

Radiation Dose Reduction Strategies in the NICU

David Dinhofer, MD^{1*}, John Amodio, MD¹, Torrance Akinsanya, M.P.A.,C.P.H.Q², Adeola Dabiri, MPA², James Shanahan², Olatokunboh Osineye², and Charles Carbone²

SUNY-Downstate Medical Center, Departments of 1. Radiology and 2. Quality Assurance, 450 Clarkson Ave., Brooklyn, New York 11203 / Direct E-mail Inquiries to: david.dinhofe@downstate.edu

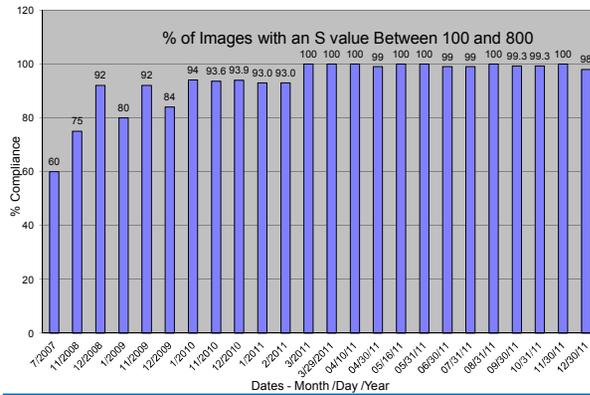


Figure 1. The S-value is a measure of exposure and is a rough estimate of the number of photons that strike the imaging plate used for Computed radiography. This value is an indirect measure of radiation exposure. This graph demonstrates the percentage of studies that fall within the S-values that were established by the radiologist and radiation physicist optimized for neonatal exams as compared to the total exams done.

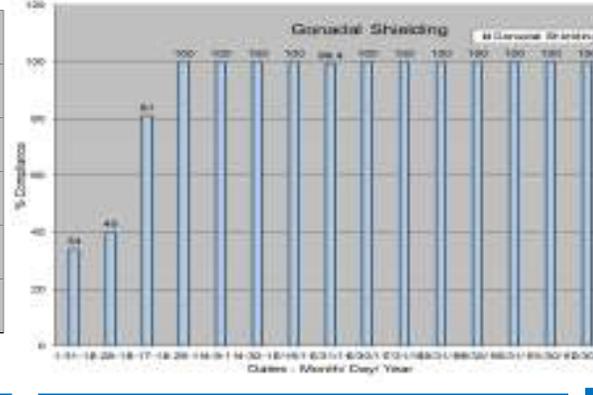


Figure 2. This graph demonstrates the percentage of studies that were verified to have a gonadal lead shield present on the image as compared to total exams done.

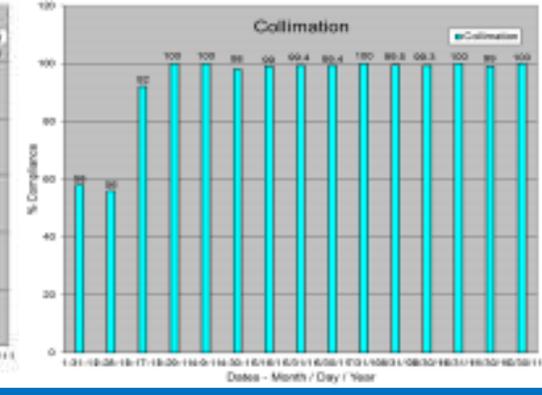


Figure 3. Collimation is the use of lead shields that limit the size of the imaging field. The collimation was judged in compliance when it met standards set up by the radiologist, the medical physicist, radiologic technologist and NYS regulations. The graph demonstrates compliance as percentage of total exams done.

Methods

Radiation Safety committee, Radiology Process Improvement Committee, Physician staff, Radiation physicist and technical staff were all involved in the design of the process improvement plan. Three main areas were used as focal points: collimation, S-value and gonadal shielding. One additional focus was included but not tracked, which was limiting image acquisition to the specific body part that was ordered in writing by the health care provider. This last one was harder than it sounds. The babies in the NICU are very small, often weighing about 1 kg or less. The one inch collimation rule (a NYS regulation) can cover a large area in a tiny neonate. Nonetheless, using standard collimation lighting and re-educating the x-ray technologists was mandated and followed. The collimation review served as a means to track this issue as well. Radiologists were involved in making sure that "What they saw, was what was ordered." The medical physicists reviewed x-ray technique and established the rule for the S-value. The weight of the project was mainly on the shoulders of the x-ray technologists. Neonatologists, Radiologists, Physicists and supervisory staff assisted. The x-ray technologists received training and education on the required changes. The physicist programed the optimum x-ray technique into each of the portable x-ray machines used in the NICU. Neonatologists were advised about collimation and the NYS requirements on x-ray orders. Radiologists performed oversight of image quality. The supervisors of the x-ray technology staff were the main source of data. They did daily checks of the collimation, gonadal shielding and S-values. This data was recorded on a binary basis of does meet standards or does not meet standards. The data was reviewed at the monthly radiation safety committee and radiology process improvement committee meetings.

Results

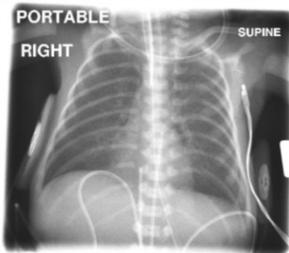
From the initiation of the changes, there was steady improvement in the outcome values over a period of two months. A baseline of 98-100% was obtained. The project was continuously tracked for one year. At the end of the year, the tracking was changed to random sampling every three months. (see graphs)

Discussion

This project highlights how teamwork and top administration support can push a project along and be a strong motivator for success. The involvement of top administration helped move the project at high speed. In addition, the involvement of multiple team members made implementation of the project rapid and easily accepted. Teamwork helped all involved feel ownership in the project which strengthened the resolve and promoted this successful project.

Summary

The project is multifaceted with a single goal: reducing radiation exposure from x-ray exams to neonates in the NICU. Reducing radiation exposure of children in the population that our institution serves has been an ongoing project for many years. In about 2007, a director of pediatric radiology was hired with a mandate and desire to reduce radiation exposure to children. He began by reviewing all CT procedures based on an ACR White Paper on CT dose, the highest source of exposure. All the protocols under his control were changed to the lowest possible dose while maintaining diagnostic quality. The rest of the staff were active in this change and helped review other procedures performed on children. An article in the NY Times titled, "X-ray and Unshielded infants," dated, February 27,2011, focused mainly on a single issue, neonatal x-ray collimation errors, which in its worst instances are called "babygrams," brought attention to Downstate. This initiated a top down review of x-ray practices in the NICU. This project was supported at every echelon of Downstate, including the CEO. The project included review of ordering procedures, evaluation of technique, and radiation protection. Ideas came from the Radiation Safety Committee, the Radiology Process Improvement Committee, the NYS Department of Health, Doctors, Medical Physicists and technical staff. We chose three areas to track: 1. S-values, 2. Image Collimation, and 3. Gonadal Shielding. By December 2011, we had a sustained improvement that substantially met our exceptional goals of 100% compliance on all three of the tracked areas.



Proper collimation

Fig 2. - The image to the left shows proper collimation. The shoulders, neck, and upper abdomen are included in the image. The arms, pelvis and head are not seen. Note, lead collimator lines on all sides of this computed radiography image.



"Babygram"

Fig 1. - The image to the left is a "babygram". It displays all limbs and the head. In this case, it was to depict dwarfism and appropriate. However, when a chest is ordered, the image should only include the neck, shoulders, and upper abdomen. Including the limbs and head which should not be in the imaging field for a routine chest exposes these parts unnecessarily. Note, there are no collimator lines.

Gonadal Shielding

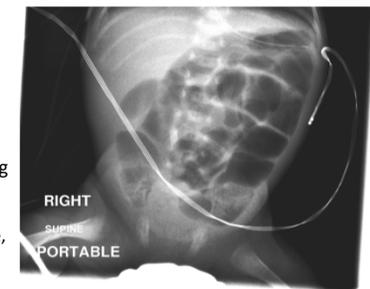


Fig 3. - Please note on the image on the right, lead shield covering the gonads of this male child. Also note, lead collimator lines on two sides of this image.