Chapter

13 Radiation protection in children undergoing medical imaging

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Introduction

The discovery of the X-ray was one of the most significant advances in medicine. Use of X-ray modalities in medical care, including radiography, fluoroscopy and angiography, and computed tomography, account for the vast majority of diagnostic imaging procedures performed in adults and children. Despite the benefits, the principle concerns for medical imaging that uses X-rays are the real and potential biological consequences. The fundamental issues with the ALARA (as low as reasonably achievable) principle as it relates to the cost (or risk) benefit ratio have been discussed in depth previously. Suffice it to say that even while the benefits of medical imaging are often not well defined or understood, the decision to perform medical imaging must weigh heavily in favor of the benefit side of this equation. While the radiation risk cannot be eliminated, it can be reduced by familiarity with, and ultimately adaption of, strategies to reduce radiation exposure in children.

There are some fundamental considerations when addressing the topic of radiation protection. First there is the underlying assumption that there is no safe level of radiation. This is the ALARA (as low as reasonably achievable) principle. The ALARA principle is a consequence of the linear no-threshold model, where what we know occurs (e.g., a significantly increased *risk* of developing cancer) at higher levels of radiation exposure is extrapolated to lower levels of radiation. The next point is that the following material will address the stochastic (versus deterministic) risks of radiation. Stochastic effects, predominantly cancer, are those where the risk is higher with higher radiation doses; the effect (i.e., cancer) is not worse. This is in distinction to deterministic effects, where there is a threshold well above ranges of radiation doses in diagnostic imaging, and the severity of the effect itself increases as the radiation dose increases. Deterministic effects include epilation and dermal burns. Virtually all radiation doses for diagnostic imaging fall below the threshold for deterministic effects. Higher dose procedures are seen in the setting of complex interventional procedures, particularly when image-guided therapy is warranted. In addition, discussion will focus on those strategies which are, in general, under the direct control of the radiologist. While technical developments and technology assessment will continue to provide new opportunities for dose reduction and radiation protection, these are a result of often protracted cooperation between the scientific/medical community and industry, and do not have an immediate and direct benefit to the child. Furthermore, material provided here is meant to serve as a guideline only. The application of various strategies for radiation protection will depend on factors such as expertise, available resources and standards of practice. Finally, and perhaps most importantly, this discussion of radiation protection will be based on the concept of adequate image quality rather than optimal image quality. That is, the objective should be a radiation dose resulting in image quality that is sufficient to establish a diagnosis.

The practice of radiation safety, whether in children or adults, assumes a responsibility of all stakeholders. This includes, but is not limited to, radiologists, medical and health physicists, radiological technologists, radiation safety officers, and administration. It is a shared responsibility. On a more global basis, industry, regulatory agencies and health care organizations also have a duty to foster technical development and innovation, as well as education, for radiation protection. Moreover, radiation protection is the responsibility of *anyone* who performs medical imaging. It must be recognized that specialists who are not radiologists may perform this imaging, and they have the same responsibility for the safety and welfare of children as do those in the radiology specialty.

The two major goals of radiation protection are to ensure that the appropriate imaging modality or imaging strategy is indicated and, when indicated, that the imaging technique is appropriate: the *right test* done in the *right way*. It is not the intent of the material in this chapter to discuss the appropriateness of imaging. Suffice it to say that while the subject of inappropriate use of imaging has been raised in the United States, this has also been highlighted as a global issue that needs to be addressed. In addition, there is some contention with the process of guideline

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