Optimizing Pediatric Radiation Exposure

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ABSTRACT

The increased risks of radiation exposure in children prompted a systematic and data-driven approach to optimizing radiation exposure. In this poster, we describe the differences in pediatric radiation exposure across three different hospitals. The results indicated that improvements had been made since last year's report, but also revealed clear opportunities for further improvement.

PURPOSE

Data-driven approach to optimizing radiation use

1. Collect and analyze data
2. Use the resulting knowledge to propose improvements
3. Test those hypotheses through small tests of change
4. Repeat steps 1-3

Introduction

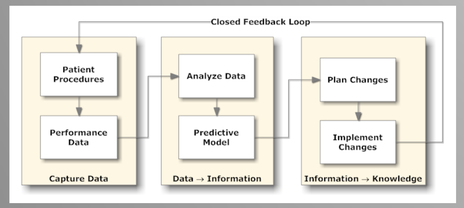
Image Gently

The Alliance for Radiation Safety in Pediatric Imaging recently recognized the following challenges

- Children are often imaged in adult-focused hospitals
- Need for diagnostic reference levels
- Need for optimization

Data-driven process improvement

- Awareness is the first step
- Continuous measurement and data analysis are the key elements behind sustainable improvement efforts



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METHODS

Recording and storing data

- In 2009, started manually extracting data from dose records stored on PACS
- In 2010, technologists began routinely entering DLP and CTDIvol into the Radiology Information System (Siemens Syngo)

Data retrieval

- MPI, Accession, Date of Service (DOS), Age, kV, mAs, CTDIvol, DLP, Time, Location, and Protocol
- Data for 3-23yr old patients was extracted from records at all three hospitals
- Data from all patients at hospital 3 (adult-focused) was examined for temporal changes

Data analysis

- The patients were then divided into 3 age groups
- The data for the two most frequent exams, Abdomen/Pelvis with contrast and Head without contrast, was plotted

Providing feedback

- Determined the expected range of values for the two most frequent exams (Head and Abd/Pelvic CT)
- Reports circulated to CT technologists and radiologists

RESULTS

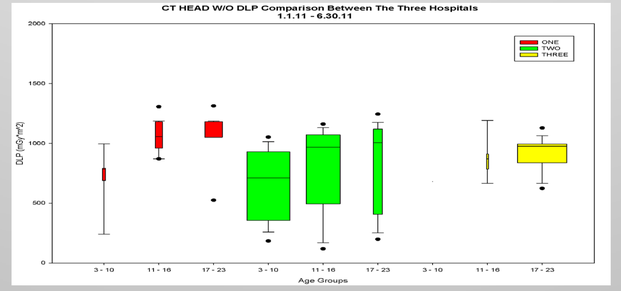
Most Frequent Exams

- Identified frequent CT at all three hospitals (hospitals 1 and 3 were adult-focused; hospital 2 was pediatric-focused)
- The most frequent exams at each hospital were CT Head and CT abdomen and pelvis
- While every exam is an opportunity to improve, the most frequent exams were the primary focus of the subsequent analysis
- Hospital 1 (an adult-focused facility) performed more abdominal/pelvic CTs than head CT exams. This suggests that CT was often the primary modality for evaluating children with abdominal pain

Ages 11 - 23								
Adult Focused			*Pediatric Focused*			*Adult Focused*		
Procedure Name	Frequency	Percent	Procedure Name	Frequency	Percent	Procedure Name	Frequency	Percent
CT Abd/pelvis with	145	33%	CT Head without	316	27%	CT Head without	243	21%
CT Head without	134	30%	CT Abd/pelvis with	180	15%	CT Abd/pelvis with	115	10%
CT Stone Protocol	40	9%	CT Head & C-Spine without	75	6%	CT Chest with	104	9%
CT Maxillofacial without	30	7%	CT Chest/abd/pelvis with	72	6%	CT Chest without (high res)	89	8%
CT Neck without	18	4%	CT Maxillofacial without	68	6%	CT Chest without	40	3%
CT C-Spine without	16	4%	CT Chest with	61	5%	CT Orbits, sella	39	3%
CT Sinus	8	2%	CT Abd/pelvis without	51	4%	CT Maxillofacial without	38	3%
CT Abd/pelvis without	8	2%	CT Neck with	34	3%	CT Neck with	37	3%
CT Chest (PE protocol)	7	2%	CT Head & Maxillofacial	33	3%	CT Chest (PE protocol)	28	2%
CT Chest with	6	1%	CT Lower ext without	30	3%	CT Angio Head	28	2%
Totals	412	94%		920	78%		761	64%

Head and Abd/Pelvic CT Results – DLP values

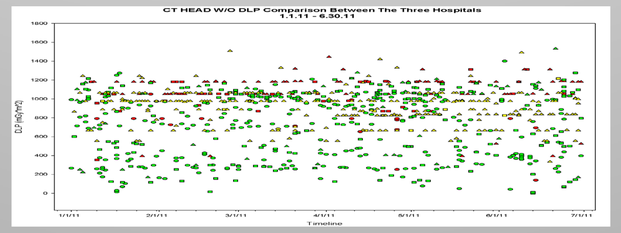
- DLP values were available for all 3 hospitals
- Only the second hospital (a pediatric-focused facility) had a sizable number of patients <11yrs
- Youngest age groups had greater variation. This likely reflects efforts to match scan parameters to patient size



A comparison of the three hospitals highlighting their DLP values over the last six months for CT Head. The width of each bar reflects the number of exams available for this analysis. The younger age groups were not frequently scanned at the two adult focused facilities.

Head CT Results – DLP values versus time

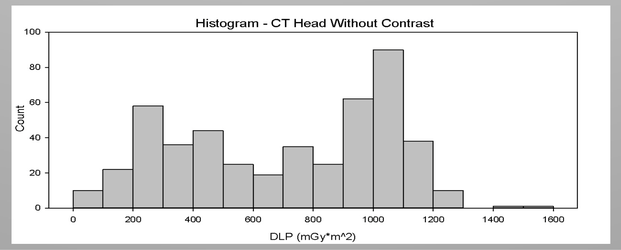
- Large variation seen for DLP values is exemplified by this scatter plot
- The variation did not change substantially during the study period



A scatter plot over time of the three hospitals' DLP values over a six month time interval. The first and third hospitals' values are fairly constant over the time frame ,with a few outliers and insignificant variation. The second hospital, however, shows more variation during this time period.

Head CT Results – Histogram analysis

- Variation in head size is much smaller than other regions such as abdomen or pelvis
- When compared to the adult-focused facilities (Hospitals 1 and 3), the pediatric facility showed data that was skewed towards lower values
- The pediatric facility often scanned children with shunts and had developed an ultralow dose protocol for their followup studies



A histogram for the pediatric facility (hospital #2) illustrates a bimodal distribution. Adult focused facilities had very few studies with DLPs in the 200-400 range.

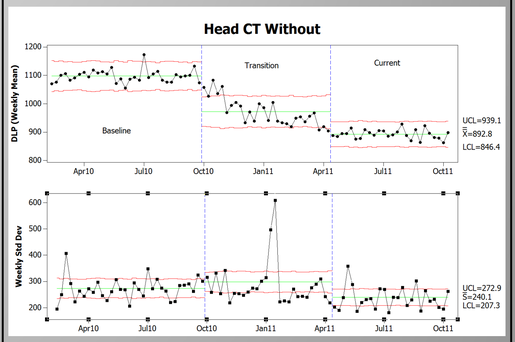
RESULTS

Knowledge gained from Image Gently was applied to our Image Wisely efforts

- Initial focus was on head CTs
  - Most common study in adults; Amenable to standardization since head size changes very little during adult life
- Observed variation in head CT protocols used in Hospital 3
  - Identified lower settings that provided acceptable image quality and implemented these throughout Hospital 3

Analysis using tools from statistical process control

- Scatterplot (not shown) hinted at the process shift
  - Control chart plotting daily mean head CT DLP showed a more convincing change
  - Xbar-S control chart plotting weekly mean head DLP was produced using Minitab 16 software and showed a clear process shift
  - Shift in process mean was also accompanied by a decrease in process variation



DISCUSSION

Optimization starts with awareness of an opportunity to improve

- Our focus to Image Gently in children led to efforts to Image Wisely with older patients
  - Pediatric facilities have learned to lower settings while preserving diagnostic utility
  - Our data indicates that adult-focused facilities can learn to "follow the low dose leaders"
  - Future efforts will continue to test the ability to reduce exposure further in selected clinical situations such as followup studies
    - Followup studies are common in young adults with prior abscesses, renal calculi, and other benign conditions
- Tools from statistical process control can simplify data analysis
- Pediatric reference levels are still needed

ACKNOWLEDGEMENT

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