Protecting children and procedures in medical imaging

Donald Frush

*Individuals and organizations must work together to reduce pediatric radiation exposure.*

Computed-tomography (CT) imaging is an invaluable imaging tool in children’s medical care, but because it uses potentially harmful x-rays, it is not without risk. The tradeoff between risks and benefits requires medical professionals to make difficult decisions each and every day. Should a test be performed at all? If so, of what type? And what is the minimum radiation dosage that will not sacrifice image quality nor diagnostic power? This is a dilemma where, amid emerging information, some answers are forthcoming, but challenges remain.

The radiation dose from pediatric (and adult) CT imaging is a headline topic. In the US, 67 million examinations are performed each year, of which up to 11% are of children. This equates to about one CT scan for every five people per year, and its use continues to grow. A 2% increase in pediatric emergency-department visits from 2000 to 2006 was vastly outpaced by a 366% increase in cervical-spine scans and a 435% increase in chest scans during this time.¹

A CT examination imparts a relatively high radiation dose, equivalent to up to several hundred chest x-rays (the effective pediatric x-ray dose is 0.02mSv versus 2–10mSv for CT). Combined with cardiac nuclear-medicine imaging, CT scans now account for about half of all radiation exposure (including background) of the US population.² The doses from one or more examinations can reach levels associated with a significantly increased risk of developing cancer.³ In fact, up to 2% of all cancer in the US could eventually be attributed to CT scans.⁴

CT radiation exposure in children raises unique considerations. They are more radiosensitive, have more time in which to manifest radiation-related stochastic effects such as cancer, and could receive a higher relative dose than adults if examination settings are not adjusted. However, CT scans save lives, help make treatment decisions, decrease diagnostic uncertainty, and provide more optimal resource use by reducing unnecessary costs. For example, the routine use of CT for appendicitis

*Figure 1.* Renal stone in a 49kg thirteen-year-old male. Indicated by the white arrow, the stone can be seen clearly in the original image at a level of (a) 93mAs, and in simulated tube-current-reduction studies at (b) 29mAs and (c) 14.5mAs. (Reprinted with permission from the American Roentgen Ray Society.⁵)

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Figure 2. Mean tube current used by Society for Pediatric Radiology members for abdominal multidetector-computed tomography in 2006 compared to 2001. Results were statistically significant (p ≤ 0.001) for all age ranges (expressed in years). (Reprinted with permission from the American Roentgen Ray Society.)

While these improvements have led to a reduction in dose (see Figure 2), do these advances go far enough? Further work is needed, including development of improved methods for calculating dose indices, such as the CT dose index (CTDI) and the resulting dose-length product (DLP) for children. CTDI is an unreliable indicator of dose indexing in children and simpler methods for dose determination must be developed, validated, and made widely available. We need standardization of CTDI and DLP among vendors, more detailed digital-imaging and communications-in-medicine information related to CT doses, and technology providing pre-scan warnings of potential doses above published guidelines.

Furthmore, information needs to be relayed as new technology is used to assure that doses applied to children are fully understood. For example, a nonmodulated gated 16-slice cardiac CT scan of children can result in an effective dose of more than 25mSv if not adjusted for patient size. Evidence-based principles must also be employed to define appropriate conditions for CT use, thus preventing unnecessary examinations.

Both CT technology and children’s health must be protected. In addition to answering questions on radiation dose and image quality, another key stumbling block is the slow response and indecision to resolve these problems through a shared effort. There must be a joint commitment by a broad range of individuals and organizations to optimize dose delivery and image quality of CT applied to children. This includes the scientific community of engineers, physicists, and radiologists, as well as regulatory agencies and professional organizations within the medical industry.

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References


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