

Radiation Dose Reduction in Fluoroscopy

By Ronald V. Bucci, PhD, Godfrey Gaisie, MD, Cheryl Miller, RT, Michael Rubin, MD, and Adam Springer, MS

Medical radiation exposure is a major concern in the United States and represents the most rapidly increasing source of radiation exposure. Children have a longer lifespan and more radiosensitive tissues than adults making them more vulnerable to long term effects of ionizing radiation. Parents are becoming increasingly concerned with radiation exposure to their children. In view of these concerns, Akron Children's Hospital (ACH) applied for the AHRA & Toshiba Putting Patients First Grant to study radiation exposure levels during routine fluoroscopy. A component of the study was to determine the radiation exposure for various fluoroscopic examinations and to compare the effective doses delivered by four types of fluoroscopic examinations at ACH to national diagnostic reference levels. Another part of the study was to determine the best methods to perform fluoroscopic studies at the lowest possible settings that are also of diagnostic quality, with the goal of decreasing the amount of radiation a patient receives.

ACH is a 374 bed multi-hospital system located in Northeast Ohio. Current radiology volume per year is approximately 100,000 exams. The ACH imaging department offers children and young adults a range of imaging procedures, from standard x-rays to advanced imaging procedures such as magnetic resonance imaging (MRI), computed tomography (CT), ultrasound, nuclear medicine, and positron emission

tomography (PET/CT). Staff includes board certified fellowship trained pediatric radiologists, radiologic technologists, pediatric radiology nurses, child life specialists, and a contracted medical physicist.

The hospital uses best practices for radiation and has current policies and procedures implemented to use the lowest effective dose for patients. The hospital utilizes ALARA and Image Gently. The staff has a further vision to accurately detect the exact radiation dose received during fluoroscopy procedures and to further reduce these doses.

The specific objectives of this project were to:

- Develop educational materials to increase the knowledge levels of referring physicians, patients, and their families of the radiologic dose they would receive during a specific examination, and what that dose would mean to them compared to the average background radiation from the environment.
- To develop presentations, both poster and oral, that would share the knowledge gained with other pediatric institutions to be given at various radiology professional meetings and conferences.
- To continue to build on our initial experience with fluoroscopic radiation dose by further estimating radiation exposure for common pediatric

radiographic examinations using current CR/DR equipment. Studies such as chest radiographs, abdomen, spine, and extremities would be included. This information would be made available to the families of patients.

The radiology world has changed over time to be more and more radiation conscious and much has been written on the subject. One article noted that the "US radiology community pays more attention to the dangers posed by ionizing radiation during fluoroscopic and CT procedures."¹ Another noted that limiting patients' exposure to ionizing radiation during diagnostic imaging is of concern to patients and clinicians.² Finally, the general public is much more cognizant of radiation. The general population also is more aware of radiation risks than ever before and, as a result, they demand and deserve accurate information regarding radiation protection.³

Implementation

ACH installed two Toshiba Kalare Fluoroscopic units in 2009. The pediatric radiologist and RT fluoroscopy specialist at ACH worked with the Toshiba applications specialist to determine the lowest exposure factors and fluoroscopic pulse rate required to produce diagnostic quality images for various age groups and examinations. These settings were standardized for all radiologists. In consultation with the physicists,

it was determined that the fluoroscopic dose area product (DAP) was required to estimate effective dose in millisieverts (mSv) for various procedures. The DAP was documented for four types of fluoroscopy examinations performed on the main campus of ACH between December 1, 2011 and May 30, 2012. The exam types included in this work were: upper gastrointestinal (UGI) without scout abdominal radiograph; UGI with small bowel follow through; voiding cystourethrograms (VCUG); and swallowing function. DAP from overhead radiographs was also determined. The DAPs were used to calculate the energy imparted, which also depends on tube kilovoltage (kV), beam half value layer (HVL) and patient thickness. Effective doses were estimated from energy imparted by using region specific conversion factors. The median and maximum effective doses were binned by age and plotted for each of the four exam types.

Findings

The measured DAPs were up to 90% less than published reference levels; however, the DAPs and effective doses were up to 10 times higher than other published data. Although diligently following radiation safety practices ensured patient doses were well below published reference levels, it is apparent that much lower doses are achievable.

Investigation is underway to further reduce dose through physical and software modifications to existing equipment, such as additional tube filtration and pediatric specific automatic brightness control algorithms.

Based on these findings, the following changes were made to the fluoroscopy procedures:

- Removal of the grid for the smaller patients
- Decrease the pulse fluoro to 2 fps
- Improve the DR technique for overhead small bowel abdomen films
- Duplicated low dose on new fluoro equipment at second hospital campus

The end result improved the staff consciousness of radiation dose and we were able to reduce the overall radiation to our patients.

Educational Outcomes

A brochure was created with the results of the average effective doses received from the aforementioned fluoroscopic exams. These have been distributed to referring physicians and are available for patients and families. A video briefly explaining concern for acquiring the lowest doses possible at ACH, and the results of our data, is being produced. This will be on the hospital Intranet for employees and physicians and on the hospital website for the public. Effective doses (mSv) will be available on the Intranet and ACH website in a format that the general public can understand. Quarterly dose spreadsheets are maintained for the main campus and one of our outlying facilities.

Conclusion

Practicing best radiation safety practices is not sufficient to ensure pediatric fluoroscopy doses are ALARA. Institutions that examine pediatric patients under fluoroscopy should work with their medical physicists and equipment manufacturers to ensure the hardware and software on their fluoroscopy equipment is optimized for pediatric examinations. ACH has implemented similar improvements for other fluoroscopy procedures. The hospital and the radiology department are grateful to AHRA and Toshiba for providing grant money for such viable studies to improve the quality of radiology and keep the children that we serve as safe and healthy as possible. ☸

References

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Ronald V. Bucci is the administrative director of radiology, Dr. Godfrey Gaisie is a CAQ pediatric radiologist and past chairman of radiology, Cheryl Miller is a radiologic technologist, and Dr. Michael Rubin is a CAQ pediatric radiologist and the chairman of radiology at Akron Children's Hospital in Akron, Oh. Adam Springer is a medical physicist with National Physics, Inc. in Cleveland, OH.