#### A comprehensive CT radiation dose reduction and protocol standardization program in a complex tertiary hospital system

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### **Disclosures**

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## **Background**

- Radiation doses from CT- Leading cause of non-background radiation exposure
- Radiation dose should be maintained As Low As Reasonably Achievable
- Revised requirements of The Joint Commission
  - Radiation dose of every CT exam should be recorded
  - Investigation of cases where radiation dose exceeds reference levels
- Establishing a real-world radiation dose reduction program is challenging



- Establishing a CT radiation dose reduction program in a large complex health system is not widely reported
- We describe a comprehensive radiation dose reduction and protocol homogenization program in a large complex system using

- Iterative process of lowest common denominator using phantom and clinical test cases

- Novel web-based information distribution system



Challenges				
3 health	4 large	5 outpatient		
systems	hospitals	centers		
Several remote	3 PACS	4 major		
locations	systems	manufacturers		
21 CT systems 9 hybrid CT	Brand new to > 10-year-old equipment			

## **Problems**

- Several, heterogeneous protocols
- Each location had local imaging protocols governed by local administrative body
- Different machines- multiple vendors; different software, hardware, weight limitations, etc
- Heterogeneous radiation doses for same protocols at different sites
- Variable maintenance of protocols at sites, paper or electronic
- Difficult to obtain protocols from another location without a phone call/email



- A CT radiation task force was created
- Weekly CT operations meeting was established
- Coordination of stakeholders- Physicians, physicists, technologists and hospital administrators

## **CT Radiation Task Force- Aims**



- To optimize patient radiation dose across scanners
- To standardize and homogenize the scan protocols and their names
- To maintain or improve image quality
- To establish mechanisms to continually track the dose
- To establish a reliable training and dissemination processes
- To make protocols readily available
- To ensure adherence to imaging protocols

## **The Optimization Process**

- All existing protocols were reviewed on a divisional basis
- 3 studies selected from the PACS for each protocol from each CT scanner
- Evaluated by a radiologist on a five point Likert scale for image quality (1-5)
- Physicist quantified the radiation dose (DLP) and image quality (CNR) using anthropomorphic phantoms
- If the image quality was maintained at the lowest dose, that protocol was programed in the scanner.

## **The Optimization Process**

- If the image quality was not maintained at the lowest dose, the protocol was optimized based on CNR metrics and previously optimized CT protocols
  - Acquisition parameters
  - Reconstruction kernels
  - Iterative reconstruction levels
- The review process was repeated with the proposed protocol.
- The lowest dose which did not compromise image quality was selected
- Redundant protocols were also eliminated, merging protocols which could give similar results- *Eg Bony pelvis from CT abdomen, pelvis; Lumbar spine from CT abdomen*





## **Protocol homogenization**

- Imaging protocol was defined across subspecialty radiologist teams
- Each protocol was reviewed by subspecialty radiologist groups
- Overlapping protocols combined
- Duplicated/outdated protocols eliminated
- New protocols developed if there was a clinical requirement
- Imaging protocols reflect specific modalities and available equipment
- After consensus, pdf document of protocol created

#### **Protocol homogenization**

- Database created linking clinical imag protocols to scanner/machine specific acquisition parameters
- Implemented in Microsoft Access
  - Contrast administration
  - Imaging phases
  - Radiation dose
  - Electronic orders

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- Sharepoint site or "Radpoint'
- "Source of truth" for all protocols

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## **Results- Protocol homogenization**

- Project start- May 2014
- Protocols reviewed- >2000 individual scanner protocols
- Optimization proceeded from division to division
- First division (Cardiothoracic) was completed in two months
- Entire optimization process completed in 9 months
- Total number of types of CT protocols decreased from 222 to 136

## **Results- Radiation dose**

- Significant improvements in radiation doses
- Improvements ranging from 23-58 % dose reduction

## **Results- Radiation dose**

Evaluation of radiation doses for each optimized protocol over a period of one year before and one year after implementation was done using geometric mean to measure differences in dose



Geomet	Improve ment	
Before	After	(%)
900	690	23
900	660	27
710	400	44
960	600	38
1845	975	47
1170	490	58
1850	970	48
	Geometri DLP, m Before 900 900 710 960 1845 1170 1850	Geometric Mean           DLP, mCy-cm           Before         After           900         690           900         660           710         400           960         600           1845         975           1170         490           1850         970



















## **Results- Protocol Usage**

- Protocol access through Radpoint
- Number of CT protocol page visits from July 2015 till date 21,037
- Average/month

- 1315



## **Discussion**

- It is possible to establish a robust radiation dose reduction and protocol homogenization program in a complex health system
- Requires participation of all stakeholders, including radiologists, technologists, physicists and hospital administrators
- Each protocol can be optimized by an iterative process that uses both clinical and phantom data

## **Discussion**

- Training of technologists is an important component of the program and we achieved this by incorporating this as a part of protocol change process
- Imaging protocol homogenization requires subspecialty operating committees and specific individuals to manage the process
- Dissemination of protocols was made easy by a novel web-based information distribution system
- Periodic protocol and dose review ensures consistent maintenance of quality





- We successfully managed the complex process of homogenizing CT protocols and optimizing radiation doses without compromising image quality
- Key elements are-
  - Establishment of CT Dose task force and CT operations committee
  - Iterative process of protocol optimization using phantom and clinical tests
  - Novel web-based information distribution system for protocols
  - Establishment of a protocol change process
  - Establishment of radiation dose tracking process