%. Given the large number of protocols in the system (150+), focusing on one high-yield protocol a week may be helpful.

Reflection

- Because of the need for training in a multi-center institution, the interventions occurred over a long time period and overlapped. Therefore, the effects of such changes were not immediate.
- Initial largest drop in dose prior to implementation of dose alerts can be explained by updates to protocols occurring once the master protocol book became available.
- Some of the protocols-of-the-week were initiated because of concerns about image quality. Average exam doses were occasionally increased which may explain the slight increase during the final period during Sept. 2016.

Future Directions

- We have recently changed our alert levels, based on new ACR DIR data. Dose thresholds will be continuously adjusted based on benchmark data. ACR DIR thresholds will likely decrease as more participating institutions improve dose.
- The CT quality team will continue running a protocol-of-the week as a component of our annual protocol review.
- Dose alert reviews are being planned for shorter intervals (3 months).
- Individual sites can receive monthly reports on response rate and unauthorized protocol use to guide in service training.