A Quality Control Monitoring Program in Digital Radiography

Matthew Hoerner, Ph.D. & Adel Mustafa, Ph.D.

Department of Radiology and Biomedical Imaging, Yale University School of Medicine, Yale New Haven Hospital, New Haven, CT

Yale NewHaven Health
Yale New Haven Hospital

Introduction

Quality control is an undervalued aspect in digital radiography imaging due to the large number of units that perform a sizable number of exams every year and the fast transition from screen-film to digital detection and display methods. Tracking this data can be difficult. Metrics such as exam repeat rate, reject rate, and exposure index (EI) are used by the imaging community to evaluate performance of the overall practice and the radiographic imaging equipment. The goal was to develop a methodology to collect, standardize, and analyze data to produce these metrics.

Methods

Each digital radiographic device is capable of exporting data for each exam performed within a given timeframe. Every month this data was collected and stored. Every three months the data was combined and processed using a software program which organizes the data, performs calculations, and standardizes the information so that it can be analyzed. The result is a large excel file which can then be used to create pivot tables and figures to facilitate further data analysis. Figure 1 illustrates the flowchart of the entire process.

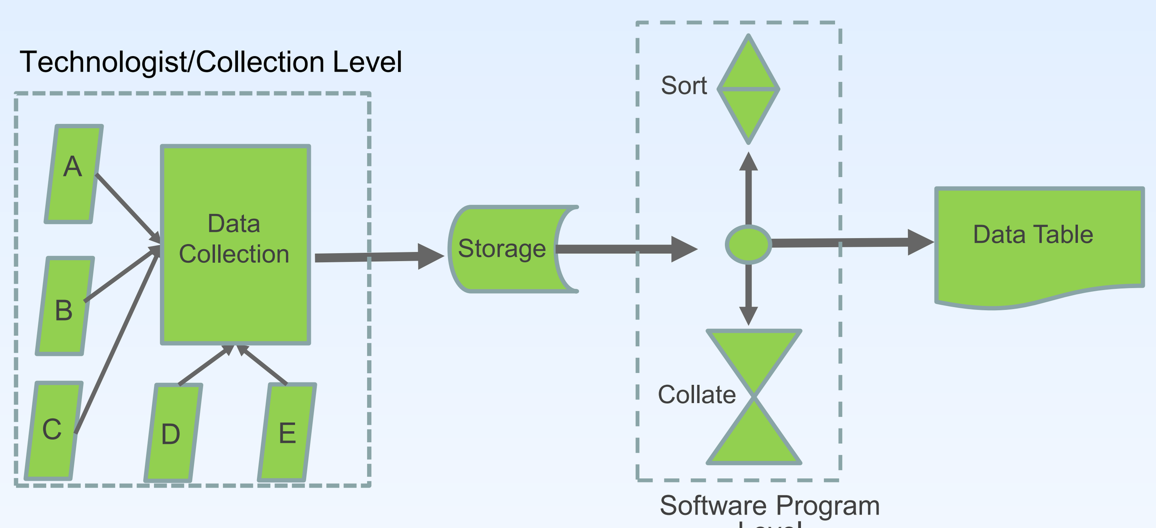

Figure 1. Flow Chart of Data Collection

Description of equipment

Over X-number of portable and fixed x-ray units were used to collect, ranging from Computed Radiography (CR) to Digital radiography (DR) detectors including five different vendors (Carestream, Canon, Fuji, Philips, and Siemens). Equipment was utilized for various hospital departments such as outpatient imaging (general and orthopedic), emergency department, pediatric, and in-patients.

Description of Data Output

Data collected involved organization of acquisition by view, body part, and protocol. Other parameters collected and calculated were reject and repeat status, IEC Exposure Index, Vendor Exposure Index, acquisition time and date. In some instances the vendors provided more information such as technique (kVp and mAs), patient age, accession and medical record number. All of this data was processed in order to provide the most relevant information in order to manage a quality control program. In our definitions, a rejected image is described as an image that is not sent to PACS and a repeated image is described as an image that wasn't rejected but repeated using the same view.

Results

Examination Breakdown

The software allows for looking at how frequent each department is using various views. Figures 2 and 3 illustrate the big differences between portable imaging for adults and pediatrics and in-patient pediatric imaging.

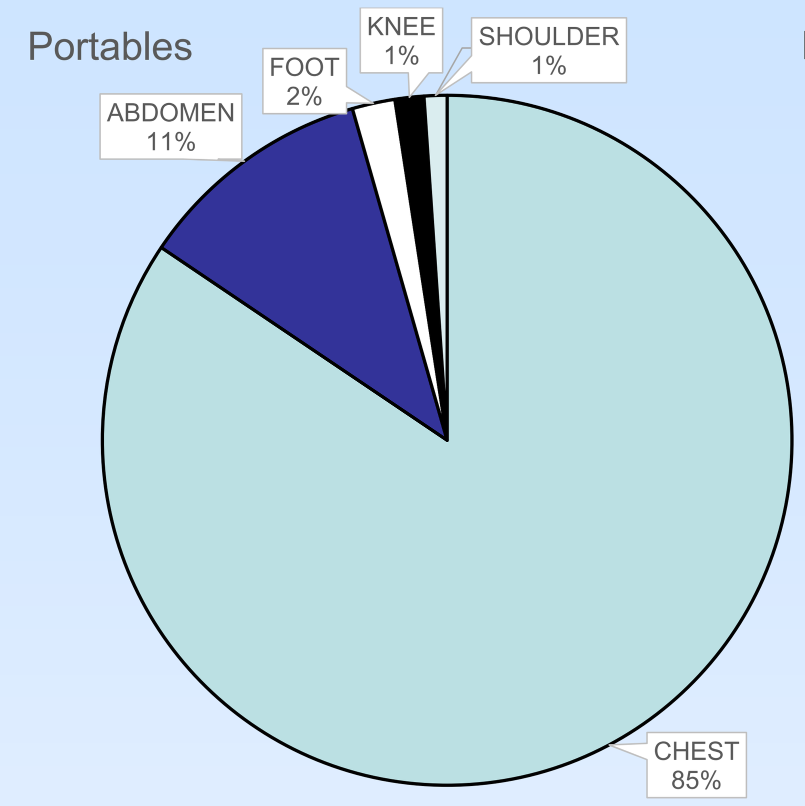

Figure 2. Exam distribution of Portable Imaging

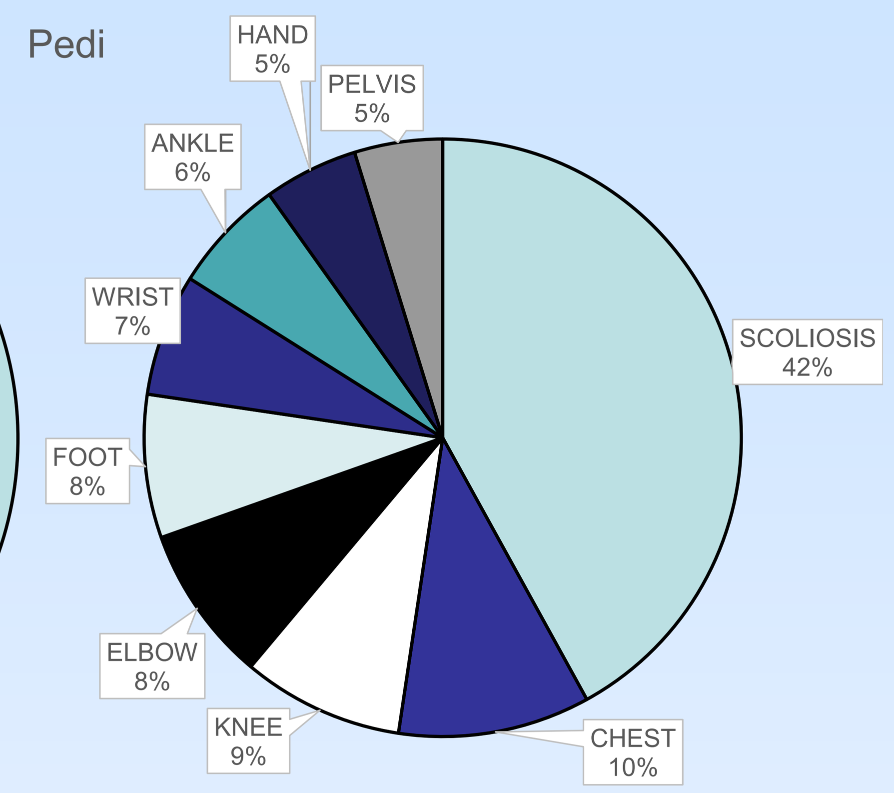

Figure 3. Exam distribution of a Pediatric outpatient clinic

This breakdown plays an important role in optimization because it illustrates prominent exams that should be continuously monitored. Figures 4 and 5 below illustrate how for portables we can monitor reject and repeat rates, as well as exposure index values. Figures 4 and 5 shows two examples of cases where exposure index values were determined to be higher than normal. Figure 4 shows the Exposure Index distribution before and after a weight-based technique chart was implemented to address portable imaging of new-born babies. Figure 5 shows the effect of implementing a technique chart in AP scoliosis images. The exposure units are higher than normal because this system uses a "Virtual Grid" which simulates the effect of a grid. Exposure Index is calculated based on the non-grid response of the detector and therefore the exposure index may appear to be higher than expected compared to Bucky exams.

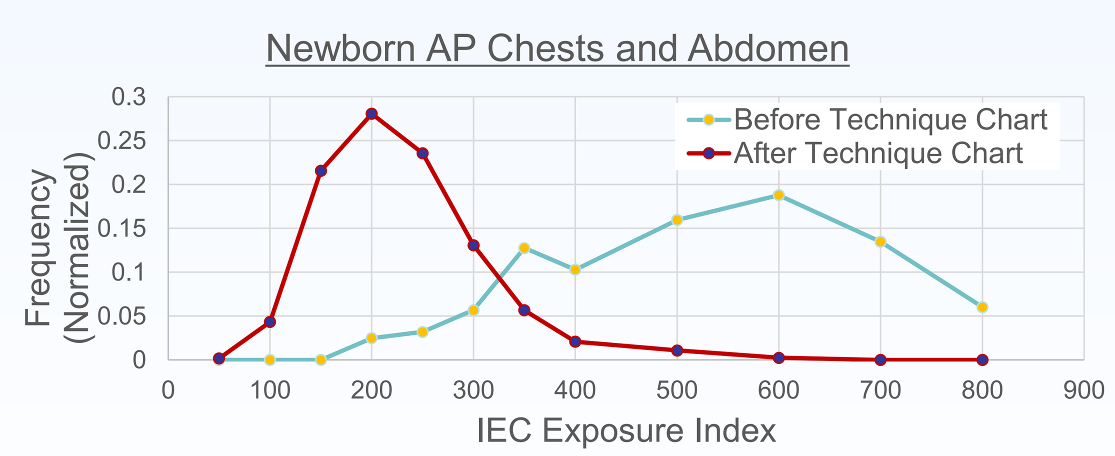

Figure 4. IEC Exposure Index before and after implementation of a technique chart for NICU patients. Blue curve mean 521, stdev 216; red curve mean 203, stdev 83

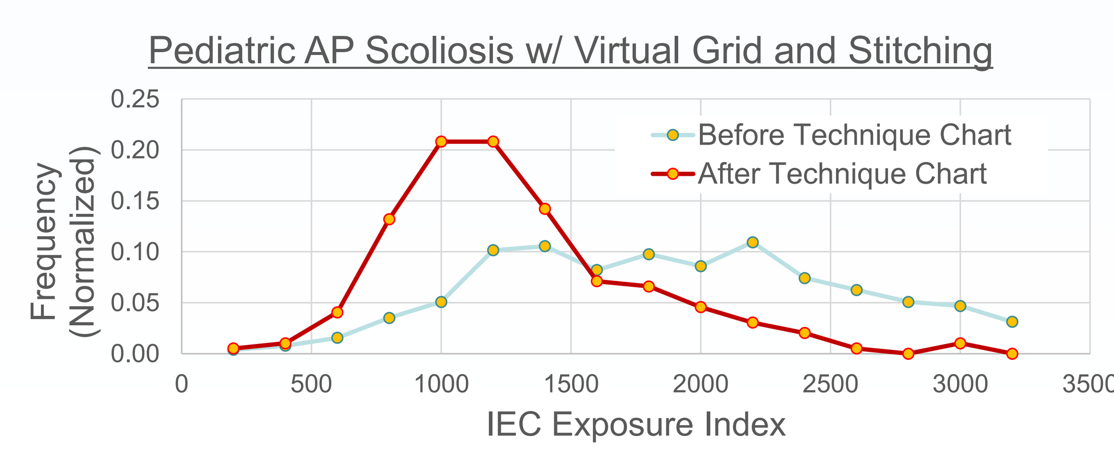

Figure 5. IEC Exposure Index before and after implementation of a technique chart for Pediatric scoliosis. Blue curve mean 1856, stdev 745; red curve mean 1192, stdev 500.

Discussion

Reject/Repeat Rate

We consistently found that the reject rate was higher for DR than CR. Over 60% of the reasons for rejecting an image was clipped anatomy and positioning. The repeat rate was between equal to the reject rate all the way up to double. Total number of repeats (rejects and repeats) approached 30% for portable imaging.

Exposure Index

This program has enlightened us to the importance of monitoring DR and CR imaging. Besides the exposure index, repeat, and reject rates it is important to examine the standard deviation or distribution of exposure index values. When comparing exposure index values against vendors it is important to recognize how each vendor calculates the exposure index. Some vendors use ROI-specific calculations while others average the exposure of the entire anatomy. At our facility we utilize a virtual/simulated scatter removal grid, and we found the EI values can be up to 2 to 3 times higher than EI values without a grid. Figure 6 shows an example how we learned to compare EI values. Units A and B both had exposure issues. Unit A had a faulty AEC that was overexposing images. Unit B was a room where the technologist was using his own technique and performing a lot of the exams out of the Bucky. Both issues were corrected through service, education, and technical adjustments. Unit C represents a unit that uses the most updated technology and could represent exposure index's that are achievable.

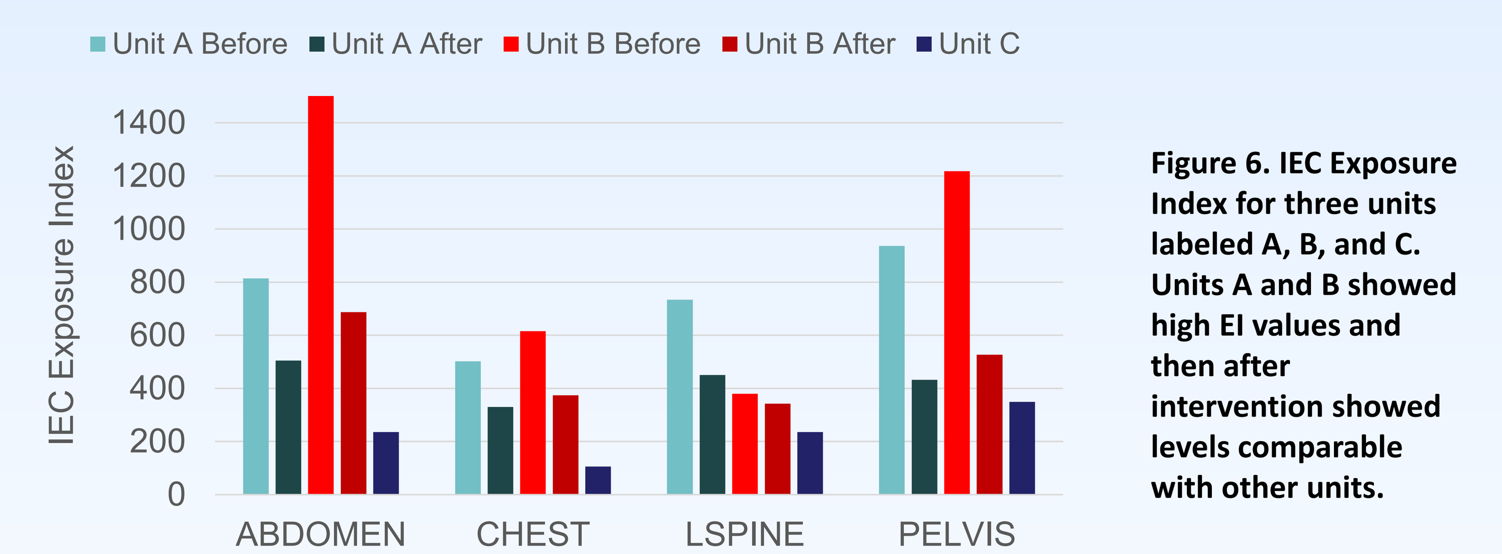

Figure 6. IEC Exposure Index for three units labeled A, B, and C. Units A and B showed high EI values and then after intervention showed levels comparable with other units.

Conclusion

All of these parameters together can identify areas where it may be necessary to implement a technique chart, enact training, or encourage technologists to improve their abilities in acquiring images. Digital imaging has made the imaging process very automotive and this has resulted in more human error with regards to repeating images and the optimization of image quality and dose. We found the best way to correct issues is through one-on-one learning and accountability .

References

1. Medical electrical equipment – Exposure Index of digital X-ray imaging systems – Part 1: Definitions and requirements for general radiography,' IEC 62494-1 Ed 1.0 2008-08
2. Jones, A. K., Heintz, P., Geiser, W., Goldman, L., Jerjian, K., Martin, M., Peck, D., Pfeiffer, D., Ranger, N. and Yorkston, J. (2015), Ongoing quality control in digital radiography: Report of AAPM Imaging Physics Committee Task Group 151. Med. Phys., 42: 6658–6670. doi:10.1118/1.4932623