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What Would Become of Nuclear Risk if Governments Changed Their Regulations to Recognize the Evidence of Radiation's Beneficial Health Effects for Exposures That Are Below the Thresholds for Detrimental Effects?

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Abstract

The 1953 Atoms for Peace Speech to the United Nations proposed applying nuclear energy to essential needs, including abundant electrical energy. The widespread fear of ionizing radiation from nuclear facilities and medical procedures began after the United States National Academy of Sciences performed a study of radiation dangers to the human genome. This study, initiated and managed by an oil industry benefactor, recommended in 1956 that the risk of radiation-induced mutations be assessed using the linear no-threshold dose-response model instead of the threshold model. It was followed by a study that wrongly linked low radiation to cancer among the atomic bomb survivors. The ensuing controversy resulted in a compromise. The National Committee on Radiation Protection adopted the precautionary principle policy in 1959, justified by fear of cancer and lack of knowledge. The United States and all other countries followed this recommendation, which remains unchanged 62 years later. Its impact on nuclear energy and medicine has been profound. Many costly regulations have been enacted to prevent very unlikely human or equipment failures—failures that would lead to radiation exposures that are below the dose thresholds for lasting harmful effects. Potential low-dose radiation therapies, against inflammation, cancer, autoimmune, and neurodegenerative diseases, are shunned.

Keywords

fear of ionizing radiation, genetic mutations, radiation-induced cancer, precautionary principle, nuclear risk, low-dose medical therapies

Fear of Radiation-Induced Genetic Mutations

During the 65-year period from the discovery of X-rays in 1895 until 1960, the health effects of nuclear radiations and X-rays became well known to physicians who employed these ionizing emissions to diagnose and treat a variety of important diseases. Unfortunately, most radiation therapies were shunned after a radiation cancer scare was disseminated. In the Atoms for Peace Speech to the United Nations on December 8, 1953,[1] President Eisenhower proposed to "lead this world out of fear and into peace" by creating the UN International Atomic Energy Agency (IAEA). "Experts would be mobilized to apply atomic energy to the needs of agriculture, medicine, and other peaceful activities. A special purpose would be to provide abundant electrical energy in the power-starved areas of the world."

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A renowned oil industry benefactor, the Rockefeller Foundation (RF), had been funding medical research since 1913. In the 1950s, it began to manage and fund the United States National Academy of Sciences (NAS) to carry out a detailed assessment of multiple areas of concern related to exposure to radiation from the nuclear weapons tests.[2,3] On February 23, 1954, the RF wrote to Eisenhower suggesting that the NAS undertake a study of radiation effects "with particular attention to the possible danger to the genetic heritage of man." The President responded favorably.[3] The resultant NAS study on the genetic effects of atomic radiation was published on June 29, 1956.[4] It recommended that the linear no-threshold (LNT) dose-response model be used to assess the risk of radiation-induced genetic mutations instead of the threshold model, which had been the basis for the "tolerance dose" rate limit that radiologists had employed for their protection, for more than three decades.[5] This LNT recommendation was controversial because it was based upon flawed research on fruit flies.[2] That research was contradicted by the 10-year study of about 75,000 children of the survivors of the bombing of Hiroshima and Nagasaki that showed no evidence of hereditary damage.[6] The NAS, however, disregarded this crucially important human evidence.[2]

The Radiation Cancer Scare

The NAS study was immediately followed by a deeply flawed study of the incidence of leukemia among the atomic bomb survivors. Published in 1957, it suggested a link between any exposure to radiation and a risk of cancer by fitting the LNT model to the data.[7] A revisit of this study in 2015 revealed that the author had combined the data in Zone D with the data in Zone E (Figure 1), which concealed the evidence of the high threshold, at 1.1 Gy, for the onset of radiation-induced leukemia. The 32,700 survivors in Zone D, whose exposures were below this threshold, had a lower-than-normal incidence of leukemia, i.e., that of the controls in Zone E.[8,9]

Since the blood-forming stem cells in bone marrow are exceptionally radiation-sensitive, it is reasonable to expect the dose thresholds for inducing cancer in other types of cells that are less sensitive, to be higher than 1.1 Gy, and the cancer latencies to be longer than the 3–12 years for leukemia. Also, the low number of cases in Zones A and B for a cancer that is commonly linked to radiation, just 48 cases in 10,051 survivors, suggests that radiation may not be a significant cause of cancer.

Much is known about the effects of low and high doses of radiation on organisms. The 41st Lauriston S. Taylor Lecture, delivered in 2018 by F. Ward Whicker, presented a broad view of environmental radiation and life. Figure 2 in that article shows the approximate acute dose ranges for 100% lethality in all kinds of organisms, from mammals (2–15 Gy), birds (5–20 Gy), plants, fish, insects, bacteria, and up to viruses (200 to about 10,000 Gy).[10]

A recent, detailed analysis has totally discredited the 1957 study.[11] This analysis is accompanied by a careful historical review that describes how a young professor of fruit-fly genetics, Edward B. Lewis, endeavored to mislead the scientific community, but could not prove or convince even his close colleagues that radiation-induced mutation was the mechanism for radiation-induced leukemia at low doses.[12] However, "as a member of the influential NCRPM (National Committee on Radiation Protection and Measurement), he forged an intellectual compromise with one of his formidable critics, Austin Brues, a leader on the BEAR Pathology Panel. Lewis

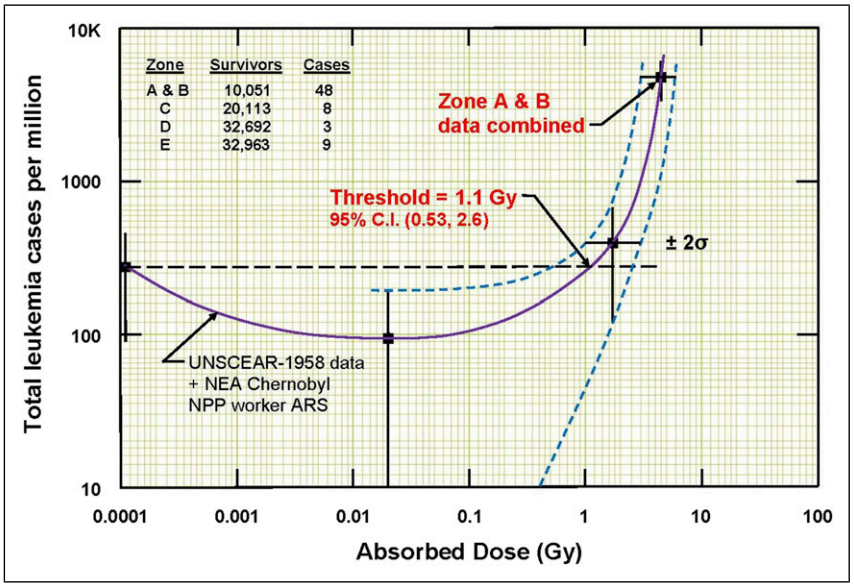

Figure 1. Evidence of a threshold at 1.1 Gy for radiation-induced leukemia from analyses of the 1950–1957 data of 95,819 Hiroshima atomic bomb survivors.[9]

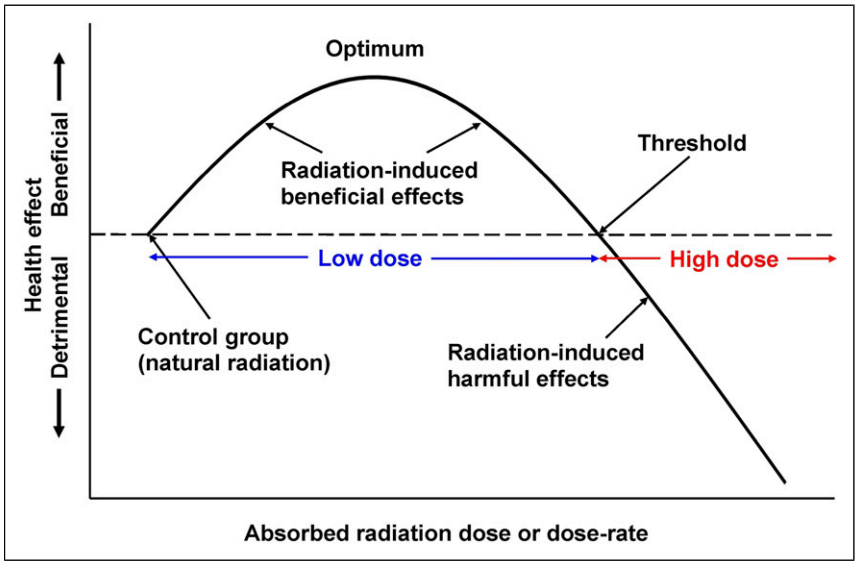

Figure 2. Biphasic dose-response model. Definition of low dose or low dose rate radiation.[9]

and Brues encouraged the rest of the Committee to follow their compromise and recommend that the LNT model be adopted."[12] In 1959, the NCRPM adopted the *Precautionary Principle* policy, which, in effect, meant that the LNT model would be employed to estimate the risk of radiation-induced cancer.[13] This decision was based on public fear and lack of knowledge. The United States and essentially all other countries followed this lead.[12]

The NCRP's justification in 1959 for adopting the precautionary principle, lack of knowledge, was faulty because there had been more than 60 years of experience in the successful use of X-rays and nuclear radiation in medicine. There were journals with thousands of publications. In 1980, Lauriston S. Taylor, founder and long-time president of the NCRP, stated that studies "calculating the numbers of people who will die as a result of having being subjected to diagnostic X-ray procedures (by applying the LNT model) ... are deeply immoral uses of our scientific knowledge."[(14)]

Nuclear Risk

The terms risk and safety are different. Risk is a quantitative term; it is the product of a hazard, such as cancer, and the probability of its occurrence. In this article, a *low radiation dose* (or dose rate) is defined in Figure 2 to be an exposure that is in the beneficial range. It is below the threshold for the onset of health detriment. The hazard of a low-dose exposure is zero, and therefore its risk is zero.

Safety on the other hand is a qualitative term; it is how a person or the public *feels* about a risk. Therefore, safety depends upon the information or the evidence of a health benefit or detriment that people receive from credible authorities. If residents had evidence that the risk of any credible radiation exposure from a nuclear facility is zero, then the facility would become safe.

Today, 62 years after the NCRP policy change, all nuclear regulators and radiation protection organizations continue to follow the precautionary principle policy with the same justification—the lack of scientific information about health effects of radiation. They disregard the evidence of dose thresholds for the onset of lasting detrimental effects. These thresholds contradict the LNT model. They also ignore the evidence of the health benefits observed in people and organisms that were exposed to low doses over the past 125 years.[9,15] More and more phantom risks or marginal health risks and safety concerns are being identified. The requirement to minimize radiation exposures to *as low as reasonably achievable* has resulted in more and more regulations.

Back in 1962, the problem of regulation was identified in a United States Atomic Energy Commission (AEC) report to President Kennedy. "Steps are being undertaken to simplify and streamline the licensing and regulatory procedures."[(16)] However, an increasing number of critics charged that its regulations were insufficiently rigorous in several areas, including radiation protection standards, nuclear reactor safety, plant siting, and environmental protection. The AEC's regulatory programs had come under such strong attack that the United States Congress abolished the AEC in 1974. Its functions were assigned to the Nuclear Regulatory Commission, for regulating the nuclear power industry, and to the Energy Research and Development Administration, which became the Department of Energy (DOE) in 1977. Responsibilities for protecting against radiation hazards were transferred to the Environmental Protection Agency, which was established in 1970.[(17)]

To address concerns about radiation risk to nuclear workers, the DOE contracted the School of Public Health of Johns Hopkins University to perform a very comprehensive study of the nuclear shipyard workers. The NSWS (1980-1988) compared three cohorts: a high-dose cohort of 27,872

nuclear workers, a low dose cohort of 10,348 workers, and a control cohort of 32,510 unexposed shipyard workers.[18] The cohorts were matched by ages and job categories. The NSWS was peer reviewed twice a year by a Technical Advisory Panel. Although the NSWS was designed to search for adverse effects of occupational low dose-rate gamma radiation, few risks were found. The high-dose workers demonstrated significantly lower circulatory, respiratory, and all-cause mortality than did unexposed workers. Mortality from all cancers combined was also lower in the exposed cohort.[18] The 'Final Report' was issued in 1991.[19] however, the scientists who did the research chose not to publish the details of this excellent study in any journal.

Today, the public remains ever so fearful that any exposure from a nuclear energy facility or a medical procedure will increase the risk of cancer. To respond to public concerns, enormous sums of money have been spent over many years to remove soil from large areas that contain very low concentrations of human-made radioactive materials.[20] The regulations for nuclear energy facilities, have greatly increased in number and complexity since the mid-1970s, to further reduce nuclear risk. Today, the cost and duration of a project to build a standard nuclear power plant, from start to first operation, is huge and very difficult to estimate.

Impact of the Radiation Scare on Medical Therapies

This unwarranted cancer scare has been amplified by the May 12, 2021 "joint position statement and call for action" developed by the IAEA jointly with 9 organizations, and in collaboration with the World Health Organization.[21] They acknowledge that X-ray imaging is immensely beneficial in the diagnosis and management of many health conditions. The benefits of X-ray imaging far outweigh "inherent radiation risks." However, they continue to urge the minimum necessary radiation exposure and implementation of the "principles of justification and optimization" for radiation protection and safety. They raise alarm about the many patients who are afflicted with clinical conditions that require recurrent imaging procedures. People have become even more fearful.

From the 1960s until the present, the medical community has generally shunned the use of low doses of radiation in medical therapies.[9] However, every year in Germany about 50,000 patients are treated by ionizing radiation for nonmalignant disorders, mostly degenerative diseases, in more than 300 radiotherapy facilities. These highly successful treatments are applied for specific indications such as preservation or recovery of the quality of life by means of pain reduction or resolution and/or an improvement of formerly impaired physical body function owing to specific disease-related symptoms. Single doses of 0.5–1.0 Gy, total doses of 3.0–6.0 Gy, and 2 or 3 fractions per week with orthovoltage or megavoltage devices are recommended.[22] The Royal College of Radiologists has reviewed the use of such radiotherapy in the UK, and a European review provides list of references on its current use in clinical practice.[23,24]

A recent article on the application of low doses of ionizing radiation in medical therapies describes the case reports of patients who were treated successfully, since 2015, for the following diseases: prostate cancer, breast cancer, colorectal cancer, uterine cancer, lung cancer, hepatocellular cancer, ulcerative colitis, rheumatoid arthritis, pemphigus autoimmune disease, type I diabetes, and the neurodegenerative Alzheimer's and Parkinson's diseases.[9] A controversial pilot study has been carried out to repeat the treatments for the Alzheimer's case, and remarkable improvements in cognition and behavior were observed in three of the 4 cases.[25,26] A randomized double-blind, placebo-controlled study on 40 cases is now underway to confirm the results of the pilot study.

When the COVID-19 pandemic was confirmed, radiation oncologists in several countries began urging the medical community to employ an old remedy, low-dose radiotherapy (RT), to stop the onset of severe lung inflammation, which causes most of the fatalities.[27,28] More than 15 clinical trials were started and nearly all gave encouraging results.[29] The mechanism of action of LD lung RT for treating COVID-19 pneumonia has been clarified.[30] However, the medical authorities ignore this safe therapy that could have prevented many of the 5 million COVID-19 deaths. Three petitions to the NRC in 2015 to end reliance on the unscientific LNT dose-response model were rejected in 2021.[31,32]

Conclusion

Eisenhower's 1953 Atoms for Peace initiative to apply atomic energy to the needs of many peaceful activities and the special purpose of abundant electrical energy resulted in a reaction from an oil industry charitable foundation. The RF began to manage a study by the NAS on the potential danger of radiation on the genetic heritage of humans. Its recommendation in 1956 to use the invalid LNT model to assess the risk of radiation-induced mutations was based on fruit-fly studies; it disregarded the study of more than 70,000 children of the atomic bomb survivors that showed no evidence of hereditary damage.

A flawed study of leukemia among the atomic bomb survivors, in 1957, linked low radiation to a risk of cancer. A dispute with the NCRP regarding this cancer study led to a compromise. In 1960, the NCRP recommended adopting the precautionary principle policy and use of the invalid LNT model to evaluate the risk of radiation-induced cancer. The United States and all other countries accepted this recommendation, which firmly established the radiation scare.

This health scare resulted in many complex regulations for nuclear energy facilities, to prevent very unlikely failures that could release small amounts of radioactive materials. The experience from the Chernobyl accident and the damaged Fukushima Daiichi nuclear power plant indicated that the radiation exposures to most of the plant employees and the surrounding residents were below the

dose and dose rate thresholds for lasting detrimental effects.[33] However, the regulations have increased the costs of constructing and operating nuclear energy facilities enormously. They have become unaffordable in the United States and most other countries. And residents remain fearful of radiation exposures.

The impact of the radiation scare in medicine has also been very harmful. Potential low-dose therapies for inflammatory diseases (pneumonia), removal of cancer metastases, autoimmune, neurodegenerative, and other diseases are shunned. Treatments of diseases with orthovoltage X-ray machines and other low-dose devices would be convenient and affordable.

If governments were to examine the origin of the radiation health scare and the evidence of the health effects of radiation exposures, they would have a basis for informing the public and then changing the radiation protection policy that was adopted more than 60 years ago. The regulations could be simplified and corrected. The result would be a return to affordable nuclear energy and improved health care without increases in attendant health risk.

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