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Medical X-Rays As an Environmental Toxin: Proposal for Professional Action

John W. Gofman, MD, PhD

In the past few months, a dam has cracked at two peer reviewed medical journals and some warnings are leaking through on the topic of fatal cancer induced by low-dose medical x-rays- specifically on x-ray-induced breast cancer (1)-and on x-ray-induced cancers from pediatric CT exams (2,3,4,5). The number of such CT exams almost doubled between 1996 and 1999.

Gone are the claims that cancer risk from low-dose x-rays is just hypothetical. Indeed, the absence of any threshold dose is explicitly acknowledged now (3), because evidence for the absence is overwhelming. Readers can study such evidence by consulting "Threshold" in the index of reference (6). A single x-ray photon is physically capable of causing unrepairable and consequential damage to genetic molecules in a cell. Risk of such damage is proportional to dose, right down to zero dose.

Strong Recommendations in Spine and the AJR: Ethical Concerns

In Spine (1), referring to spinal x-rays to monitor scoliosis treatment, the authors of a National Cancer Institute study conclude: "Ionizing radiation exposure is a very well-established breast cancer risk factor. . . It is recommended that every effort be made to reduce exposures further. . ."

In the American Journal of Roentgenology (2), referring to the evidence that x-ray dose during pediatric CT exams is generally two to 14 times higher than needed, Lee Rogers, MD, editor-in-chief, exhorts radiologists to reduce dose per procedure: "Get with it! . . . This one is a no-brainer."

Ethical concerns arise when anyone gives patients of any age a potentially lethal agent without measuring the dosage and without making every effort to reduce the dose per procedure to the lowest level at which the benefit can be acquired. The widespread assumption, that x-ray dose-levels are already as low as possible, is demonstrably mistaken, not only for childhood x-rays (4,5,6,7,8,9).

Past the Tip of the Iceberg: Here's the Rest

My own 1999 medical monograph (6) presents powerful evidence

that accumulated exposure to medical x-rays has become a necessary co-actor in over half the age-adjusted death-rate from cancer in this country. Additionally, the 1999 monograph presents striking evidence that accumulated x-ray exposure is also a necessary co-actor in over half the age-adjusted U.S. death rate from coronary heart disease. My 1995 monograph on breast cancer (7), using data and methods completely independent from the 1999 monograph, yields the same finding for that disease.

Despite widespread circulation among leading peers, my new findings have not been refuted at all. A few physicians have said, "This cannot be right, because it is so far out of line with the conventional wisdom." Denial is not scientific refutation. When challenged, they could neither identify any error within my work, nor could they defend the conventional wisdom on a scientific basis.

By contrast, I have explained why the new findings differ from the conventional wisdom, and why the new evidence is far more credible (6). The new findings clearly fall within the range of informed scientific expectation. On this issue, the benefit of any doubt clearly belongs with prudence.

How Medical X-Rays Relate to Environmental Causes of Disease

How do medical x-rays relate to environmental causes of disease? First, x-rays themselves are an exogenous (environmental) agent. Second, x-ray-induced mutations co-act with other environmental causes of disease. For carcinogenesis, the well known co-actor model (initiator, promoter) is accepted by radiation biologists too (10). Our Unified Model of Atherogenesis (6) also takes account of co-action between x-ray-induced mutations and the well established risk-factors.

The pathogenic role of x-rays is to cause carcinogenic and atherogenic mutations, which can interact with various environmental pollutants, endogenous and exogenous hormones, dietary and tobacco metabolites, and other endogenous and exogenous agents. Conversely, carcinogenic environmental pollutants can exert their own pathogenic force via x-ray induced mutations. Thus, any plans to reduce the impact of environmental causes of cancer and coronary heart disease must include realism about a uniquely potent cause of acquired mutations in the population: medical x-rays.

The Story of What Happened in Toronto, Canada

About 20 years ago, radiologists in Toronto, Canada, invited a team of medical physicists from the University of Toronto's Radiological Research Lab to observe their busy x-ray imaging practices, to measure actual doses, to teach low-dose techniques, to tune-up existing equipment, and to ensure proper processing of exposed films (11,12).

The result? The consultations demonstrated that-without loss of image quality-average dose could be reduced by a factor of at least 3 with little work, and by a factor of 10 or more if all conditions were optimized. These achievements, obtained without purchases of major new equipment, demonstrated that the key to

dose reduction is not "state of the art" equipment. The keys are technique, dose-measurement, quality control, and attitude.

This is still the case, according to Joel E. Gray, PhD, medical physicist, who recently retired from the Mayo Clinic to become a consultant based in Danbury, Connecticut: "Techniques for reducing radiation exposure in angiography and fluoroscopy are relatively simple, inexpensive and easily applied to general radiographic imaging." (9) Dr. Gray identifies specific ways to reduce dose per x-ray procedure by up to a factor of 5, including dosage during CT exams. He also says: "It is time for the radiology imaging community-radiologists, medical physicists and technologists-to take the necessary steps that will optimize x-ray imaging systems to reduce radiation exposures and improve image quality (8)."

Proposal: Toronto-Type Consultations in San Francisco

X-ray imaging procedures can save lives. I definitely do not advocate rejecting the undeniable benefits from x-ray imaging. What I advocate is obtaining the benefits at much lower doses per procedure.

How? First, let's focus on the high-volume places. Each hospital and its associated radiologic practices can invite regular Toronto-type consultations on dose-reduction. Second, priority should be given to reducing dose in the two kinds of imaging procedures that account for most of the x-ray exposure: CT scans and fluoroscopy (including fluoroscopy during surgeries, angioplasties, etc.).

Toronto-type consultations can produce (a) periodic, documented evidence for the community that dose per x-ray imaging procedure is progressively falling and (b) hard evidence that a reliable dose-record exists for each patient.

The Issue of Delay: Irreversible Harm

My new findings (6) result in the estimate that we could prevent about 250,000 future deaths per year, nationwide, just by cutting the average x-ray dose per x-ray imaging procedure in half-which is demonstrably feasible, even with old equipment. However it is certainly not necessary to embrace my new findings, in order to embrace the above proposal for Toronto-type consultations. After all, the main regulatory and advisory groups (13) and a leading radiology journal (2,3) now acknowledge that x-rays even at low doses are a cause of cancer. In the future, radiologists, other physicians using x-rays, and referring physicians may all be held accountable for having evidence that patients receive x-ray doses at the lowest levels at which the imaging benefit can be obtained.

I intend to initiate friendly dialogues with my medical colleagues on establishing Toronto-type consultations, which are guaranteed to deliver real health benefits and can be quickly implemented on a voluntary basis. No one in medicine wants coercion.

But if we in the medical profession endorse the "Non-Precautionary Principle," by taking the position that we should delay on reducing doses per x-ray procedure until everyone agrees

on exactly how many premature deaths will be prevented, we can never un-do the harm inflicted during the waiting period. What medical arguments exist against instituting Toronto-type consultations throughout San Francisco before the end of year 2001?

Members of the San Francisco Medical Society have the opportunity to show leadership, which their colleagues nationwide could easily emulate-thus solving a health issue rapidly, efficiently, internally and inexpensively, to the benefit of everyone.

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