Cancer Risks and Radiation Exposure From Computed Tomographic Scans

How Can We Be Sure That the Benefits Outweigh the Risks?

The introduction of the computed tomographic (CT) scanner ushered in a new era of internal medicine diagnosis. Conditions that once required laparoscopy for diagnosis could now be diagnosed on the radiology reading board. The previously opaque anatomy of the living brain could now be visualized. The best part was that the test was “noninvasive,” fast, and painless. With the exception of patients who were allergic to dye or had renal insufficiency, CT was considered completely safe. No wonder it had such a significant effect on the practice of medicine.

Two articles in this issue of the Archives make us question if we have gotten carried away in our enthusiasm. Every day, more than 19,500 CT scans are performed in the United States, subjecting each patient to the equivalent of 30 to 442 chest radiographs per scan. Whether these scans will lead to demonstrable benefits through improvements in longevity or quality of life is hotly debated. What is becoming clear, however, is that the large doses of radiation from such scans will translate, statistically, into additional cancers. With CT scan use increasing annually, it is imperative that clinicians take into account the radiation risks when assessing the benefit to their patients.

The number of CT scans is remarkable: a recent study of nearly 1 million nonelderly adults showed that 70% received CT scans during the 3-year period of study (2005-2007). There were an estimated 72 million CT scans conducted in 2007 alone. The doses of radiation from them also are eye opening. Although most patients receive relatively low doses from their scans, nearly 20% of the study’s population received “moderate” exposures of between 3 and 20 mSv, and some 2% (translating to as many as 1.4 million patients nationwide) were exposed to “high” and “very high” doses of 20 mSv to more than 50 mSv.

What risks, then, are posed by radiation exposure from CT scans, and are such risks justified? Two studies in this issue of the Archives help inform this discussion by providing actual effective radiation doses in the most commonly used CT scans and the cancer risks associated with this radiation. Smith-Bindman and colleagues collected actual data on radiation dosages for the most commonly used CT scans at 4 institutions in the San Francisco Bay area in California in 2008. They found a surprising variation in radiation dose—a mean 13-fold variation between the highest and lowest dose for each CT type studied (range, 6- to 22-fold difference across study types). There was no discernible pattern to the variation, which occurred within and across institutions. The investigators found a median effective dose of 22 mSv from a typical CT coronary angiogram and 31 mSv for a multiphase abdomen-pelvis CT scan. At one institution, exposure was a staggering 90 mSv for a multiphase abdomen-pelvis CT scan.

Even the median doses are 4 times higher than they are supposed to be, according to the currently quoted radiation dose for these tests. Just 1 CT coronary angiogram, on average, delivers the equivalent of 309 chest radiographs. From their data, Smith-Bindman et al estimated the risk of cancer, taking into consideration age, sex, and study type. By their calculations, 1 in every 270 forty-year-old women undergoing a CT coronary angiogram will develop cancer from the procedure.

In a second study, Berrington de González and colleagues determined CT scan use frequency using data from a large commercial insurance database, Medicare claims data, and IMV Medical Information Division survey data. They estimated there were 72 million CT scans performed in 2007. Excluding scans conducted after a diagnosis of cancer and those performed in the last 5 years of life, Berrington de González et al projected 29,000 excess cancers as a result of the CT scans done in 2007. These cancers will appear in the next 20 to 30 years and by the authors’ estimates, at a 50% mortality rate, will cause approximately 15,000 deaths annually.

In other words, 15,000 persons may die as a direct result of CT scans physicians had ordered in 2007 alone. Presumably, as the number of CT scans increase from the 2007 rate, the number of excess cancers also will increase. In light of these data, physicians (and their patients) cannot be complacent about the hazards of radiation or we risk creating a public health time bomb.

The effort to avoid unnecessary excess cancers must be multifaceted. First, radiation protocols should be improved to eliminate the 13-fold difference in radiation dose for the same CT scan; exposures will be significantly reduced if all institutions were to use the lowest-dose technique. Smith-Bindman and colleagues, for example, that the “usual” protocol sometimes unwittingly increased radiation. The authors offer several techniques to improve the quality of CT scans. In addition, patients should be fully informed about the radiation risk; it is unlikely that many patients now appreciate that a
single CT scan may represent the radiation equivalent of hundreds of chest radiographs.

A popular current paradigm for health care presumes that more information, more testing, and more technology inevitably leads to better care. The studies by Berrington de González et al and Smith-Bindman et al counsel a reexamination of that paradigm for nuclear imaging. In addition, it is certain that a significant number of CT scans are not appropriate. A recent Government Accountability Office report on medical imaging, for example, found an 8-fold variation between states on expenditures for in-office medical imaging; given the lack of data indicating that patients do better in states with more imaging and given the highly profitable nature of diagnostic imaging, the wide variation suggests that there may be significant overuse in parts of the country. For example, a pilot study found that only 66% of nuclear scans were appropriate using American College of Cardiology criteria—the remainder were inappropriate or uncertain.

The articles in this issue make clear that there is far more radiation from medical CT scans than has been recognized previously, in amounts projected to cause tens of thousands of excess cancers annually. Also, as these scans have become more sensitive, incidental findings lead to additional testing (and often more radiation), biopsies, and anxiety. Although a guiding principle in medicine is to ensure that the benefit of a procedure or therapy outweighs the risk, the explosion of CT scans in the past decade has outpaced evidence of their benefit. Although there are clear instances when CT scans help determine the treatment course for patients, more and more often patients go directly from the emergency department to the CT scanner even before they are seen by a physician or brought to their hospital room. To avoid unnecessarily increasing cancer incidence in future years, every clinician must carefully assess the expected benefits of each CT scan and fully inform his or her patients of the known risks of radiation.

Rita F. Redberg, MD, MSc

Correspondence: Dr Redberg, Editor, Archives of Internal Medicine, University of California, San Francisco, 505 Parnassus, M1180, San Francisco, CA 94143-0124 (redberg@medicine.ucsf.edu).

Financial Disclosure: None reported.

REFERENCES