CT Radiation Exposure: How Bad Is It, and How Can It Be Reduced in Practice?

Aaron Sodickson, MD, PhD

CT has greatly advanced our diagnostic capabilities throughout all areas of medicine. These diagnostic benefits have combined with widespread availability and rapidity of scanning to produce tremendous increases in CT utilization, currently estimated at approximately 70 million CT scans per year in the US. However, rapidly increasing utilization has heightened concerns about the collective radiation exposure to the population as a whole [1], and about the high levels of cumulative exposure that may occur in patients undergoing recurrent imaging for chronic conditions or persistent complaints [2,3].

Radiation risks have been alternately downplayed and exaggerated in the literature and lay media, resulting in great confusion about the magnitude of these risks. While conventional x-ray, fluoroscopy, and nuclear medicine studies also expose patients to ionizing radiation, CT has appropriately received the greatest scrutiny because of the relatively high radiation dose per exam – although it comprises about 15% of all medical imaging procedures, it produces approximately half of the population's medical radiation exposure [4].

The objective of this talk is to convey some understanding about the approximate levels of risk imparted by CT, and the factors influencing these risks, to encourage a more rational decision making process by enabling risk estimates to be weighed against the perceived benefits of imaging. I will review common radiation terminology, typical dose values for common CT exam types [5], and technology and patient factors that influence dose. I will describe the most commonly used Linear-No-Threshold risk model of the BEIR-VII report [6] and demonstrate how it may be used to easily make order of magnitude cancer risk estimates.

Finally, we will explore practical opportunities to reduce radiation exposure [7], including CT technique optimization, utilization control, and potential opportunity areas where MRI may play a role if the common challenges of access, exam duration, and technical complexity can be overcome.

References:

1. Brenner DJ, Doll R, Goodhead DT, Hall EJ, Land CE, Little JB, Lubin JH, Preston DL, Preston RJ, Puskin JS, Ron E, Sachs RK, Samet JM, Setlow RB, Zaider M. Cancer risks attributable to low doses of ionizing radiation: assessing what we really know. Proc Natl Acad Sci U S A. 2003 Nov 25;100(24):13761-6.
2. Sodickson A, Baeyens PF, Andriole KP, Prevedello LM, Nawfel RD, Hanson R, Khorasani R. Recurrent CT, cumulative radiation exposure, and associated radiation-induced cancer risks from CT of adults. Radiology. 2009 Apr;251(1):175-84.
3. Berrington de Gonzalez A, Mahesh M, Kim KP, Bhargavan M, Lewis R, Mettler F, Land C. Projected cancer risks from computed tomographic scans performed in the United States in 2007. Arch Intern Med. 2009 Dec 14;169(22):2071-7.
4. Mettler FA, Jr., Bhargavan M, Faulkner K, Gilley DB, Gray JE, Ibbott GS, Lipoti JA, Mahesh M, McCrohan JL, Stabin MG, Thomadsen BR, Yoshizumi TT. Radiologic and nuclear medicine studies in the United States and worldwide: frequency, radiation dose, and comparison with other radiation sources--1950-2007. Radiology. 2009 Nov;253(2):520-31.
5. Mettler FA, Jr., Huda W, Yoshizumi TT, Mahesh M. Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology. 2008 Jul;248(1):254-63.
6. National Research Council (U.S.). Committee to Assess Health Risks from Exposure to Low Level of Ionizing Radiation. Health risks from exposure to low levels of ionizing radiation : BEIR VII, Phase 2. Washington, D.C.: National Academies Press; 2006
7. Amis ES, Jr., Butler PF, Applegate KE, Birnbaum SB, Brateman LF, Hevezi JM, Mettler FA, Morin RL, Pentecost MJ, Smith GG, Strauss KJ, Zeman RK. American College of Radiology white paper on radiation dose in medicine. J Am Coll Radiol. 2007 May;4(5):272-84

Synopsis:

The objective of this talk is to convey some understanding about the approximate levels of risk imparted by CT, and the factors influencing these risks. I will review common radiation terminology, typical dose values for common CT exam types, and technology and patient factors that influence dose. I will demonstrate how to make order of magnitude cancer risk estimates using the most common Linear-No-Threshold risk model. Finally, we will explore practical opportunities to reduce radiation exposure, including potential opportunity areas where MRI may play a role if the common challenges of access, exam duration, and technical complexity can be overcome.