

SCIENTIFIC AMERICAN

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How Much Do CT Scans Increase the Risk of Cancer?

Researchers reevaluate the safety of radiation used in medical imaging

By [Carina Storrs](#) | Tuesday, July 9, 2013 |

Ever since physicians started regularly ordering CT (computed tomography) scans four decades ago, researchers have worried that the medical imaging procedure could increase a patient's risk of developing cancer. CT scanners bombard the human body with x-ray beams, which can damage DNA and create mutations that spur cells to grow into tumors.

Doctors have always assumed, however, that the benefits outweigh the risks. The x-rays, which rotate around the head, chest or another body part, help to create a three-dimensional image that is much more detailed than pictures from a standard x-ray machine. But a single CT scan subjects the human body to between 150 and 1,100 times the radiation of a conventional x-ray, or around a year's worth of exposure to radiation from both natural and artificial sources in the environment.

A handful of studies published in the past decade have rekindled concerns. Researchers at the National Cancer Institute estimate that 29,000 future cancer cases could be attributed to the 72 million CT scans performed in the country in 2007. That increase is equivalent to about 2 percent of the total 1.7 million cancers diagnosed nationwide every year. A 2009 study of medical centers in the San Francisco Bay Area also calculated an elevated risk: one extra case of cancer for every 400 to 2,000 routine chest CT exams.

The reliability of such predictions depends, of course, on how scientists measure the underlying link between radiation and cancer in the first place. In fact, most estimates of the excess cancer risk from CT scans over the past several decades rely largely on a potentially misleading data set: cancer rates among the long-term survivors of the atomic bomb blasts in World War II.

“There are major concerns with taking the atomic bomb survivor data and trying to understand what the risk might be to people exposed to CT scans,”

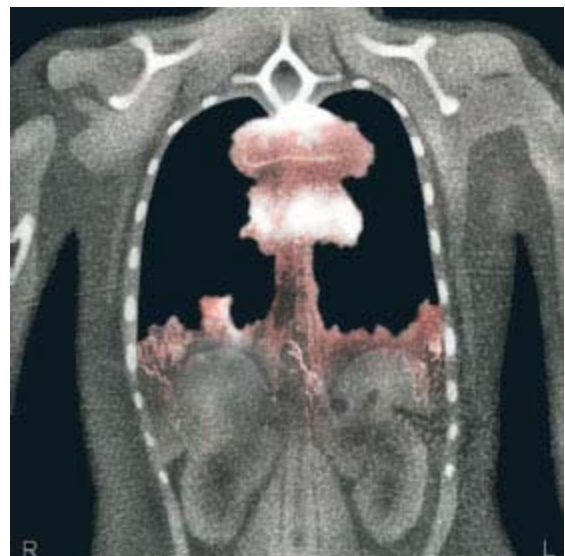


Image: Shannon Freshwater

says David Richardson, an associate professor of epidemiology at the University of North Carolina Gillings School of Global Public Health who has done research on the atomic bomb survivors.

About 25,000 atomic bomb survivors were exposed to relatively low doses of radiation comparable to between one and three CT scans. The number of cancer cases that developed over the rest of their lives is not, however, large enough to provide the necessary statistical power to reliably predict the cancer risk associated with CT scans in the general population today. Given these difficulties, as well as renewed concerns about radiation levels and the lack of mandatory standards for safe CT exposure (in contrast to such procedures as mammography), a dozen groups of investigators around the world have decided to reevaluate the risk of CT radiation based on more complete evidence.

A growing number of clinicians and medical associations are not waiting for definitive results about health risks and have already begun figuring out how to reduce radiation levels. Two radiologists at Massachusetts General Hospital, for example, think that they can decrease the x-ray dosage of at least one common type of CT scan by 75 percent without significantly reducing image quality. Likewise, a few medical associations are trying to limit superfluous imaging and prevent clinicians from using too much radiation when CT scanning is necessary.

Outdated Data

For obvious ethical reasons, researchers cannot irradiate people solely to estimate the cancer risk of CT. So scientists turned to data about survivors of the atomic bombs dropped on Hiroshima and Nagasaki in August 1945. Between 150,000 and 200,000 people died during the detonations and in the months following them. Most individuals within one kilometer of the bombings perished from acute radiation poisoning, falling debris or fires that erupted in the immediate aftermath of the attack. Some people within 2.5 kilometers of ground zero lived for years after exposure to varying levels of gamma rays, from a high end of more than three sieverts (Sv)—which can burn skin and cause hair loss—to a low end of five millisieverts (mSv), which is in the middle of the typical range for CT scans today (2 to 10 mSv). A sievert is an international unit for measuring the effects of different kinds of radiation on living tissue: 1 Sv of gamma rays causes the same amount of tissue damage as 1 Sv of x-rays.

Several years after the blasts, researchers began tracking rates of disease and death among more than 120,000 survivors. The results demonstrated, for the first time, that the cancer risk from radiation depends on the dose and that even very small doses can up the odds. Based on such data, a 2006 report from the National Research Council has estimated that exposure to 10 mSv—the approximate dose from a CT scan of the abdomen—increases the lifetime risk of developing any cancer by 0.1 percent. Using the same basic information, the U.S. Food and Drug Administration concluded that 10 mSv increases the risk of a fatal cancer by 0.05 percent. Because these risks are tiny compared with the natural incidence of cancer in the general population, they do not seem alarming. Any one person in the U.S. has a 20 percent chance of dying from cancer. Therefore, a single CT scan increases the average patient's risk of developing a fatal tumor from 20 to 20.05 percent.

All these estimates share a serious flaw. Among survivors exposed to 100 mSv of radiation or less—including the doses typical for CT scans—the numbers of cancer cases and deaths are so small that it becomes virtually impossible to be certain that they are significantly higher than the

rate of cancer in the general population. To compensate, the National Research Council and others based their estimates primarily on data from survivors who were exposed to levels of radiation in the range of 100 mSv to 2 Sv. The fundamental assumption is that cancer risk and radiation dose have a similar relationship in high and low ranges—but that is not necessarily true.

Another complicating factor is that the atomic bombs exposed people's entire body to one large blast of gamma rays, whereas many patients receive multiple CT scans that concentrate several x-rays on one region of their body, making accurate comparisons tricky. Compounding this issue, the atomic bomb survivors typically had much poorer nutrition and less access to medical care compared with today's general U.S. population. Thus, the same level of radiation might correspond to greater illness in an atomic bomb survivor than in an otherwise healthy person from today.

Dialing Down the Dose

To conclusively determine the risk of low radiation doses and set new safety standards for CT radiation, researchers are beginning to abandon the atomic bomb survivor data and directly investigate the number of cancers among people who have received CT scans. About a dozen such studies from different countries examining rates of various cancers following CT scans will be published in the next few years.

In the meantime, some researchers have started testing whether good images can be produced with radiation doses lower than those generated in typical CT scans. Sarabjeet Singh, a radiologist at Mass General, and his fellow radiologist Mannudeep Kalra have an unusual way of conducting such investigations. Rather than recruiting living, breathing human volunteers for their studies, they work with cadavers. In that way, they can scan bodies many times without worrying about making people sick and can perform an autopsy to check whether the scan has correctly identified a medical problem.

So far the researchers have discovered that they can diagnose certain abnormal growths in the lungs and perform routine chest exams with about 75 percent less radiation than usual—a strategy Mass General has since adopted. Singh and Kalra are now sharing their methods with radiologists and technologists from hospitals and scanning centers across the U.S. and around the globe.

Medical associations are stepping in to help as well. Because the FDA does not regulate how CT scanners are used or set dose limits, different centers end up using an array of radiation doses—some of which seem unnecessarily high. In the past year the American Association of Physicists in Medicine has rolled out standardized procedures for adult CT exams that should rein in some of these outlier centers, Singh says. Furthermore, an increasing number of CT facilities across the U.S. receive accreditation from the American College of Radiology, which sets limits for radiation doses and evaluates image quality. In 2012 accreditation became mandatory for outpatient clinics that accept Medicare Part B if the facilities want to get reimbursed for scans.

No matter how much clinicians lower the levels of radiation used in individual CT exams, however, a problem remains. Many people still receive unnecessary CT scans and, along with them, unneeded doses of radiation. Bruce Hillman of the University of Virginia and other researchers worry that emergency room physicians in particular order too many CT scans,

making quick decisions in high-pressure situations. In a 2004 poll 91 percent of ER doctors did not think a CT scan posed any cancer risk. Doctors and their patients may finally be getting the message. A 2012 analysis of Medicare data suggests that the previously rampant growth in CT procedures is flattening out and possibly waning.

“The jury is still out on whether there is a small cancer risk,” says Donald Frush, chief of pediatric radiology at Duke University Medical Center. “But the safest thing is to assume that no amount of radiation is safe. And if we find out in 20 years that a little bit was not harmful, then what did we lose by trying to minimize the dose?”