Radiation Awareness and Medical Imaging:

Balancing Benefits Physicians Can See with Risks They May Not

By Ira J. Ungar, MD

Background image courtesy University of Ottawa Heart Institute

Medical imaging has given medicine a powerful tool for diagnosing a host of diseases. It is credited with allowing earlier detection of numerous disease processes. Medical imaging has no doubt revolutionized the way certain diseases are detected and treated and has had a measurable impact in successful treatment of and improving survival in illnesses that were once almost universally fatal.

In light of these advances, it is no surprise that physicians' use of medical imaging — including advanced medical imaging that requires ionizing radiation — has risen dramatically in recent years.

In addition to the increased use of advanced imaging for scheduled tests, the use of computed tomography in the emergency setting and the launch of multi-detector CT units has brought concerns of how to quantify and manage an individual's cumulative "medical" radiation exposure. Although enhanced technology has shortened imaging acquisition times, the per-scan radiation exposure of today's multi-detector CT scans may be higher than earlier units.

Increased Imaging and Increased Exposure

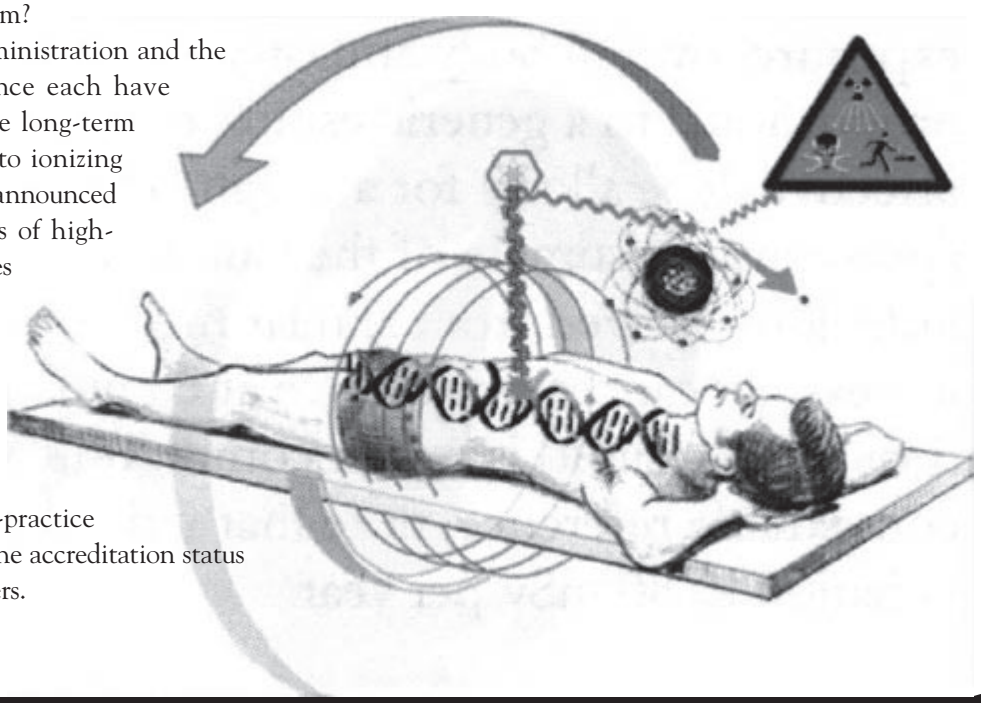
All of the factors mentioned previously have raised the issue of what does the increased exposure to ionizing radiation mean in the long term?

The Food and Drug Administration and the National Academy of Science each have expressed concerns about the long-term effects of repeated exposure to ionizing radiation.[1] In 2010, the FDA announced it will require manufacturers of high-grade medical imaging devices to include safety controls to prevent excessive radiation doses. The controls would alert providers if they are using a higher-than-recommended dose. The FDA is also considering best-practice measures that will be tied to the accreditation status of hospitals and imaging centers.

In 2005, a National Academy of Sciences report underscored that any level of ionizing radiation may have carcinogenic effects. The American College of Radiology published a White Paper in 2007 on "Radiation Dose in Medicine" that outlines several steps and interventions to help address the issue of ionizing radiation exposure from medical imaging.[2]

Statistics lend credence to those concerns.

- A study published in the *New England Journal of Medicine* in 2007, titled "Computed Tomography — An Increasing Source of Radiation Exposure," showed that the annual number of CT scans tripled between 1995 and 2005.
- In recent testimony to a U.S. House of Representatives subcommittee, Rebecca Smith-Bindman, MD, of the University of California, San Francisco, estimated that one in five individuals in the U.S. undergoes a CT scan every year.



- The number of CT scans performed annually in the U.S. has risen from around 3 million in 1980 to more than 62 million today.[3]
- Because CT scans involve much higher doses of radiation than standard X-rays, the general population is experiencing a marked increase in radiation exposure. One CT chest scan carries as much radiation as about 400 chest X-rays, according to the FDA.[4]
- Epidemiologic studies indicate that the radiation dose from even two or three CT scans results in a statistically detectable increase in the risk of cancer, especially in children — who are most vulnerable. Lifetime risk of cancer *due to CT scans* is now estimated to be as much as one percent, according to Dr. Smith-Bindman.

The BEIR VII study of 2004, the latest in a series of reports from the National Research Council's Committee on the Biological Effects of Ionizing Radiation (BEIR), addresses the health effects of exposure of human populations to low-dose, low-LET (linear energy transfer) ionizing radiation. This study serves as a major source of information for evaluating health risks from exposure to ionizing radiation and particularly for developing quantitative estimates of risk.

The BEIR studies were of survivors of the atomic bombings in Hiroshima and Nagasaki, workers in the nuclear industry, and patients who had received radiation treatment for acne and thyroid cancer.

BEIR VII found:

- There are intimate links between the dose-dependent induction of DNA damage in cells, the appearance of gene or chromosomal mutations through DNA damage misrepair and the development of cancer.
- The radiation causes free radical "ions" that may break DNA strands.
- When repairs to the damage are attempted, there can be mistakes that lead to mutations and translocations.
- These errors of repair can lead to development of cancer decades later.

Cardiac Computed Tomography Angiography (CCTA) — The Dilemma of High Diagnostic Value with High Radiation

Since the explosion in popularity of the 64-detector row cardiac computed tomography angiography (CCTA) about five years ago, various studies have shown CCTA to provide high diagnostic accuracy for detection of obstructive coronary artery disease compared with invasive angiography. However, studies have also shown these devices to expose patients to significantly higher levels of radiation than other medical imaging techniques. A study featured in the January 2009 issue of the *Journal of the American Medical Association* concluded that a CCTA examination was the equivalent of 600 chest X-rays.[3]

The challenge facing the medical community is finding ways to use these remarkable technologies in the most effective and safest manner possible to avoid unnecessary radiation exposure for patients.

Steps for Mitigating Radiation Exposure

The International Commission of Radiological Protection's Publication 87 and the ACR White Paper of Radiation Dose in Medicine offer several strategies for equipment operators as well as ordering physicians and radiologists to reduce ionizing radiation exposure from advanced medical imaging.

Operators
Reduce/limit the scan volume with CTs. Avoid unnecessary overlapping of images. Reduce the pitch factor with spiral CTs.
Use z-filtering with multi-slice CT units.
Reduce milliamp second values (radiation intensity).
Use automatic exposure control by adapting scanning parameters to the patient cross section.
Shield superficial organs, such as eyes, thyroid and breast (bismuth shields).
Separate factors for children.
Use partial rotation techniques for head CTs.
Become familiar with and use the CT manufacturer's radiation dose-reduction techniques.

Ordering Physicians and Radiologists
Assess the risk-benefit of the study being performed. Make appropriate, stepwise use of investigative studies. Before ordering a study, consider whether the study's results will impact patient management.
Consider non-ionizing tests for initial investigation before advanced imaging.
Ensure that qualified medical personnel perform the medical imaging studies.
Do not repeat CT exams unless clinically indicated or if other approaches can be utilized.
Obtain a prior history of the patient's ionizing radiation imaging studies and communicate that information to the radiologist.
Carefully consider risk-benefit of chest and abdomen/pelvis CT imaging in girls and young women, due to radiation dose to breasts and ovaries.
Ensure sound technique when administering advanced imaging studies.
Develop clinical care pathways for CTs, particularly with regard to imaging of patients with uncomplicated headaches, chest pain and nephrolithiasis.
Establish specific thresholds for cumulative dose of ionizing radiation for each patient.
Calculate each patient's cumulative dose of ionizing radiation and report to practitioners when thresholds are reached.

Highmark Radiation Safety Awareness Program to Support Physicians in Monitoring Cumulative Radiation in Patients

One limitation physicians and radiologists face when trying to determine a patient's prior radiation exposure can be a lack of imaging records for that patient. Information for a patient who has had an imaging procedure ordered by another physician in the past may not be readily available. To assist providers with this issue, Highmark has teamed with National Imaging Associates to offer the Highmark Radiation Safety Awareness Program beginning March 1, 2011.

The program tracks CT, PET and nuclear cardiology modalities in the inpatient and outpatient settings while the patient is a Highmark member. It utilizes claims history to monitor a patient's lifetime accumulated radiation exposure. Other tests included in the lifetime radiation calculation include all ionizing diagnostic imaging tests, angiography, bone density tests, diagnostic nuclear medicine and any imaging study with a millisieverts (mSv) dosage greater than 0.5.

For the Highmark program, at-risk patients are considered to be those with cumulative radiation (Dose Limit) exposure equal to, or exceeding, 50 millisieverts (mSv), a level that has been identified as causing a statistically (epidemiologically) significant increased risk of developing radiation-associated cancers. Exposure is based on the standard average dose per study. When a new radiologic study that utilizes ionizing radiation is ordered for an at-risk patient, a peer-to-peer consultation is offered between the ordering physician and an NIA radiologist physician to discuss alternatives.

The program's goals include:

- Informing providers of a patient's prior exposure history
- Enhancing patient safety
- Reducing future cancer risk by utilizing imaging radiation appropriately

The program features a claims-based, patient-specific radiation exposure accumulator that advises providers if their patient already has high-level exposure to radiation at the time a new CT, PET or nuclear cardiology test is ordered. When a patient is flagged, as the ordering physician, you will be notified when you request a preauthorization by telephone, or through a notification presented during the imaging authorization function on NaviNet. At that time, you will be offered an NIA peer discussion should you want to discuss the case with another physician. In addition, a Dose Limit Threshold Notification will also be sent via fax or mail with the authorization or adverse determination letter. Providers can also view additional educational information on Highmark's Radiation Awareness Program page, which can be found on our Provider Resource Center.

Some other important features of the program are as follows:

- **The program does not apply to patients with a cancer diagnosis or to those ages 65 and older.**
- The patient's lifetime radiation exposure calculation **does not impact medical necessity decisions**; the information is only intended to assist the provider in managing radiation exposure for their patient.
- Data provides a balanced view of the risks and benefits of imaging studies with ionizing radiation.
- Radiation exposure information is intended for ordering physicians only and is not provided to the Highmark members.
- The program's elements are consistent with national standards and positions of professional societies.

Additional information about the program can be found online by choosing the *Highmark Radiation Awareness Program* link on the Highmark Radiology Management Program page of the Provider Resource Center. Educational webinars are also planned. Watch the Plan Central page of NaviNet as well as the Today's Message section of the Provider Resource Center for webinar details and registration.

References:

1 FDA Aims to Rein in Radiation Based Medical Scans, Associated Press, Feb. 9, 2010

2 J Am Coll Radiol 2007;4:272-284. Copyright © 2007 American College of Radiology

3 Computed Tomography – An Increasing Source of Radiation Exposure, Brenner, David J., PhD, DSc; and Hall, Eric J., DPhil, DSc; N Engl J Med 2007; 357:2277-84

4 JAMA. 2009;301(5):500-507 Feb. 2009, Jörg Hausleiter, MD, et al, JAMA