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## REPORT

Unsafe at any dose

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After four decades of research, the former director of the Atomic Energy Commission's Biomedical Research Division of Livermore Laboratory concludes that there is no such thing as a safe dose of radiation. Although he was the first to prove it, he's not the only one.

by Terri Mitchell

John W. Gofman, M.D., Ph.D., Professor Emeritus of Molecular and Cell Biology at the University of California at Berkeley is one of the most distinguished medical and nuclear scientists in the world. His research shows that no amount of radiation, no matter how tiny, is safe. Further, he has come to the shocking conclusion that exposure to radiation from medical procedures is a "highly important (probably principal) cause" of cancer and ischemic heart disease in America.

The use of radiation in medicine dates to 1896. From that time through the 1960s, people drank it, bathed in it, slept with it, applied it to their bodies, smoked it, ate it in zwieback and put it in their dinnerware (red Fiestaware). At one point, enterprising capitalists were going to turn America into a "plutonium economy", using atomic explosions instead of dynamite for big projects, and radioactive isotopes to create energy. Because of the concerns of John Gofman and others, America was not rendered radioactive. However, America was, and still is, sold on radiation. We laugh at people drinking radioactive water, and then make an appointment for a whole body scan.

Radiation is big business. X ray machines have mutated into fancier-and-fancier versions capable of delivering radiation with greater intensity. The industry is huge-many of the same companies that manufacture CT scanners also sell nuclear power plants.[1] The radiation industry is cloaked in dogma about "safe doses", and firmly ensconced in the halls of medical science. We accept radiation as part of our healthcare-a necessary part of medicine. Yet, with all the acceptance of radiation, what if we found out that it was causing the very problems it's supposed to cure? What if radiation was helping create the serious diseases it ends up diagnosing and treating?



## Radiation and breast cancer

In 1994, Gofman, who was a former researcher on the atomic bomb, was invited to give a talk on radiation and breast cancer at a meeting held by the American Association for the Advancement of Science. Gofman was aware of research showing that there was increased breast cancer in Japanese women who survived the U.S. atomic bombings of Hiroshima and Nagasaki. Studies on mice and guinea pigs, showed that cancer-resistant animals developed breast cancer if given repeated doses of radiation. But the most damning research about breast cancer and radiation was preliminary data from young women who had undergone repeated fluoroscopies as part of their tuberculosis treatment from 1930-1950. These women were developing breast cancer at more than double the expected rate.

In 1970, Gofman and his colleague Arthur Tamplin, wrote to The Lancet, expressing their concern that the amount of radiation needed to double the risk of breast cancer was low according to these old studies-20-50 accumulated rads.

Young women were especially vulnerable, and the greater the radiation exposure, the greater the risk. The evidence was there that radiation exposure could significantly increase the risk of breast cancer, but few were following up on this old research.

In preparing for the breast cancer talk, Gofman began looking into how many cases of breast cancer in America might be caused by radiation exposure. His first estimate was that 35% of all breast cancer cases wouldn't exist had the women not been exposed to medical radiation. His revised estimate, published a year later, was 75%. Gofman paid particular attention to such exposures during 1920-1960 because those exposures would contribute to breast cancer rates for at least the next 45 years. Gofman did not believe these exposures were the only cause of the women's cancers; but he believed they had a major role in making them come about.

According to Gofman, the lag time between radiation exposure and cancer is variable. Data shows that the average lag-time between radiation exposure from the American raids on Japan and the appearance of breast cancer in Japanese women was about 12 years. However, it can occur sooner or later. Radiation has greater carcinogenic effects on younger people. Data from the Japanese studies show that if a woman was 20 years-old or younger when exposed to the radiation, she had a 13-fold elevated risk of breast cancer occurring by the time she was 35 (assuming 1 Sievert of radiation). Some studies put the risk for older women at double. Regarding children, it has been stated that 10 rads administered to a fetus is enough to produce all forms of childhood cancer whereas the same amount in an adult would not have that effect.[2]

Critics were unable to demonstrate that Gofman's 75% radiation-induced breast cancer figure was wrong. They could challenge it using different assumptions, but as Gofman puts it, "they were unable to show any basis for thinking that their assumptions were more likely to be right than our assumptions." (Editor's note: human radiation research is necessarily based on a lot of assumptions because human experiments cannot be done). The alarming figure made Gofman start wondering about other cancers. Breast cancer was surely not unique in being promoted by medical radiation.

Among the mountains of data Gofman had accumulated was a little-known study from 1976 that seemed to show a connection between the area of the country you live in and your risk of getting cancer. According to the study, if you live in an area where there is more natural radiation, you are less likely to get cancer. Gofman reanalyzed the data and came to a different conclusion, but the real value of the study was not in its conclusions, but in its data. Buried in the numbers was a different correlation—a correlation between the number of physicians per 1,000 people and the number of cancer deaths.

Although this evidence hinted at a connection between cancer, doctors and radiation procedures, Gofman failed to pursue it at that time. Later on, when he was trailing breast cancer in earnest, the implications of that old research hit home. The data made sense—if doctor density was greater, there would be more tests involving radiation given to more people. If true, it would lend credence to the concept that medical radiation is an important contributor to cancer. The data was doubly important because it was based on numbers having nothing to do with radiation. Radiation data is notoriously controversial, and lends itself to manipulation, but this database is free of statistical manipulations.

Using the data, Gofman examined all types of cancers, both for men and for women. Except for female genital cancer, cancer mortality consistently correlated with increasing numbers of physicians per 100,000 people. When he looked at death due to other causes, such as appendicitis or car wrecks, there was no correlation. But there was a correlation between the number of doctors and mortality from diabetes, ulcers and ischemic heart disease. Gofman thinks some of the "ulcers" were actually stomach cancer, and the diabetes deaths not accurately reported as to the underlying cause of death. That left cancer and heart disease.

#### Radiation and heart disease

We know how radiation causes cancer. It damages DNA, and mutations occur when the body tries to repair the damage. Most of the damage will be successfully repaired, but the repair system is not perfect. It leaves mistakes in DNA. These mutations, as they are called, have the potential to make a cell behave abnormally, i.e. become cancerous.

Radiation-induced cancer we understand, but heart disease? How would radiation cause heart disease? According to Gofman, the same way as cancer. Radiation damages DNA—this time the DNA is in the arteries. (Consider that chest x rays are aimed right at the heart.) The radiation-induced changes create a cancer-like phenomenon in the arteries known as atheromas—oma meaning tumor.[3] Gofman believes that the interaction between atheromas and lipids blocks arteries and causes blood clots.

Another interesting feature of what radiation can do to blood vessels was noted by a researcher named Arthur Elkeles. Elkeles was able to link up the age-related loss of calcium from bone and build-up in soft tissue (including arteries) with radiation. In 1977, he wrote that "alpha-ray activity in an aorta with severe atherosclerosis may be 220 times higher than in an aorta without significant atherosclerosis." Damaged areas known as plaques were documented hot-spots for radiation. Elkeles believed that the



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calcium/radiation phenomenon "paved the way" for full-blown heart disease.

Edward A. Martell showed the validity of the radiation/heart disease connection by using data from smokers. People who smoke frequently develop early heart disease. Martell noted that cigarette smoke contains radioactive isotopes. Those isotopes accumulate in lungs and blood vessels, where they emit continuous low levels of radiation. That radiation causes changes in blood vessels.

One of the striking effects of radiation is to cause arterial cells to multiply abnormally. Abnormal growth of cells lining the arteries narrows them. And abnormal growth of smooth muscle tissue surrounding the artery creates something similar to scar tissue which presses on the arteries, and ruins their flexibility. It's not cholesterol that "clogs" arteries; it's abnormal cell growth that narrows arteries. Cholesterol collects in areas already damaged.

As early as 1944, it was shown that plaques and foam cells could be produced with radiation. Since that time studies have been done showing that lesions, impaired nitric oxide function, permeability of the blood vessels, "sticky" platelets and increased free radicals—all of which are features of heart disease—can be created with radiation. In fact, atherosclerosis, in its entirety, can be created with radiation. And studies show that people who have undergone radiation of areas containing major blood vessels often develop atherosclerosis in those blood vessels. It doesn't happen overnight, however. In a study on dogs, the effects of radiation on main arteries was not seen for four to five years. However, the time lag may be dose-dependent. In one grisly report, a 21-year-old man had a fatal heart attack a year and four months after receiving 3,696 rads of radiation for Hodgkin's disease. An autopsy showed atherosclerosis. New research shows that radiation ages heart cells—it speeds up aging. And new data on the atomic bomb survivors indicates that some of them have abnormally low levels of T-helper cells (CD4), and this is especially true of those who have had heart attacks. Clearly, radiation causes serious damage to cells.

Radiation also damages small blood vessels. It was demonstrated in experimental animals that irradiation of muscles causes microvessels to shrink with age. In unirradiated muscles, the microvessels got bigger with age. Blood flow was significantly lower in irradiated muscles.

Radiation is not the only cause of damaged vessels, but it is an important cause, according to Gofman. It's a cause that deserves far more scrutiny. And because medical radiation is the greatest source of radiation exposure to most people, this source of radiation has to be implicated in the high rate of heart disease in America.

Safe radiation?

Gofman has a lot of pioneering research under his belt. He was part of the team that discovered the various forms of lipoproteins such as LDL and established their relationship with heart disease. He has worked on the chemistry of plutonium, and he has done important research on how radiation affects chromosomes. But perhaps his most important contribution is his research on "safe" radiation.

The cornerstone of radiation diagnostics is the concept that radiation is safe as long as it's kept at a certain level. A body scan center told us when we asked about radiation, that we're allowed 5 rads a year—as if 5 is some magical number above which we'll get cancer and below which we won't. Not so, says Gofman. There is no safe dose of radiation.

The proof goes thusly: if there is a safe dose of radiation, then all the damage of that dose will be repaired. Radiation damages DNA. Damaged DNA is recognized by the body's DNA repair program, which goes into action. All of the damage must be repaired perfectly for radiation to be safe. Any damage imperfectly repaired creates mutations—any one of which has the potential to create cancer.

According to Gofman, "The dose from low-LET (linear energy transfer) ionizing radiation is delivered by high-speed electrons, traveling through human cells and creating primary ionization tracks. Low-LET radiation includes x rays, gamma rays and beta particles."<sup>[4]</sup> In other words, radiation slams through cells, leaving broken and damaged DNA in its path. The "trails" it leaves behind are called "tracks".

Astounding new research

If a safe dose of radiation exists, then a cell sustaining only a few tracks should be able to repair itself. If this is the case, then doing experiments where a cell is hit with only a few particles of radiation would prove that a small dose of radiation is safe—that the damage can be repaired. One particle of energy leaving one track is the lowest dose of radiation a cell can possibly get. If one particle did no lasting damage, scientists could work up from there to the lowest possible dose of radiation that would be safe, i.e., perfectly repaired.

The first-ever report on the effects of one single particle of radiation shot through one single cell, creating one single track, was

published in The Proceedings of the National Academy of Sciences. This amazing research was done at Columbia University's Radiological Research Accelerator Facility. It shows that the lowest possible dose of radiation is not only not safe, but does far more damage than previously thought. In the authors' own words: "Our data provide the first demonstration that a single particle hit in the nucleus, which kills only 20% of the cells, is indeed mutagenic." One single particle.

The alpha particles in this study were from radon, a more energetic source of radiation than x rays. Radon is a decay product of uranium, and is the primary source of "background" radiation in the U.S. It is the second leading cause of lung cancer in America, after smoking. Columbia University's researchers were after data on how radon causes lung cancer. (Radon is found in many homes and buildings).

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1 For more information on the "atomic brotherhood", see Mark Hertsgaard's Nuclear Inc. published by Pantheon.

2 Wanebo, et al.

3 It's interesting to note that a radiation-induced tumor doesn't have to be malignant. For example, in a study on people who received a certain radioactive contrast material (no longer manufactured), the relative risk of getting a benign tumor was 50% higher than people not getting the material. See Travis, et al.

4 John W. Gofman. 1990. Radiation-Induced Cancer from Low-Dose Exposure: An Independent Analysis. San Francisco: CNR, p. 18-2.

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What does one particle of radiation do?

In the first studies, researchers aimed a single particle at the nucleus of the cell-where DNA is located. Eighty percent of the cells shot through the nucleus survived. This contradicts the belief that if radiation slams through the nucleus, the cell will die. But the bad news is that the surviving cells contained mutations. Cells have a great capacity to repair DNA, but they cannot do it perfectly. The damage left behind in these studies from a single particle of alpha radiation doubled what damage was already there. This proved, beyond a shadow of a doubt, that there is no such thing as a safe dose of radiation. If one particle of radiation leaves damage behind-damage that can lead to cancer-then no amount of radiation is "safe". That doesn't mean that every mutation leads to cancer. The vast majority do not. But every mutation has the potential to become an abnormally growing cell, and the effects are cumulative over time.

They did more studies, hitting cells with more particles. If the cells are hit with 8 particles, about 10% of them survive, but with more damage. Twenty particles of radiation shot through one cell kills it with very few exceptions. The interesting thing about this is that a high dose of radiation that kills cells outright may be less dangerous than a lower dose that merely cripples them. Lethal hits leave no imperfectly repaired (mutated) survivors. Cells that are completely destroyed can't multiply with mutations. On the other hand, killing too many cells will kill the entire organism.

The radiation from x rays is less energetic than that from radon. But it is not less dangerous. Joint research between scientists at Brookhaven National Laboratory and the National Center for Scientific Research in France demonstrates that low LET radiation, including x rays, cause a type of damage similar to the serious double-strand breaks where radiation blasts through both strands of DNA, leaving it completely broken. The radiation from x rays causes similar damage by hitting each strand individually, but close together. The result is similar to a double strand break.

### Indirect damage

What happens when an alpha particle whizzes through the cell, but misses DNA? In this case, it hits cytoplasm, the body of the cell. In 1999, Hei's group at Columbia did experiments, again shooting predetermined numbers of alpha particles through each cell. They came up with a very surprising finding. Hitting cytoplasm causes mutations in DNA. That seems odd; how could radiation damage something it doesn't touch? The answer is that radiation creates secondary free radicals. These are the types of radicals health-conscious people are familiar with. They have lower energy than radiation and they don't cause the same type of damage or as much of it. However, they can actually be worse because again, this is sublethal damage the body will attempt to repair, and mutations will inevitably result.

The body has evolved an "antioxidant defense system" to help stop these kinds of free radicals. Dietary antioxidants also help protect against them. Hei's group demonstrated that glutathione was effective, and other studies show that N-acetylcysteine, SAME, MSM and other sulfur-containing antioxidants also protect against secondary free radicals created by radiation.

### A mysterious finding

In the late '90s, it was discovered that ionizing radiation causes damage a different way. Previous research showed that adding the growth liquid from irradiated cells to non-irradiated cells could kill them. It wasn't because of free radicals or radiation damage. This is strange. Researchers at Harvard and the Los Alamos National Laboratory looked into and found that the irradiated cells might be communicating somehow with non-irradiated cells.



Some radiation terms

Rad stands for "radiation absorbed dose". A rad is the amount of radiation a person receives per gram of tissue. Ionizing radiation is photon energy that knocks electrons out of their orbits and sends them flying. The energy of the flying electrons is measured in volts. A millirad is one one-thousandth of a rad, or .001. A centi-gray (cGy) is a rad. A Roentgen is .96 of a rad, or almost a rad. X rays are radiation generated by a machine as opposed to radioactive substances, and they're essentially the same energy as gamma rays which are less than alpha rays. A source of alpha rays is radon.

Meanwhile, Hei's group came up with convincing proof that irradiated cells could cause mutations in their nonirradiated neighbors. And further, that the phenomenon could be blocked by a chemical that interferes with communication between cells (lindane).

The Harvard/Los Alamos researchers also found that interfering with cellular communication stopped the damage, and this year they published proof that "bystander" cells that get no radiation at all nonetheless have changes in the expression of tumor suppressor gene p53 and a related gene that controls the cell cycle known as p21. These genes play roles in cancer. This means that radiation affects crucial genes.

The future

Researcher Hei and colleague Gloria Calaf have begun studying how breast cells respond to estrogen after being hit with alpha radiation. So far they've shown that changes occur in BRCA, the "breast cancer susceptibility gene". Researchers at Loma Linda have speeded up and worsened prostate cancer with one low-dose whole body irradiation and a growth factor. These kinds of "real world" experiments will lead to a greater understanding of radiation's contribution to cancer.

We now know that radiation damages cells in at least three different ways: directly, through free radicals and through cellular communication. The idea that there is such a thing as a "safe" dose of radiation has been disproved. Where does that leave Gofman's observation that radiation is a significant cause of heart disease and cancer? Gofman acknowledges that radiation is not the only cause of heart disease and cancer, and he's quick to point out that multiple factors contribute. Poor diet, chemicals, viruses and a lack of exercise have proven connections to heart disease and cancer, which is a multi-stage process. But far from being disproved, Gofman's observations have gained even greater support by recent radiation research. Whether we like it or not, the very thing we use for diagnosing and treating heart disease and cancer is helping cause it.

Every dose of radiation we get is cumulative. It's very important that we realize and understand that medical radiation, and indeed all radiation, is not benign. It damages tissues even though we can't feel it or see it. It can come back to haunt us years after exposure, with very serious and devastating effects. The acceptance of radiation as safe by us as individuals and by us as a society has to be challenged. Radiation is a business, an industry, not a natural part of our lives-even though we grew up believing it was. The blind acceptance of our doctor's assurances that radiation is safe-is dangerous. The blind acceptance of radiation in our society is short-sighted and potentially self-destructive.

Informed consent should become routine for radiation procedures, just as it is for other medical procedures. For this to occur, the truth about radiation has to be available to everyone-the risks as well as the benefits. No longer can we pretend that a body scan here-and-there, a chest x ray now-and-then or a quick-look-at-our-colon has no lasting effect. They do. And until we accept that, high rates of cancer and heart disease will continue, and we, ourselves, may become one of the statistics.

## Books

John W. Gofman. 1996. Preventing Breast Cancer: the Story of a Major, Proven, Preventable Cause of this Disease. San Francisco: CNR Book Division.

John W. Gofman. 1999. Radiation from Medical Procedures in the Pathogenesis of Cancer and Ischemic Heart Disease: Dose-Response Studies with Physicians per 100,000 Population, 1st ed. San Francisco: CNR Book Division. (Available through [www.x-raysandhealth.org](http://www.x-raysandhealth.org)).

## References

Azzam EI, et al. 2001. Direct evidence for the participation of gap junction-mediated intercellular communication in the transmission of damage signals from alpha-particle irradiated to nonirradiated cells. *Proc Natl Acad Sci USA* 98:473-78.

Azzam EI, et al. 1998. Intercellular communication is involved in the bystander regulation of gene expression in human cells exposed to very low fluences of alpha particles [see comments]. *Radiat Res* 150:497-504.

Boice JD, et al. 1977. Breast cancer in women after repeated fluoroscopic examinations of the chest. *J Natl Cancer Inst* 59:823-32.

Boudaïffa B, et al. 2000. Resonant formation of DNA strand breaks by low-energy (3 to 20 eV) electrons. *Science* 287:1658-60.

Calaf GM, et al. 2000. Establishment of a radiation- and estrogen-induced breast cancer model. *Carcinogenesis* 21:769-76.

Dossing M, et al. Radiation-induced lesions of the aorta (letter). *Br Med J* 1(6066):973.

Elkeles A. 1977. Metabolic behavior of alpha-ray activity in large human arteries: relationship to atherosclerosis. *J Am Geriatrics Soc* 25:179-82.

Elkeles A. 1969. Alpha-ray activity in the large human arteries. *Nature* 221:662-64.

Elkeles A. 1961. Radioactivity in calcified atherosclerosis. *Brit J Rad* 34:602-5.

Gridley DS, et al. 1997. Enhancement of prostate cancer xenograft growth with whole-body radiation and vascular endothelial growth factor. *Anticancer Res* 17(2A):923-8.

Hei TK, et al. 1997. Mutagenic effects of a single and an exact number of particles in mammalian cells. *Proc Natl Acad Sci USA* 94:3765-70.

Johnson LK, et al. 1982. Differential radiation response of cultured endothelial cells and smooth myocytes. *Anal Quant Cytol* 4:188-98.

Johnson LK, et al. 1982. Differential radiation response of cultured endothelial cells and smooth myocytes. *Anal Quant Cytol* 4:188-98.

Lauk S. 1987. Endothelial alkaline phosphatase activity loss as an early stage in the development of radiation-induced heart disease in rats. *Radiat Res* 110:118-28.

Loftus CM, et al. 1987. Management of radiation-induced accelerated carotid atherosclerosis. *Arch Neurol* 44:711-14.

Lorenz E. 1950. Some biologic effects of long continued irradiation. *Am J Roentgenol* 63:176-85.

Mackenzie I. 1965. Breast cancer following multiple fluoroscopies. *Brit J Cancer* 19:1-9.

Martell EA. 1975. Tobacco radioactivity and cancer in smokers. *Am Sci* 63:404-12.

Martell EA. 1974. Radioactivity of tobacco trichomes and insoluble cigarette smoke particles. *Nature* 249:215-17.

Martell EA. 1983. Bronchial cancer induction by alpha radiation: a new hypothesis. *Proc 7th Intl Congress Rad Res*, paper C6-11. JJ Broerse, et al., Ed. (Martinus Nijhoff: Amsterdam, Netherlands).

Menendez JC, et al. 1998. Effects of radiation on endothelial function. *Int J Radiat Oncol Biol Phys* 41:905-13.

Oh CW, et al. 2001. Induction of a senescence-like phenotype in bovine aortic endothelial cells by ionizing radiation. *Radiat Res* 156:232-40.

Powers BE, et al. 1999. Long-term adverse effects of radiation inhibition of restenosis: radiation injury to the aorta and branch arteries in a canine model [see comments]. *Int J Radiat Oncol Biol Phys* 45:753-59.

Powers BE, et al. 1999. Long-term adverse effects of radiation inhibition of restenosis: radiation injury to the aorta and branch arteries in a canine model [see comments]. *Int J Radiat Oncol Biol Phys* 45:753-59.

Sheehan JF. 1944. Foam cell plaques in the intima of irradiated small arteries. *Arch Path* 379:297-08.

Sutherland BM, et al. 2000. Clustered DNA damages induced in isolated DNA and in human cells by low doses of ionizing radiation. *Proc Natl Acad Sci* 97:103-8.

Tamplin AR, et al. 1970. Radiation-induced breast cancer. *Lancet* Feb. 7, 1970:297.

Tokunaga M, et al. 1994. Incidence of female breast cancer among atomic bomb survivors, 150-1985. *Radiat Res* 138:209-23.

Travis LB, et al. Mortality after cerebral angiography with or without radioactive Thorotrast: an international cohort of 3,143 two-year survivors. *Radiat Res* 156:136-50.

Tribble DL, et al. 1999. Ionizing radiation accelerates aortic lesion formation in fat-fed mice via SOD-inhibitable processes. *Arterioscler Thromb Vasc Biol* 19:1387-92.

Verheij M, et al. 1994. Ionizing radiation enhances platelet adhesion to the extracellular matrix of human endothelial cells by an increase in the release of von Willebrand factor. *Radiat Res* 137:202-7.

Wanebo CK, et al. 1968. Breast cancer after exposure to the atomic bombings of Hiroshima and Nagasaki. *NEJM* 279:667-71.

Wu L-J, et al. 1999. Targeted cytoplasmic irradiation with alpha particles induces mutations in mammalian cells. *Proc Natl Acad Sci USA* 96:4959-64.

Zhou H, et al. 2000. Induction of a bystander mutagenic effect of alpha particles in mammalian cells. *Proc Natl Acad Sci* 97:2099-104.

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