Optimizing Radiation Use during Computed Tomography and Fluoroscopy

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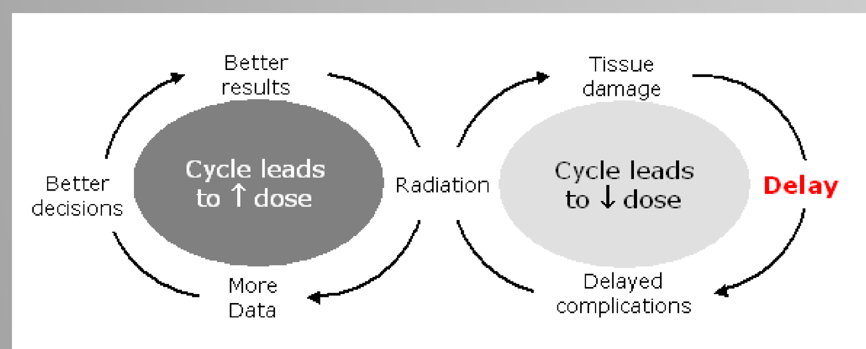
ABSTRACT

We propose that optimal use of ionizing radiation can be achieved through a data-driven process improvement strategy. In this poster, we describe processes for collecting and analyzing data from CT and fluoroscopic procedures. The results revealed clear opportunities for improvement. Feedback to frontline teams then led to measurable improvements in system performance.

PURPOSE

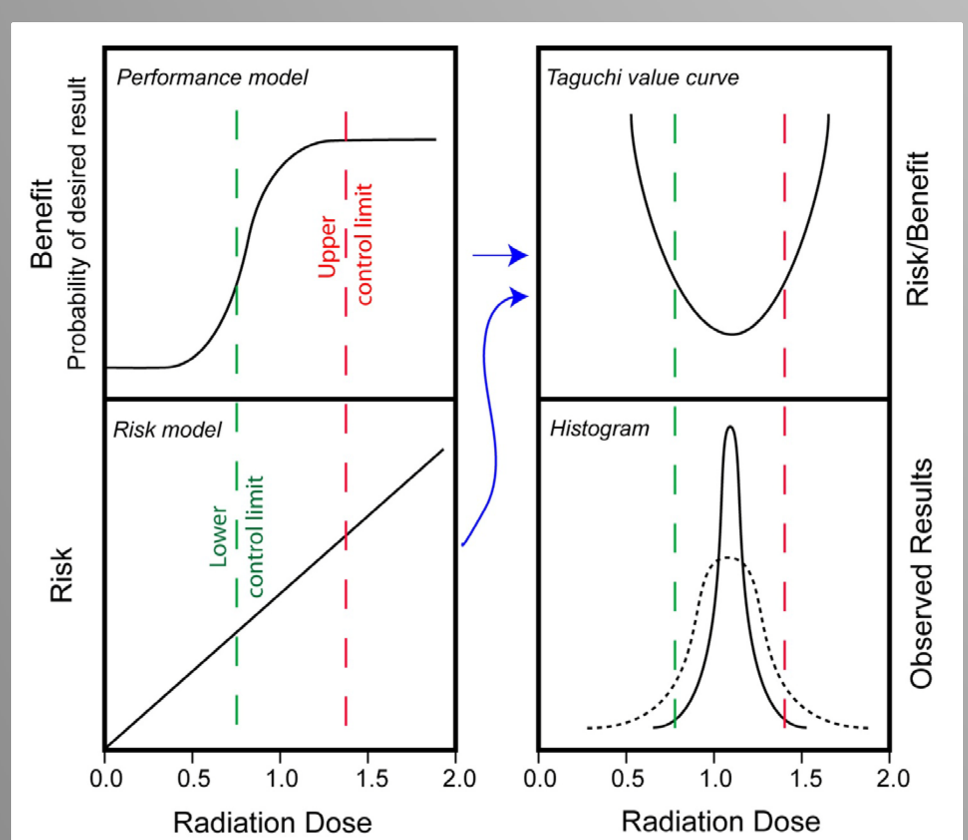
Radiation use reflects the balance

- Data from imaging helps improve clinical decisions
- Tissue damage from ionizing radiation carries risk



Strategies for optimizing this balance

- Quality = conformance to expectation
  - Propose a target value (optimal solution)
    - Radiation required to meet the clinical need
  - Measure actual system performance
    - Calculate difference between observed and target
    - Revise system to minimize these differences



REFERENCES

1. Miller DL et al, *Reference levels for patient radiation doses in interventional radiology: proposed initial values for US practice.* Radiology 2009; 253: 753
2. Smith-Bindman R et al, *Radiation dose associated with common computed tomography examination and the associated lifetime attributable risk of cancer.* Arch Intern Med 2009; 169:2078,
3. Duncan JR, Evens RG, *Using information to optimize medical outcomes*, JAMA 2009; 301: 2383

METHODS

Capturing data from fluoroscopic procedures

- Starting in June 08, technologists enter fluoroscopy time into the radiology information system (RIS)
- Expanded to include reference point air kerma (K_{ar}) for any procedure with K_{ar} >2Gy

Capturing data from CT exams

- Dose reports archived on PACS
- Expanded in Feb 2010 by having technologists record dose length product (DLP) in RIS

Analyzing data

- Every month, the Quality and Safety Office extracts data from the RIS and prepares reports

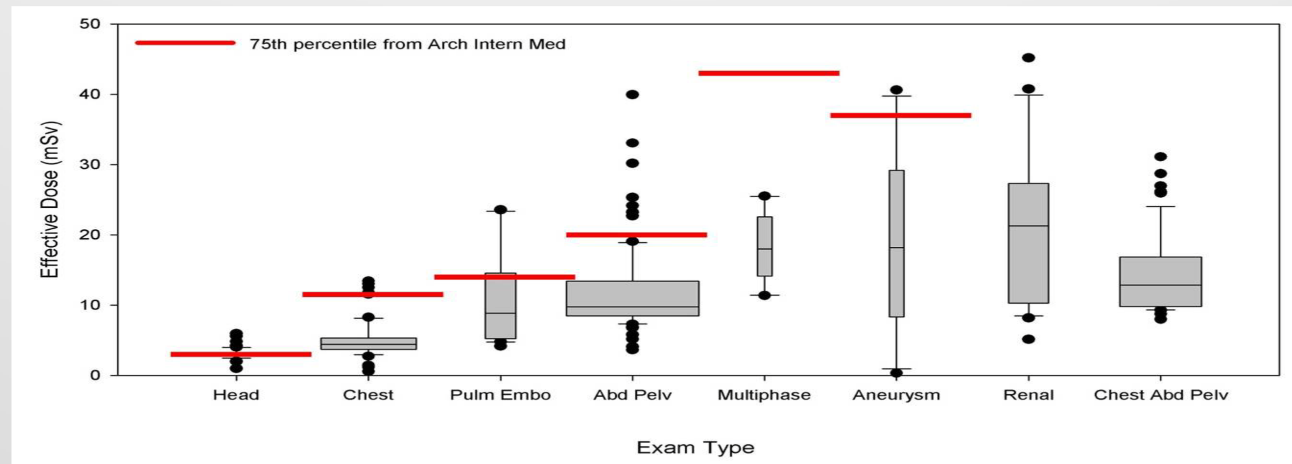
Providing feedback

- Selected fluoroscopy cases reviewed at M&M conference
- Reports circulated to CT technologists and radiologists

RESULTS

Adult CT results

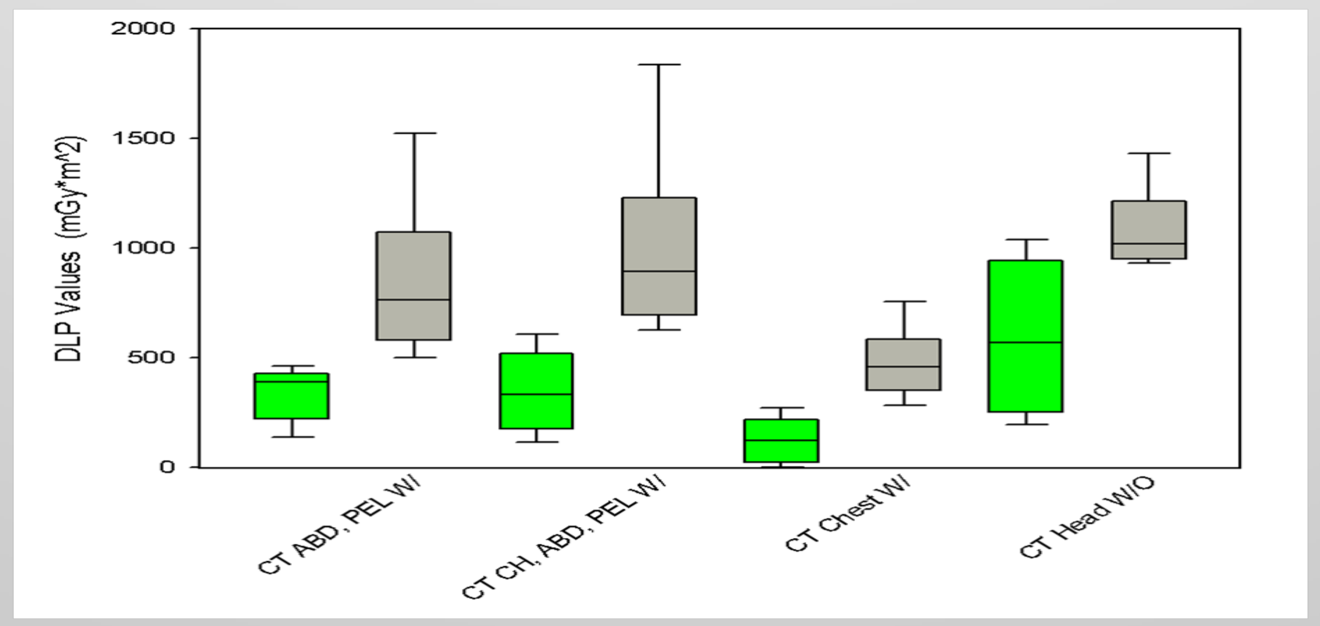
- DLP values converted to mSv
- Compared our results to published data
  - Good but not great
  - 2-3 fold variation was common
  - Not uncommon that abdominal exams exceed 20mSv, especially with multiphase exams such as renal protocol



Box plot of adult CT data. The top and bottoms of each gray box are the 75th and 25th percentiles. Line within the box is the 50th percentile. Whiskers extend out to the 5th and 95th percentiles and outliers are represented by round symbols. For comparison, 75th percentile from Smith-Bindman et al is shown as a red line. The width of each box reflects the relative number of CT exams.

Adult practices can learn from pediatric centers

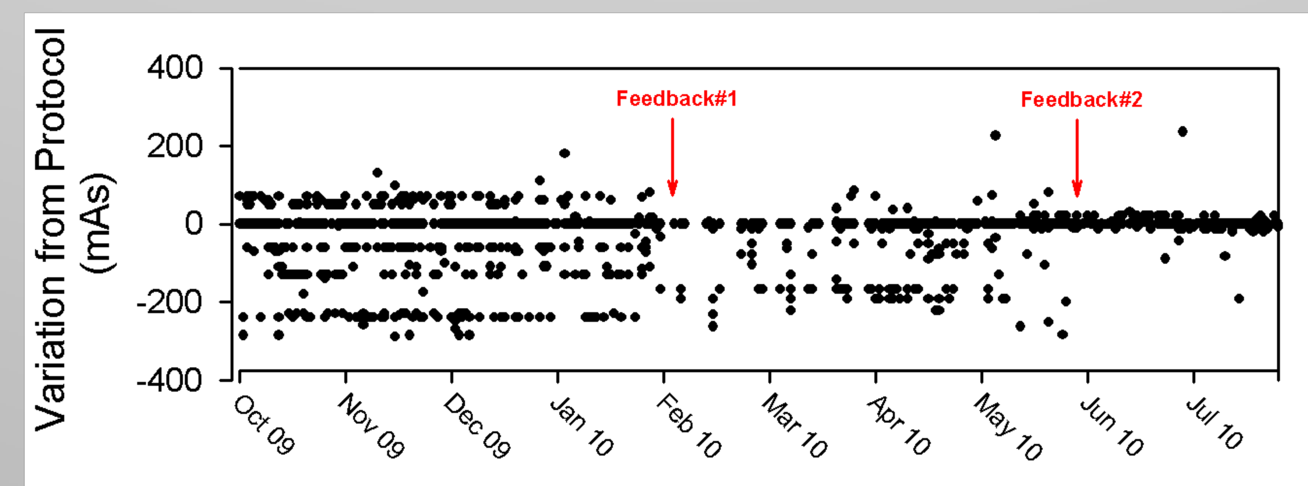
- Results from St Louis Children's Hospital (SLCH) show the impact of improvement efforts from the last 10 years
  - Difference is more than would be expected from difference in patient size
    - Teens are often adult sized
  - Less variation at SLCH even though population is more variable
    - Head CT was exception and reflects an improvement opportunity



Box plot comparison of CT exams from Barnes-Jewish Hospital (grey boxes) and St. Louis Children's Hospital (green boxes). CPT codes were used to group exams. With the exception of head CTs, the 95th percentile at SLCH is below the 5th percentile from BJH. This difference clearly reflects an attempt to "child size" CT protocols at SLCH. Since SLCH frequently images older children (teenagers) who are essentially the same size as many adults, these results suggest that the pediatric radiologists at SLCH have learned to accept studies with more noise.

Ample opportunity for further improvement

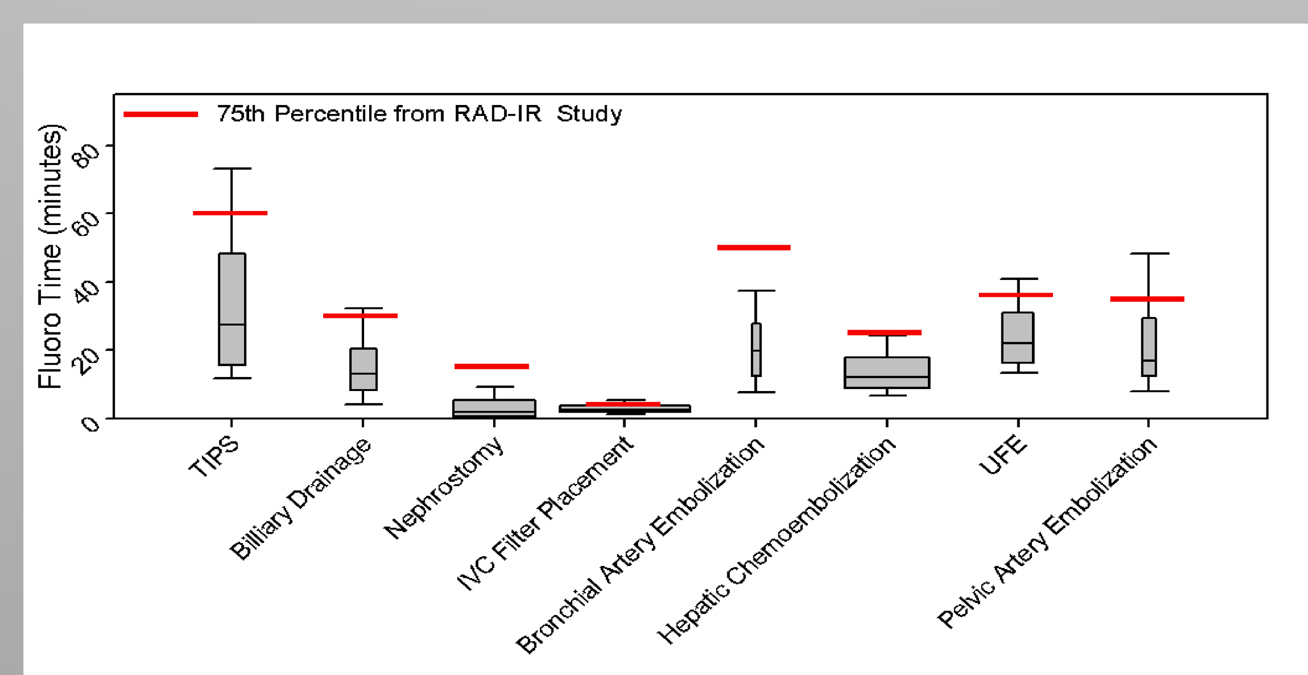
- Variation in pediatric head CT dose prompted further analysis
  - Deviation from protocol was common
  - Feedback led to improvement efforts
    - Continued measurements showed the resulting decreases in deviation from protocol



SLCH has a series of age specific head CT protocols that are designed to lower the photon flux (mAs) for younger children. Adherence to these protocols was assessed in Jan 2010 and then reported to CT technologists and neuro-radiologists. The subsequent improvement effort led to a substantial reduction in deviation from protocol. Results were reassessed in May 2010 and led to a second successful improvement cycle.

Fluoroscopy results

- Identified procedures using CPT coding patterns
  - Compared our results to published reference levels
    - Good but could be better
- Increased awareness of radiation use both during and after complex procedures
- Need
  - Capability to collect a complete set of radiation metrics from every case
  - Comprehensive set of reference levels

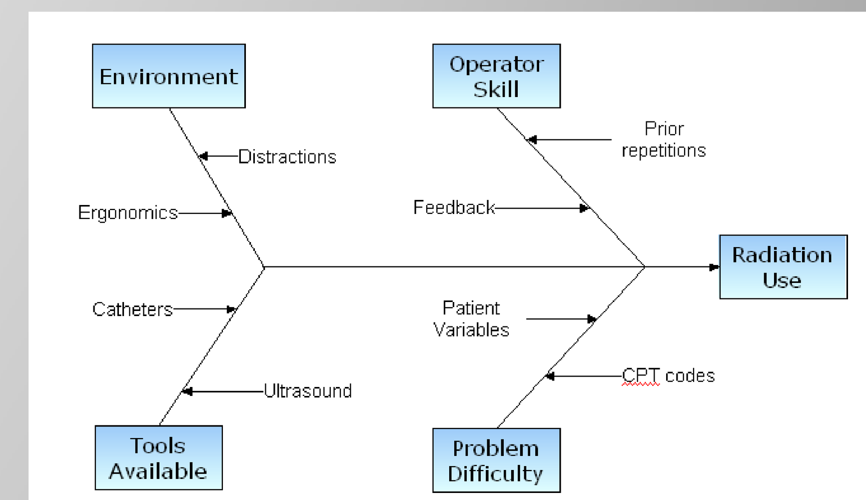


Box plot comparing complex fluoroscopy procedures from Barnes-Jewish Hospital (BJH) to published reference levels. In every case, top of the grey box (75th percentile from BJH) is below the target value (75th percentile from the RAD-IR study). While fluoroscopy time is a convenient measure of cognitive bandwidth (Beta et al, JVIR 2009; 20:769), it is a poor surrogate for radiation risk. Furthermore, much of the data from the RAD-IR study was obtained more than a decade ago and improvements in imaging and device technology could account for the observed pattern.

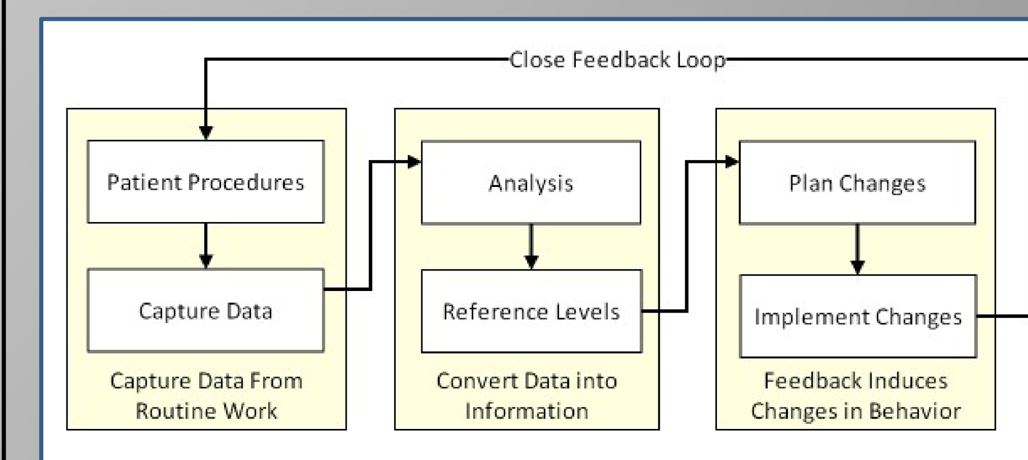
DISCUSSION

System requirements for optimizing radiation use

- Data capture
  - Routine and continuous of radiation metrics
  - Also need to capture a wide variety of other factors



- Data analysis
  - Reference levels as trigger tools
    - Prompt investigation into possible causes for continual or excessive deviations from expected results
- Feedback to frontline teams
  - Plan and implement potential improvements
  - Continually collect data to assess the efficacy and efficiency of those process changes



CONCLUSION

Data-driven process improvement is key to optimizing radiation use during CT and fluoroscopic procedures

- Requires investments in systems capable of data collection, analysis and feedback
- Investment opportunities
  - Technology – automated dose reporting and comparison to reference values
  - Human factors – standardized protocols, training

Closing thoughts from W. Edwards Deming

- While every measurement contains flaws, when faced with a decision, I'd rather rely on data than emotion
- It is not necessary to change, survival is not mandatory

ACKNOWLEDGEMENT

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