# Editorials

## Overuse of Computed Tomography and Associated Risks

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Use of computed tomography (CT) has increased considerably since the 1990s.[1] It was estimated that more than 62 million CT scans were performed in the United States in 2007, and CT use is growing 10 percent annually.[1,2] CT has substantially advanced medical care through improved diagnosis, but its use comes with potential harms, including cancer risk from radiation; detection of incidental findings that may lead to additional and often unnecessary diagnostic testing and treatment; and accidental radiation overdose. Moreover, CT is too often performed when its use is unlikely to enhance patient health or change clinical care.

Radiation exposure to the U.S. population from medical imaging increased 600-fold over the past 20 years.[3] Common CT scans deliver ionizing radiation doses in ranges that increase cancer risk.[4] Chest CT typically delivers more than 400 times the radiation of standard chest radiography. CT radiation doses to adults are higher and more variable than generally quoted,[5] so doses may be substantially higher than necessary and potentially hazardous. Because CT technologists rarely adjust technical parameters based on patient age or body weight, doses may be even higher and more variable in children, who are more radiosensitive than adults and have more remaining life-years for cancer to develop. However, radiation-induced cancer risk is not limited to children. In contrast to widely held beliefs, cancer risks from radiation likely remain elevated even among middle-aged and older adults,[6] which is particularly concerning considering that CT imaging rates greatly increase with advancing age. An estimated 1.5 to 2 percent of all cancer diagnoses in the United States are attributable to CT use.[2]

Another harm of CT is identifying incidental findings or other findings of unknown clinical significance that may result in overdiagnosis and overtreatment. As many as 50 percent or more of patients may have such findings identified on some types of CT imaging.[7,8] Unexpected findings challenge physicians to ensure the lesion is harmless. This often results in a cascade of costly follow-up procedures, leading to additional radiation from imaging and potential morbidity from invasive testing. An example of this was presented by a radiology chairman who had a renal lesion, a hepatic mass, and multiple noncalcified lung nodules discovered on CT colonography, all of which were found to be benign after spending more than $50,000 in diagnostic workup and five weeks of recovery from surgical resection of the lung nodules.[9] Ironically, improvements in imaging resolution have led to further overdiagnosis and overtreatment because increasingly smaller lesions can now be seen.

In 2009, more than 400 patients received eight to 30 times the normal radiation dose from a CT scan for stroke diagnosis; many of these patients experienced short-term adverse effects such as hair loss, with uncertain long-term risks.[10] After additional reports of radiation overdosing from CT, the U.S. Food and Drug Administration responded with plans to increase oversight of medical imaging radiation.[11] This will likely include recommendations that facilities record and track CT radiation, and that institutions and professional societies create diagnostic reference levels (i.e., target dosing levels that would trigger investigation and implementation of dose-reduction strategies if exceeded). The U.S. House of Representatives Subcommittee on Health recently concluded that more data are needed to standardize CT and improve its safety,[12] and the California Legislature passed a bill (SB 1237, Padilla)[13] that requires radiation dose information to be recorded in patient medical records.

Given the clinical importance of CT, several harm-reduction steps are recommended. First, physicians must reduce the number of CT scans ordered, which are clearly being used more often than clinically necessary. This overuse is likely the result of self-referral, low tolerance for ambiguity, lack of risk awareness, fear of litigation, and lack of evidence-based guidelines for when CT imaging is most helpful. Before ordering a CT scan, referring physicians should ensure that it is clinically indicated and has not been recently performed, and consider alternatives such as magnetic resonance imaging or ultrasonography, if appropriate. CT should be used only when it is likely to enhance patient health or change clinical care. Unfortunately, few evidence-based guidelines are available that offer guidance as to when CT is indicated. Existing guidelines are largely based on expert opinion and often do not consider the range of adverse outcomes, from safety risks to the clinical consequences of ▶

postimaging decisions and interventions. Rigorous studies that evaluate when CT use improves patient outcomes are critically needed.

Second, when CT is necessary, the radiologist or other clinician conducting the examination should apply the ALARA (as low as reasonably achievable) principle. Evidence suggests CT radiation doses could be reduced by 50 percent or more without affecting diagnostic accuracy.[14] Manufacturers and groups (e.g., the Image Gently campaign from the Alliance for Radiation Safety in Pediatric Imaging, at http://www.pedrad.org/associations/5364/ig/) are working to reduce doses, but there is no organization that is responsible for standardization, so CT protocols and techniques are neither uniform nor optimized. Nonetheless, techniques and guidelines are available for dose reduction, including low-dose protocols, breast and thyroid shields, limiting the area imaged, and use of single-phase studies, when possible. Referring physicians should provide detailed information regarding the clinical question so studies can be tailored to limit radiation. Further, manufacturers should install safeguards—including displays with understandable dose information for increasing dose awareness and recognizing errors—and lead efforts to standardize dose protocols across settings.

Third, physicians should inform patients of CT risks before imaging.[15] Currently, patients do not routinely receive information about radiation dose or associated risks. Further, physicians may lack information, leaving them ill-informed to advise their patients.

Fourth, physicians should monitor individual exposure over time and provide the information to patients. CT scanners almost uniformly calculate and present information that quantifies the radiation dose used in the examination (metrics such as dose-length product and CT dose index), which could easily be recorded in the patient's medical record. This will be required by the previously mentioned California bill when it takes effect in 2012.[13] These metrics of the radiation dose emitted by the machine can also be used to estimate an approximate effective radiation dose absorbed by the patient. Further, these dose and exposure metrics should be tracked in the medical record over time to increase physician awareness about imaging radiation and to determine when a patient has a high cumulative dose from multiple imaging procedures, which may motivate alternative diagnostic strategies. Diagnostic reference levels should be developed to put these numbers into perspective.

As CT technology advances and CT use increases, physicians, technologists, and patients must be informed of its benefits and risks. Guidelines for use and lowest effective doses will come from ongoing research studies and efforts by professional societies and manufacturers, but everyone should take steps to ensure cautious, appropriate, and safe use of this transformative technology. Physicians who order imaging have an obligation to educate their patients about the potential risks associated with CT.

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