Reducing Radiation to Children: The Resident's Role

Ravi Shankar Prasad, MD

As I anxiously waited to perform my first upper-gastrointestinal series during my pediatric rotation, I was taken aside by my attending radiologist and instructed how to limit radiation to the 11-year-old patient. From the proper shielding of the patient to the narrow collimation of just the esophagus, I was surprised at the amount of meticulous detail given to radiation exposure. Most of all, I remember being cautioned by the pediatric radiologist "to go light on the fluoro pedal. We don't want any lead-foots here!" At that point, it was emphatically brought home to me that many of the wonderful toys in radiology carry an unseen risk, radiation exposure, that needs to be constantly regulated.

Radiology is a product of 20th-century ingenuity and creativity. Our dabbling in technology has created an arsenal of diagnostic and therapeutic tools for treating patients; unfortunately, our technological success has created an unforeseen risk that needs to be addressed. The advents of multidetector scanners, fusion technology, the substitution of radiographic studies for clinical examination, and a more litigious society have led to an explosion of studies being performed. As a result, radiation exposure to the public has dramatically increased, which has prompted recent discussions on how radiologists can play a role in regulating dose exposures. Furthermore, because in many institutions, radiology residents are in charge of the radiology departments for about 12 hours each day, how can we limit radiation exposure to our patients?

The use of computed tomography (CT) scans has grown tremendously since the introduction of the technology in 1973. Between 1981 and 1995, the estimated annual number of CT examinations performed rose from 2.8 million to 20 million, an increase of almost sevenfold [1]. Compared with plain radiography, CT makes a disproportionate contribution to total radiation exposure. In a study conducted in Britain, CT accounted for only 4% of all radiological studies but contributed more than 40% of the collective radiation dose [2].

Recently, the effects of radiation doses on pediatric patients have been scrutinized publicly [3]. This select group of patients has been overlooked in terms of dose limitations until recently. In one study conducted between 1996 and 1999 [4], a 92% increase in the number of abdominal and pelvic CT examinations was observed in patients younger than 15 years of age. The dramatic increase in the number of scans being performed is largely due to the logistics of multidetector CT scanners, which often obviate the need for sedation, a critical issue in pediatric patients.

In a recent study by Brenner et al. [4], the increased lifetime risk of cancer from the approximate 600,000 pediatric abdominal and head CT studies performed each year was estimated at roughly 0.35% over the background risk. Although this appears to be a relatively small increase in risk for developing cancer, it is not negligible given the high probability of multiple studies throughout the patients' lives. Even though only 4% of CT examinations occur in pediatric patients, they contribute to 20% of all potential lifetime cancer mortality from CT examinations, ranging from pediatric leukemias to solid organ tumors such as breast cancers.

Risk-benefit analysis of pediatric CT—when the technology is used appropriately—is heavily favored toward benefits [5]. For instance, not only have pediatric CT scans reduced the number of explorative surgeries being performed but the use of CT-guided percutaneous biopsies has eliminated the trauma resulting from more invasive surgeries. For this reason, radiologists have recently advocated adjusting imaging parameters on pediatric patients, including reducing the milliampere-seconds and increasing the pitch, which could result in a 30% to 50% dose reduction without compromising imaging quality [6].

Given the risks of radiation exposure, even as residents, we need to have a more proactive attitude toward governing our field. Most radiology departments in academic centers are designed to operate on resident supervision after normal business hours. As a result, our input is invaluable in the studies that are being performed in our department, because we are directly responsible for the care of the patients undergoing radiological procedures.

The best way we can address this issue is to educate clinicians and ourselves. Most radiology residents are introduced to the radiation exposure issue while rotating through their first fluoroscopy rotations and/or pediatric rotations; however, our medical colleagues are less informed of the radiation risks with various studies. This can be addressed in two fashions.

First, studies ordered after hours should be approved through radiology residents. This prevents inappropriate studies from being performed. Many clinicians are unaware of the best radiographic test for a particular diagnosis; as a result, there is a risk that the wrong study will be performed, resulting in an equivocal reading, which will require repeating the study using the proper protocol. For instance, a resident could alert a clinician that a contrast-enhanced study is indicated for the evaluation of a hilar mass or that performing magnetic resonance imaging for the evaluation of ligamentous injury in potential neck trauma not only reduces

0091-2182/04/$30.00 • DOI 10.1016/j.jacr.2003.11.017

radiation risks to the patient but also improves diagnostic sensitivity.

Second, emergency department personnel need to be informed of the risks of radiation exposure. The majority of after-hours studies are funneled through the emergency department; therefore, concentrating on educating the emergency room (ER) staff is highly productive. Each year, ERs throughout the nation are inundated with increasing numbers of patients. Often, triage personnel request radiographic studies without performing thorough physical examinations. The supply and demand issues of ER staff and patient load often dictate this practice.

I suggest that residents along with emergency radiologists prepare presentations for ER staff members on radiation dosages and risks as pertaining to their department. These presentations should serve to make ER staff members aware of the radiation exposure issue and to offer proposals for a symbiotic arrangement for performing radiographic studies taking this issue in mind.

Furthermore, in the age of digital radiology, having a picture archiving and communication system can significantly reduce the number of unnecessary studies ordered. For those residents working in digital departments, relaying the results of prior studies to ER clinicians can curb superfluous studies from being ordered. In my experience as a resident, I have encountered on a number of occasions redundant studies being ordered because clinicians were unaware that similar studies had been recently performed. An additional CT urogram for stone detection will likely not have a significant morbid impact on a patient, but the study contributes to the cumulative radiation exposure throughout the patient's life without offering any new significant imaging findings. If clinicians have access to the results of recent prior studies, their clinical management of patients may be significantly altered, and repeat studies may be avoided.

Finally, residents can play an active role in monitoring radiation exposure to pediatric patients. This is one area of radiology in which inappropriate examinations can have a more significant deleterious effect on the patient population. Because public awareness of radiation exposure to the pediatric population has recently increased, most departments are conscientious about adjusting imaging parameters to the ages and sizes of their patients. As residents, we should routinely check to see that the parameters have been adjusted for pediatric patients. I suggest that pediatric radiologists discuss with their residents proper imaging parameters for children.

Despite our attempts at regulating radiation exposure, we need to realize that we may be facing a losing battle. In an age when radiology is increasingly seen not as an accessory to clinical diagnosis but often as a replacement for an initial clinical examination, the number of studies being performed will only increase. Furthermore, the development of multidetector scanners and fusion modalities such as positron emission tomography and CT, as well as the improved sensitivity of studies, contributes to a rapid increase in prescribed radiographic procedures. Despite these obstacles, we must remain proactive in regulating radiation exposure to our patients. Even though we rarely physically interact with patients, we are providing an essential clinical diagnostic service that mandates our input on the patient's care. As residents, we can escape the "lead-foot" stereotype and make our departments more radiation friendly for the health of our patients. This is definitely a challenging proposal but essential to explore if we are to be viewed as responsible clinicians by our fellow medical colleagues and the people we serve.

REFERENCES

1. Bahador B. Trends in diagnostic imaging to 2000. London: Financial Times Pharmaceuticals and Healthcare Publishing; 1996.
2. Shrimpton PC, Edyvean S. CT scanner dosimetry. Br J Radiol 1998;71:1-3.
3. Sternber S. CT scans in children linked to cancer later. USA Today 2001;21:A1 January.
4. Brenner DJ, Elliston CD, Hall EJ, Berdon WE. Estimated risks of radiation-induced fatal cancer from pediatric CT. Am J Roentgenol 2001;176:289-96.
5. Coren ME, Ng V, Rubens M, Rosenthal M, Bush A. The value of ultra fast computed tomography in the investigation of pediatric chest disease. Pediatr Pulmonol 1998;26:389-95.
6. Zenman RK, Baron RL, Jeffrey RB Jr, Klein J, Siegel MJ, Silverman PM. Helical body CT: evolution of scanning protocols. Am J Roentgenol 1998;170:1427-38.

Ravi Shankar Prasad, MD, University of Medicine and Dentistry of New Jersey, Department of Radiology, Robert Wood Johnson University Hospital, 1 Robert Wood Johnson Place, New Brunswick, NJ 08903; e-mail: rsprasad77@yahoo.com.