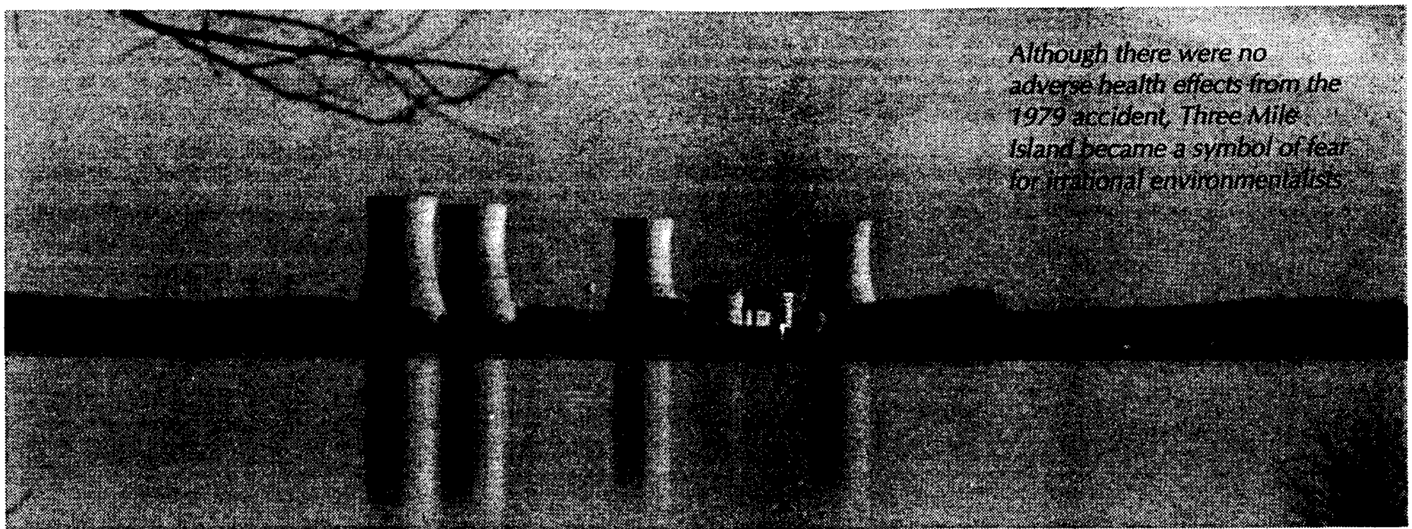

Although there were no adverse health effects from the 1979 accident, Three Mile Island became a symbol of fear for irrational environmentalists

Carlos de Hoyos

The Significant Health Benefits Of Nuclear Radiation

by Jerry M. Cuttler, D.Sc.

Many of the negative images of nuclear energy, especially those developed since the 1979 Three Mile Island accident, relate to perceptions of adverse health effects, specifically the possibility of inducing cancer and genetic damage, from any exposure to ionizing radiation.[1] The irony is that we are continuously exposed to radiation from natural sources.

Do exposures from human-made sources really significantly increase the normal incidence of cancers and birth defects? What about the beneficial health effects from low doses we've been hearing about? The answers to these questions are important because humanity now faces severe environmental, energy and medical issues, which greatly affect our quality of life. Nuclear technologies can provide realistic remedies, but fear about exposures to any human-made radiation greatly constrains their application.

We in the nuclear community make arguments about relative risks, but people make their own judgments about the acceptability of various risks, regardless of our comparisons. It would be possible to gradually change public notions about nuclear technology if, instead of trivial risks, a different, more positive picture of radiation's significant beneficial health effects could be communicated. The problem is strong resistance from influential scientists in recognizing the real benefits and discounting insignificant risks. This has led to a raging controversy over the past decade, and pressures from many scientific organizations to change regulatory policy.

The facts, as I will show, are quite clear. When the controversy will be resolved is unclear.

Radiation Carcinogenesis and LNT

The German physicist Wilhelm Röntgen discovered X-rays in 1895, and the French physicist Henri Becquerel discovered radioactivity in 1896. Since then, a tremendous amount of research has been carried out on the effects and aftereffects of ionizing radiations, and many very important applications have been found. Harmful health effects following large exposures were identified, almost immediately, and radiological protection advice was issued and updated, as more accurate information became available.

The early recommendations were concerned with avoiding burns and delayed effects from intense short-term radiation. This involved defining a safe limit for exposures (for example, ~0.2 rads per day in 1934 and 0.3 rads per week in 1951) based on the concept of a threshold. (See box, p. 49.) By 1955, this threshold concept was rejected by the International Commission on Radiological Protection (ICRP), which adopted instead a concept of cancer and genetic risks, kept small compared with other hazards in life.

"Since no radiation level higher than natural background can be regarded as absolutely 'safe,' the problem is to choose a practical level that, in the light of present knowledge, involves negligible risk."[2] This change in philosophy

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was brought about by new biological information—epidemiological evidence of *excess* cancer malignancies among radiologists and indications of *excess* leukemia cases in the survivors of the atomic bombings at Hiroshima and Nagasaki—"stochastic effects," whose probability of occurrence, not the severity, was assumed to be proportional to the size of the dose.[2]

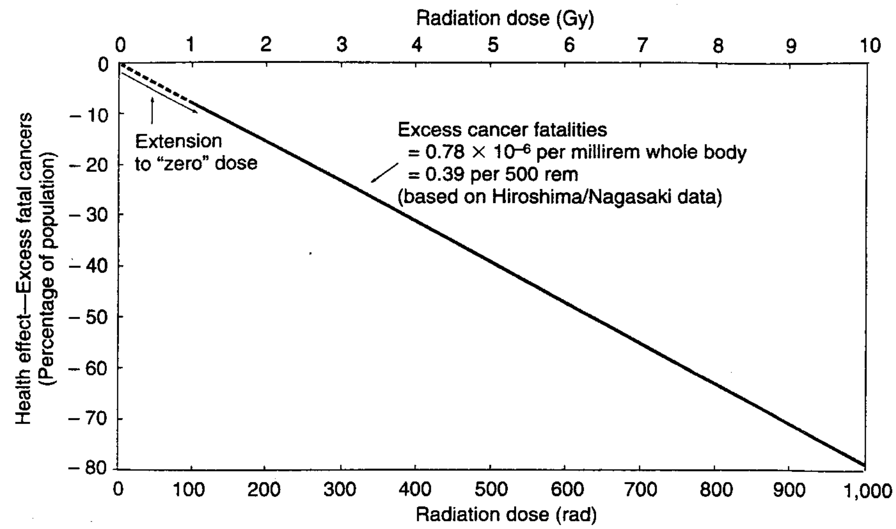


Figure 1
THE LINEAR DOSE-RESPONSE MODEL FOR RADIATION-INDUCED CANCER

The linear dose response model for calculating the risk of death from cancer as a result of radiation dose, takes the known cancer death rate from high doses, and extrapolates it down to "zero" dose (upper left of graph). This is done despite the fact that there are no data showing increased cancer risk at the lower dose region.

Source: Cuttler (Ref. 22)

This is the origin of the linear no-threshold or LNT model of radiation carcinogenesis. It derives from the hypothesis that a single impact of ionizing radiation on a cell causes an alteration, which could develop into a mutation, which could eventually become the first cancer cell in a tumor, which then could cause death. The likelihood of this transformation, from a normal cell to organism death, is assumed to be proportional to the radiation dose.

Statistically significant data on excess cancer deaths, which follow exposures to high radiation doses, are fitted by a straight line, which is then extended down to zero dose. This straight line goes through the entire lower-dose region where there was *no statistically significant* human data.

The LNT model for an acute (short-term) exposure is shown in Figure 1. This model is generally used to calculate the excess number of cancer fatalities following exposure to a low dose from a (human-made) source of radiation. A risk reduction factor, in the range from 2 to 10, may be applied to the integrated dose of a chronic (long-term) exposure at a low dose rate.

The increase in the average dose (above natural background radiation) received by the population from the human-made source is evaluated, and this average dose is multiplied by the slope of the LNT line to predict the increase in the normal fraction of these people who will die from cancer, instead of from a different cause. (In Canada, this is approximately 28 percent.) The incremental exposure received by a person from a human-made source is multiplied by this factor to determine his/her increased risk of dying from cancer.

Non-linear Effects and Non-scientific Influences

It is fascinating to review the early investigations that were carried out to determine what radiation does to living things. Thousands of these studies revealed a variety of beneficial health effects after exposures to low doses. Many people actually began to consume small amounts of a radium solution, sold in bottles as an elixir, until the practice was stopped after several well-publicized cases of radium poisoning caused by overconsumption.

Epidemiology on the famous radium dial painters by R.D. Evans identified a maximum body burden of radium (0.1 Ci), including a 10 to 100 safety factor, and a threshold (lifetime) skeletal dose (approximately 1,000 cGy), below which no long-term excess cancers or other adverse effects appeared.[3, 4]

Why was the very large amount of scientific information on beneficial effects and on thresholds for adverse effects ignored when the LNT model was formulated, and ignored again when more research was carried out?

To understand the answer, we have to consider the social and political environment at the time when the new radiation protection recommendations were formulated. Scientists were agonizing over their roles in the development and

How Radiation Is Measured

Radiation "dose," or "exposure," is a measure of energy absorbed per unit of mass. There are two sets of units used, the older units having been renamed.

For equivalent tissue damage from different types of radiation, the rem was defined as "rad equivalent man"—or rad times a quality factor. For gamma and beta radiation, the quality factor for most significant energies is 1, so "rad" and "rem" are taken as equal in these cases. For alpha rays and neutrons, the quality factor is greater, indicating that there is more damage from the same absorbed energy.

New unit	Old unit	Equivalent used here
1 gray (Gy) =	100 rad =	100 cGy (centi-gray)
1 sievert (Sv) =	100 rem =	100 cSv (centi-sievert)

actual use of atomic bombs in war. The creation of large stockpiles of more powerful nuclear weapons in several countries raised enormous moral issues and fears about their potential use.

Scientists realized they could not put "the genie back in the bottle," so they began to campaign against further A-bomb development, testing, and production, and for nuclear disarmament. Concerns began to be expressed about potential, long-term adverse health effects following exposures to very small amounts of radioactive fallout. Until that time, the information about beneficial health effects and thresholds had not been rigorously scientific.

Over the past 50 years, however, many research programs were carried out to study the incidence of adverse biological effects, measured at high doses and extrapolated linearly to zero dose. During the past 30 years, many observations of beneficial health effects were either ignored or suppressed.[5]

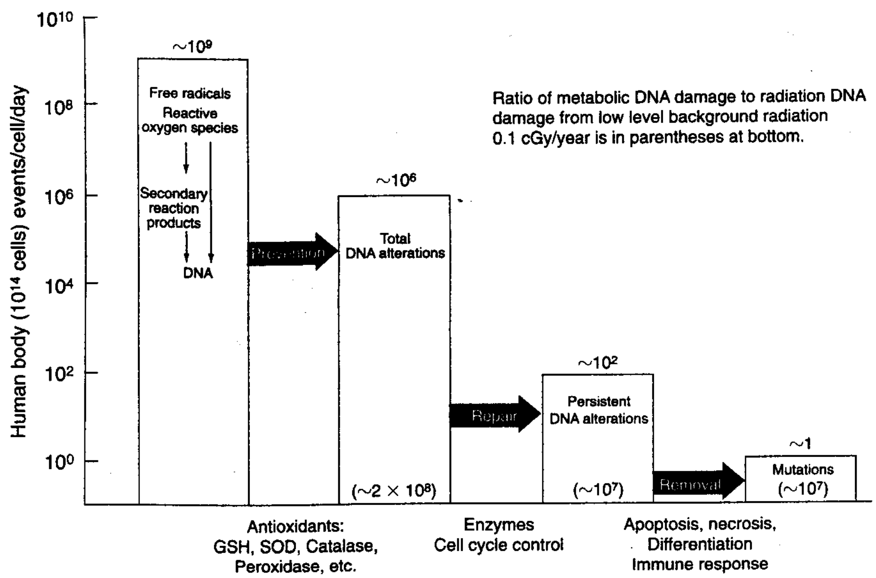


Figure 2
BIOLOGICAL MODEL OF DNA DAMAGE-CONTROL SYSTEM AT 0.1 cGy/YEAR NORMAL RADIATION

Low doses of radiation stimulate many cellular functions, including oxidation damage prevention, enzymatic repair, and immunological and apoptotic removal of DNA damage.

Source: Pollycove and Feinendegen (Ref. 11)

Atomic Bomb Survivors

The principal scientific evidence that supports the LNT model is the 1950-2020 Life Span Study of cancer mortality among the Hiroshima-Nagasaki survivors. The two A-bombs dropped in August 1945 killed between 150,000 and 200,000 of a total population of 429,000 people.[6,7] The Life Span Study sample of 86,572 people contains roughly half of the survivors who were within 2.5 km of the bombs.[8]

Based on the many concerns expressed over the past 50 years about the risk of fatal cancers from nuclear radiation, how many of the A-bomb survivors would we expect to have died from cancer, in excess of the normal incidence of cancer? Several people I asked recently indicated they would expect that in excess of 20 to 50 percent of the survivors would have died!

So, let us examine the recent data in Table 1.[8] It is very surprising to note only 334 *excess* deaths, 40 years after the event, among this very large group! Now, 36,459 people were far enough away to have received no significant radiation exposure, so we might consider the fraction 334 ÷ 50,113 = ~ 0.7 percent, or 334 ÷ 7,578 = 4.4 percent as the attributable risk. But the authors of this Life Span Study prefer the ratio [334 – (–42)] ÷ (7,578 – 3,013) = 8 percent. Of this group, 56 percent were alive in 1991, and 38,092 had died. So we could conclude that ~1 percent of them died from radiation-induced cancer.

Survivors under 20 years of age at the time of bombing constitute 40 percent of the population, but a much smaller fraction of the deaths, because cancers generally occur late in life. The final results will depend strongly on what happens to these survivors as they enter their cancer-prone years after age 50.

Those over 50 at the time of bombing did not live long enough to show evidence of radiation-induced cancer, because of the ~20 year latency period.

A-BOMB SURVIVORS' OBSERVED AND EXPECTED DEATHS FROM SOLID CANCERS (1950-1990)

Dose (Sv)	Dose (rem)	Number of Subjects	Observed Deaths (1)	Expected Background (2)	Excess Deaths [(1) – (2)]	Statistical Uncertainty* √(1) + (2)
0	0	36.459	3,013	3,055	–42	78
0.005-0.1	0.5-10	32,849	2,795	2,710	85	74
0.1-0.2	10-20	5,467	504	486	18	31
0.2-0.5	20-50	6,308	632	555	77	34
0.5-0.10	50-100	3,202	336	263	73	24
1.0-2.0	100-200	1,608	215	131	84	19
>2.0	>200	679	83	44	39	11
	Totals:	86, 572	7,578	7,244	334	

Among the atomic bomb survivors in Hiroshima and Nagasaki, there have been only 334 deaths from cancer in excess of the normal incidence of cancer in the population. Also, there are no significant excess deaths below a dose of 1 Sv (100 rem).

Source: Pierce et al. (Ref. 8) * My rough assessment—J.C.

Leukemia was the first malignancy to appear. By 1985 almost all the radiation-induced leukemias to be observed were recorded; the number of excess deaths determined is 87.

Nuclear scientist Ralph Lapp states there were approximately 300,000 survivors in 1950 when the Life Span Study was undertaken. He estimates that in 2020, about 800 will have died from A-bomb radiation, or about 0.3 percent of the Hiroshima-Nagasaki population. Because one of every four survivors (or 75,000) will die of cancer, one in a hundred of these deaths will be caused by the A-bomb radiation.[6]

A rough assessment of the statistical uncertainties (standard deviations) of the excess deaths in the table, indicates that they are quite large, below doses of 0.5 Sv (50 rem). And there is controversy over the Life Span Study rejection of the T65D type of dosimetry in favor of DS86 dosimetry, which underestimates the neutron contribution and leads to a much higher risk estimate. This suggests there are no significant excess deaths below a dose of 1 Sv (100 rem).

There is also no mention of important confounding factors for cancer incidence, such as the widespread, severe malnutrition, the pollution caused by the A-bomb blasts/fires; the psychological stress from burns, sickness, and loss of family members, friends, and homes; the loss of medical care, and so on.

Thus, the LNT model is not supported by any statistically significant evidence.[9] It should also be noted that there was no detectable increase in the incidence of mutations in the children or grandchildren of the A-bomb survivors.

The Nature of Cancer

Because fear of cancer is the issue, let us briefly examine the nature of cancer.[10] Cancer is a single disease and it is a hundred diseases. The unifying aspect of cancer is uncontrolled growth—the appearance of disorganized tissues that expand without limit, compromising the function of organs and threatening the life of the organism. Each cell type, each tissue, may spawn a distinct type of tumor with its own specific growth rate, prognosis, and treatability.

Virtually all malignant tumors are now thought to be monoclonal in origin; that is, the starting point for a tumor is a single abnormal cell, rather than a large group of normal cells being recruited by some agent into becoming cancer cells. Human tumors often become apparent only after they have grown to a size of 10 billion to 100 billion cells, in a person of 10 trillion to 100 trillion cells (cell weight is about 10^{-9} g).

Cancer is generally a disease of old people, because it usually takes a long time to accumulate the multiple mutations required to accelerate cell growth and disable growth suppression. To become a fatal tumor, a normal cell must undergo many changes—a long, complex series of successive changes in its behavior. Several decades must pass from the initiation of the tumor to its ultimate detection in the clinic.

The most disquieting fact about carcinomas is that they do not respect territorial boundaries. They grow locally and, eventually progressing further, shed small clumps of progeny cells able to start new colonies—so-called metastases—in other organs. These progeny cells travel through blood or lymph to lodge at distant sites.

Cancer cells evolve into a large number of diverse cells with new traits that allow them to grow more rapidly, compete more effectively with normal cells, and evade defenses. Tumor cell populations sooner or later exceed the ability of the host to nourish them. Often, long before that, tumors will compromise the functioning of a vital organ, leading to illness and then death.

The incidence of cancer increases exponentially with age, compatible with multistep, time-dependent tumor progression. For example, in the United States, the annual death rate from colon cancer rises from 14 to 83 to 400 per million, as people age from 40, to 60, to 80 years—a factor of ~6 and ~30. The risk increases approximately as the fifth power of elapsed time (Reference 10, p. 157).

What causes formation of abnormal cells or acceleration of the process leading to cancer? Many factors and carcinogens have been identified: genetics, diet, chemicals, biological agents, ionizing radiation, and so on. More are discovered every week, and the list appears endless. But recent research has revealed an immensely high rate of cell damage that is caused by normal metabolic activity as a result of attack by reactive oxygen species.[11]

Stimulation of Defenses

Living organisms have many defenses, both within and outside the cell, to prevent, repair, and remove cell damage.[11] These defenses can limit cell proliferation by signalling growth-factor rationing and growth-suppressor genes, and by other means. In addition to removing cells with persistent DNA damage, the immune system also plays an important role fighting certain types of cancers, especially if the

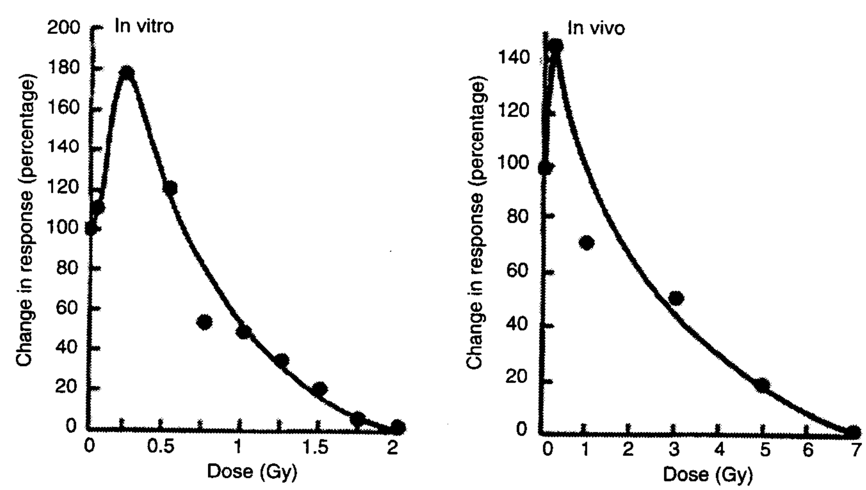


Figure 3
STIMULATION OF IMMUNE SYSTEM WITH RADIATION
Low-level radiation doses, such as a 10-fold increase in background radiation, stimulate prevention and repair of ongoing, natural DNA damage, in vitro and in vivo.
Source: Makinodan and James (Ref. 20)

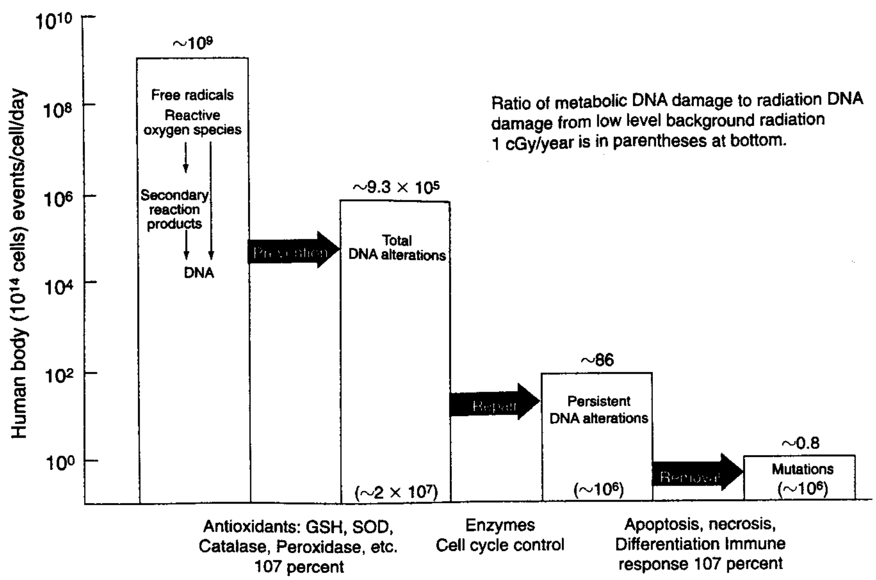


Figure 4
POTENTIAL EFFECT OF 1 cGy/YEAR BACKGROUND RADIATION ON RATE OF DNA MUTATION

Low-level radiation can decrease the gene mutation rate, thus decreasing mortality in general, and cancer mortality.

Source: Pollycove and Feinendegen (Ref. 11)

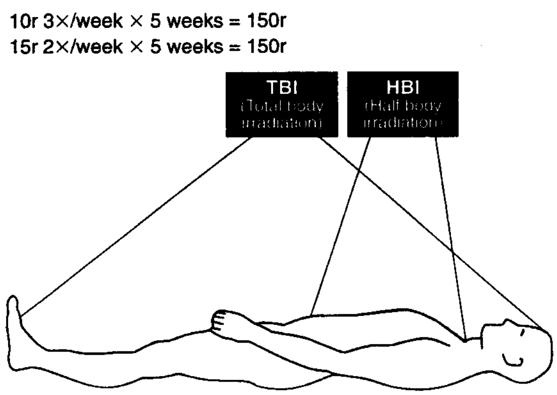


Figure 5
SCHEMATIC OF LOW-DOSE IRRADIATION THERAPY

Low dose irradiation therapy can be total body (TBI) or half body irradiation (HBI). Possible therapies are for 150 r, administered over five weeks, either three times a week at 10 r, or twice a week at 15 r.

immune system becomes stimulated.[11-13] Severe psychological stress, leading to depression and despair, adversely affects the defenses, creating hormonal imbalance and suppressing immune activity, allowing faster cancer progression.[14] As organisms age and mutations accumulate, their defense mechanisms become weaker and less effective in preventing new cancers and controlling the many cancers that have already started. For a long, healthy life, it is very important to maintain and enhance the performance of our natural defenses.

It was mentioned earlier that a large number of investigations were carried out over the past century into the effects of radiation on many different biological organisms, including plants. Many of these studies revealed significant beneficial health effects after exposures to low radiation doses. There is overwhelming evidence of this phenomenon,[15-20] and a model of the effect of ionizing radiation on living organisms has been provided by Pollycove and Feinendegen.[11]

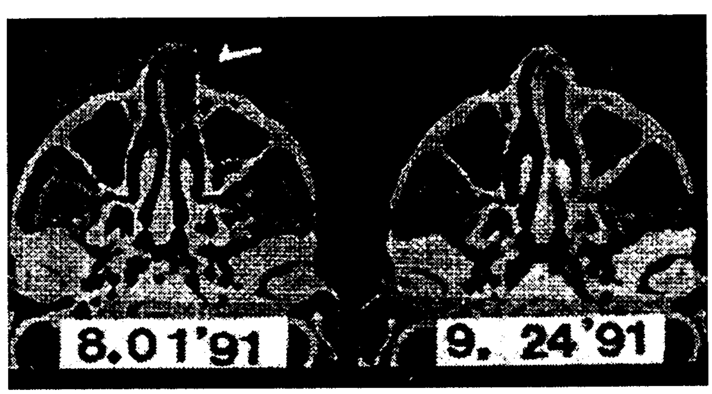
Recent studies show that low doses of radiation stimulate many cellular functions, including oxidation damage prevention, enzymatic repair, and immunologic and apoptotic removal of DNA damage (Figure 2). Acute, large doses (more than 50 cGy) impair these functions, causing adverse health effects. But chronic low doses, such as a 10-fold or even 100-fold increase in background radiation, stimulate prevention and repair of DNA damage and the immune system (Figure 3), which decreases the gene mutation rate (Figure 4), leading to the beneficial effects of decreased mortality in general and decreased cancer mortality specifically.

Therapeutic stimulation of these

Figure 6
SUPPRESSION OF CANCER IN UPPER NASAL CAVITY BY HALF-BODY LDI THERAPY

Research with mice, rats, and human beings has shown that low-dose body irradiation stimulates the immune system and prevents and removes cancer metastases, as shown here. Note the shrinkage of the tumor (see arrow) from August 1, 1991 (at left) to September 24, 1991 (right).

Source: Takai et al. (Ref. 21)



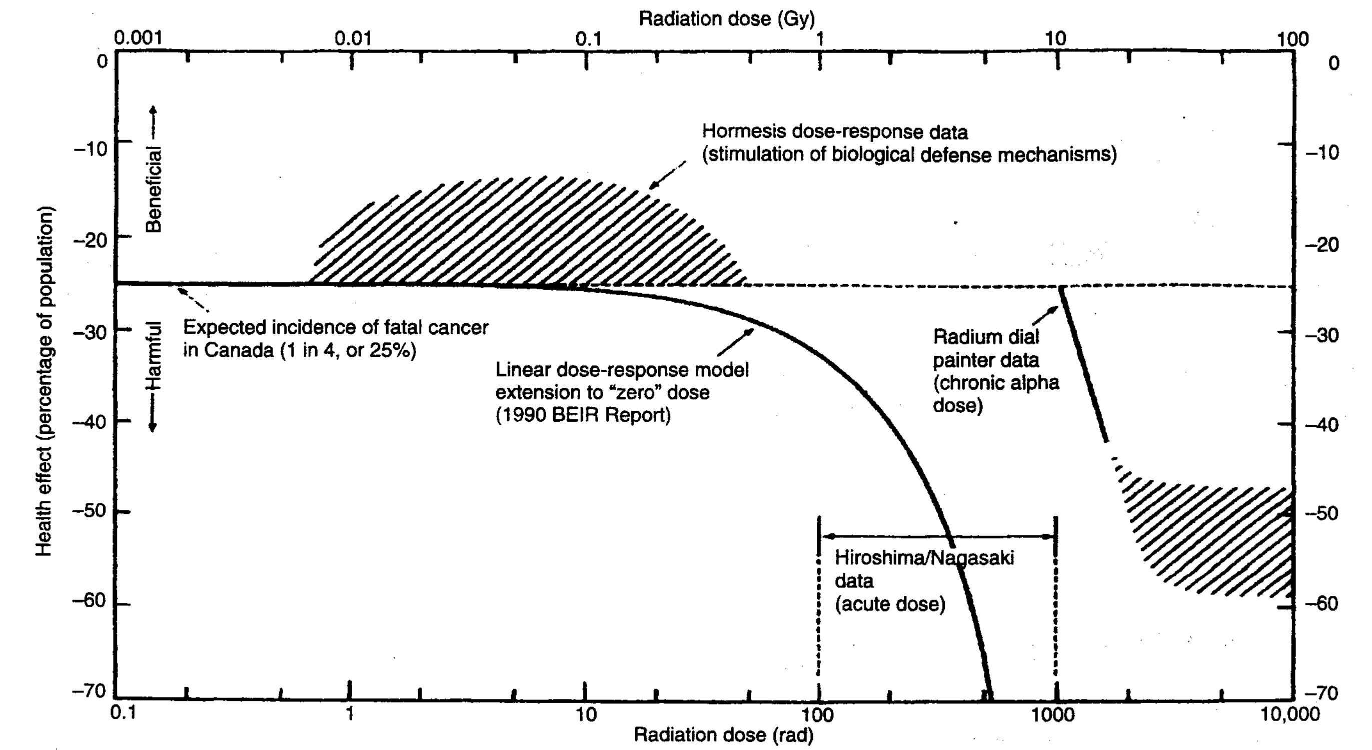


Figure 7

THE LINEAR MODEL WITH RADIATION DOSE ON A LOGARITHMIC SCALE

The beneficial effects of low-dose radiation can be seen in the hatched area above the dashed line, which marks the expected incidence of fatal cancers in Canada.

Source: Cuttler (Ref. 22)

defenses by low dose body irradiation (Figure 5) prevents and removes cancer metastases in mice, rats and humans (Figure 6).[21] The cell damage caused by the low dose radiation is insignificant compared to the metabolic oxidative DNA damage prevented, repaired, and removed by the stimulated defenses, leading to overall beneficial effects (Figure 7).[22]

Many medical studies have been carried out to determine the cancer risk after diagnostic and therapeutic treatments involving radiation, and there are very surprising results. The Canadian breast cancer study, published in 1989, compares breast cancer mortality with radiation dose, after fluoroscopic examinations for tuberculosis, between 1930 and 1952.[23] The plotted data from nine provinces (Figure 8) show a surprising decrease in risk at low doses (34 percent and 16 percent at the dose points of about 15 cGy and about 25 cGy).[24]

A recent study of hyperthyroidism treatment using radioiodine (at an average total dose of about 300 MBq, 50,000 cGy to the thyroid and 28 cGy

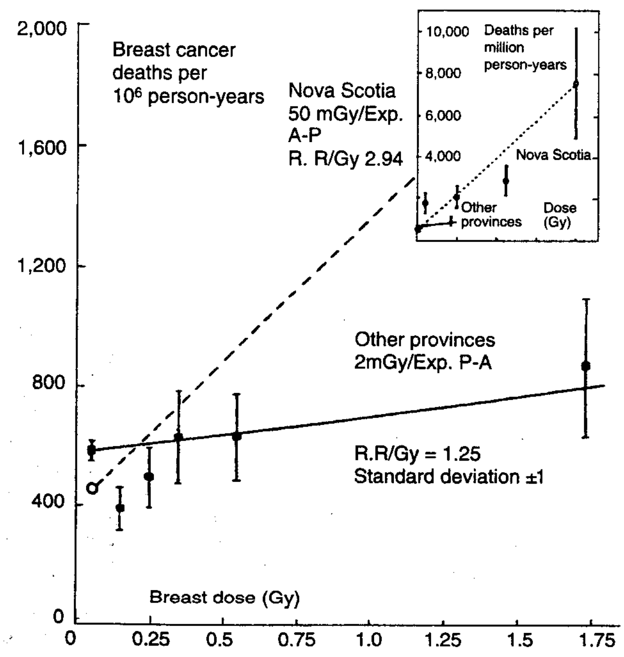
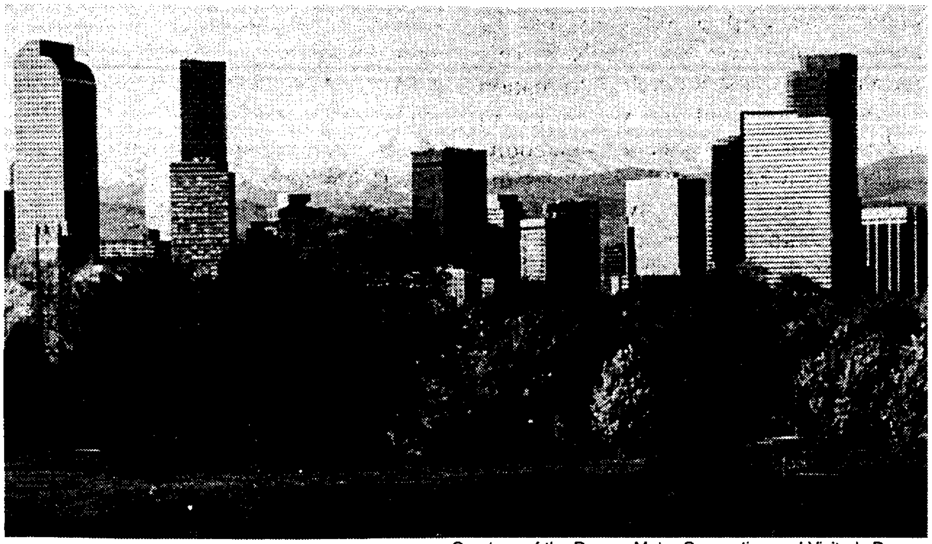


Figure 8

CANADIAN BREAST CANCER STUDY, AFTER FLUOROSCOPY EXAMINATIONS FOR TUBERCULOSIS

A Canadian study looked at breast cancer mortality rates of women who had fluoroscopic examinations for tuberculosis, between 1930 and 1952. The data from nine provinces show a surprising decrease in cancer for women who received low doses (34 percent and 16 percent at the dose points of approximately 15 and 25 centi-gray). The data show a reduction of 10,000 cancers in 1 million women who were actually exposed to 15 centi-gray, *instead of the linear conclusion that there would be 900 excess cancers expected at that dose.*

Source: Webster (Ref. 24)



Courtesy of the Denver Metro Convention and Visitor's Bureau

Residents of Denver typically get more background radiation, because of its higher altitude, than those who live in low-lying areas. The evidence indicates that there are health benefits from this radiation.

whole body) revealed a significantly lower cancer incidence and a lower cancer mortality.[25]

Japanese scientists, in fourteen universities and two research institutes, have been studying the beneficial effects of low radiation doses for 20 years, and they have found remarkable bio-positive effects,[18] including these:

- rejuvenation of cells (increase of SOD and cell membrane permeability)
- moderation of psychological stress through stimulation of key enzymes
- suppression of and therapy for adult diseases, such as diabetes and hypertension
- suppression of cancer through enhancement of the immune systems
- suppression of cancer and radio-adaptive response by activation of DNA repair and cell killing.

Therapeutic Applications

One of these Japanese scientists, K. Sakamoto, provided total-body low-dose irradiation (LDI) therapy (using 6 MV X-rays) in conjunction with local, high-dose palliative radiation treatment to a patient with advanced ovarian cancer, after surgery. The LDI therapy, 15 fractionated doses of 10 cGy over a five-week period, achieved total elimination of the cancer metastases.

This success led to a program of LDI therapy for approximately 150 non-Hodgkin's lymphoma patients, including many intermediate and high-grade cases. This LDI therapy was given to patients who had previously received localized high-dose radiation and chemotherapy, and did not get better. Sakamoto found that the LDI enhanced their immune systems and other defenses, thereby achieving many cures, which have lasted more than 10 years.

Figure 9 shows that the recurrence-free survival rate of non-Hodgkin's lymphoma patients was increased by this therapy from about 50 percent to about 84 percent.[26] Despite these excellent survival rates, this controversial program ended recently when Dr. Sakamoto retired.

Similar effectiveness of the LDI therapy for non-Hodgkin's lymphoma had been noted at the Harvard Medical School in the 1970s, and more recently in France.[27] This success has led to the recent approval of a proposal for a clinical trial of LDI therapy in Europe.[28]

A comprehensive review of this application of low dose radiation therapy indicates that significant therapeutic benefits can be expected.[29] Nevertheless, oncologists seem to be very reluctant to use, or even consider, this therapy. For example, I note the current experiences of an American patient who has been requesting LDI therapy for a rare form of lymphoma (blood cancer). Only one oncologist, at the Johns Hopkins Medical Institute, was willing to provide this therapy. The patient's improvement observed after this treatment has been comparable to that achieved with chemotherapy, but with no symptomatic adverse side effects.[30]

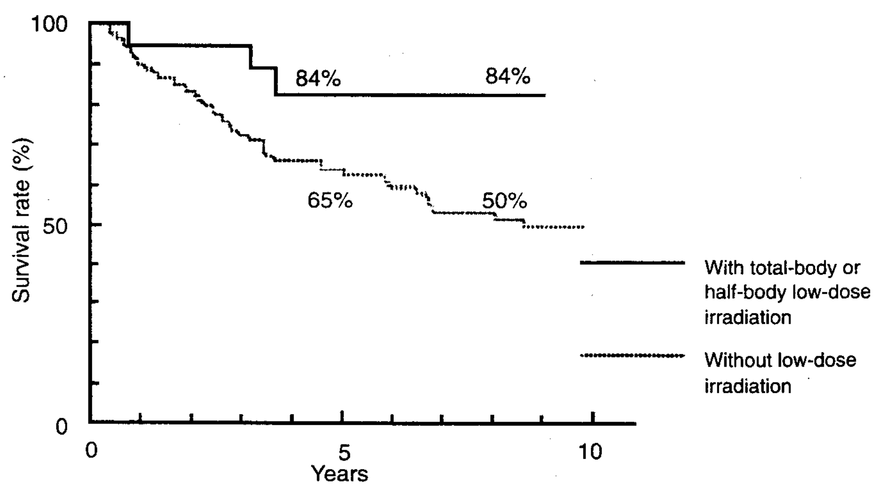


Figure 9

SURVIVAL RATES OF NON-HODGKIN'S LYMPHOMA PATIENTS WITH AND WITHOUT TOTAL- OR HALF-BODY LOW-DOSE IRRADIATION

These are the 9-year survival data reported by Sakamoto et al. of 23 low-dose radiation patients and 94 control patients with similar histological tumor grades. The survival rate of the low-dose radiation patients is 84 percent, compared with 50 percent survival of the control patients. The 12-year survival rate of the low-dose patients remains at 84 percent.

Source: Sakamoto et al. (Ref. 26)

Chernobyl and UNSCEAR 2000

April 26, 2001 was the 15th anniversary of the tragic Chernobyl accident, an accident that set off immediate, very strong reactions of fear and outrage throughout the world. Many people expected that the radioactivity released at Chernobyl would cause millions of cancer deaths and the birth of abnormal babies. The reality, however, is totally different.

The reality was documented in the 1,220-page *UNSCEAR 2000 Report: Sources and Effects of Ionizing Radiation,* that was released in June 2000[31] and tabled in September 2000 at the United Nations General Assembly. (UNSCEAR is the United Nations Scientific Committee on the Effects of Atomic Radiation.) It took the 146 committee members and staff from 21 countries, six years to collect and study the facts in 5,400 documents, in order to prepare the 20-page summary and 10 annexes of technical details.[32] This report is the most credible information on this subject, and was written by an independent, non-nuclear organization.

The UNSCEAR report compares the radiation dose that an average person receives from all types of natural and human-made sources. It estimates the health effects of this radiation, including those caused by the Chernobyl accident.

The average natural radiation dose is 2.4 mSv (0.24 rem) per year, but the report presents data (Figure 10) indicating that ambient radiation levels are many tens and hundreds times higher in some geographical regions where many people live. No adverse health effects related to radiation were ever observed among populations exposed to such high natural doses.

Human-made radiation sources expose the average person annually to much less radiation; for example, 0.4 mSv (0.04 rem) from medical diagnostics; 0.1 mSv (0.01 rem) from A-bomb tests in the 1960s; 0.05 mSv (5 millirem) from the Chernobyl accident; and less than 0.01 mSv (1 millirem) from nuclear electricity. Because radiation from natural or human-made sources affects living cells in the same way, we should not expect the health effects to be any different for those who receive the same dose from either source, in the short-term or the long-term.

Now, on Chernobyl: Of the 134 Chernobyl employees who developed symptoms of acute radiation disease, 28 died from radiation sickness and two died as a result of fire and falling objects—all the others with the symptoms of acute radiation disease recovered. Many emergency workers came to the station to remove radioactive debris, so as to allow the staff to continue operating the other three reactors. No

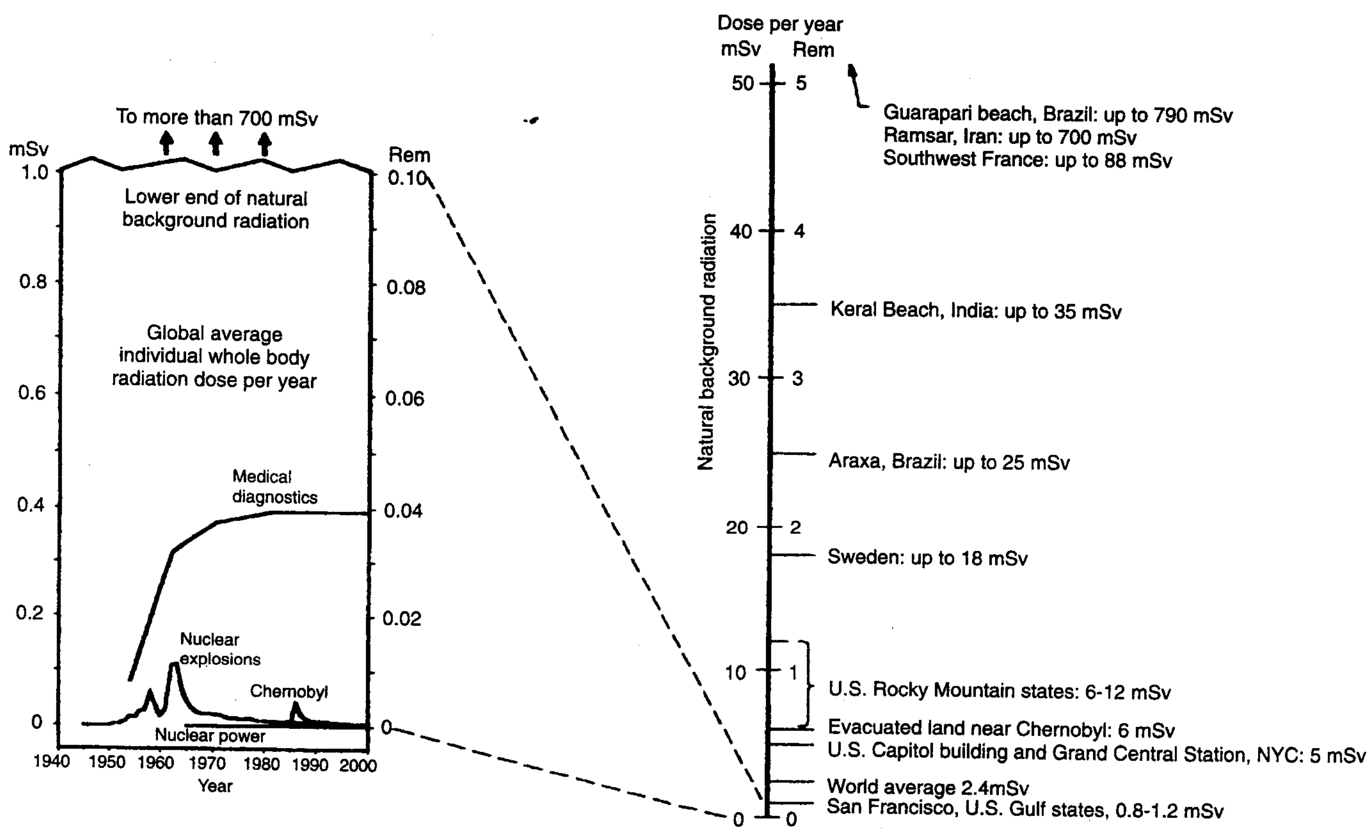


Figure 10

COMPARISON OF NATURAL AND HUMAN-MADE RADIATION, AVERAGE ANNUAL DOSE (1940-2000)

The average natural background radiation dose is 2.4mSv (0.24 rem) per year, but in many areas, the radiation levels are much higher, because of the altitude or mineral deposits in the soil. The human-made radiation dose to individuals per year is much smaller—for example, only 0.4 mSv (0.04 rem) from medical diagnostics.

Source: Rockwell (Ref.39); some data are adapted from Zbigniew Jaworowski's paper at the International Conference on Radiation, Teheran, Iran, Oct. 18-20, 2000, based on UNSCEAR figures increases above the normal incidences of cancers or leukemias for the population as a whole were observed among these 381,000 clean-up workers.

The authorities moved 116,000 people from their homes in 1986, and 220,000 more later, in order to avert a lifetime (70-year) dose of more than 350 mSv (which is double the world's natural average background radiation), even though many people live very healthy lives in areas that are much more radioactive.

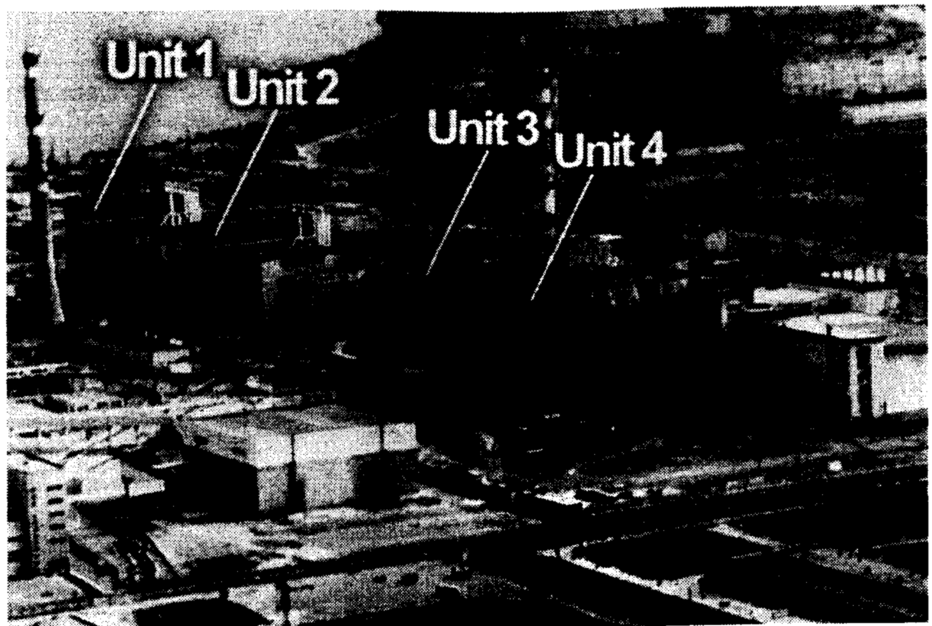
Careful health screening of all the people in the Chernobyl area began in 1986. Nothing like this thorough health program had existed before in the area. So far, this has identified a total of about 1,800 thyroid cancers. Before the accident, the incidence of thyroid cancers noticed in children was ~0.2 per 100,000 in Belarus and Ukraine; no data are available from Russia. The maximum incidence rates registered in 1987 to 1998 were as follows: Belarus 17.9, Ukraine 4.9 and Russia 26.6 per 100,000 children.

Does this mean that these cancers were caused by the accident? Normally, it takes 10 or more years for cancers to develop, if radiation is the cause, but half of these thyroid cases were found sooner than that (in Russia, for instance, in the second year after the accident, there were 9.1 cases per 100,000).

Also, the number of these thyroid cancers is *lower* in areas of higher dose! Could they be occult (small, stable) thyroid cancers? These happen naturally, and rarely cause medical problems.[33] Typically, there are many thousands of such thyroid cancers in a population of 100,000. The number varies according to geographic location, and depends on many different factors.

In the United States, there are 13,000 such cancers per 100,000 people (and 24,000 thyroid cancers per 100,000 in Hawaii). Is it therefore valid to conclude that there was an increase in thyroid cancer incidence after the Chernobyl accident, when there was no equivalent screening before the accident?

In a report of the U.S. National Council on Radiation Protection on thyroid cancer,[34] we have the remarkable statement that, "available human data on low dose I-131 [Iodine-131] exposures have not shown I-131 to be carcinogenic in the human thyroid." The National Cancer Institute carried out a 14-year study of thyroid cancers found all over the United States, in the 30-year period after the 100 A-bomb tests in Nevada, in the 1950s and early 1960s. The 1997 report compared the number in each area with the amount of radiation, and did not find any evidence to associate thyroid cancer to this radiation.[35-36]



Courtesy of Pacific Northwest National Laboratory, Soviet-Designed Reactor Safety System

The four 1,000-MW nuclear reactors at Chernobyl. Unit 4 is the damaged reactor.

So, it seems that the 1,800 "excess" thyroid cancers, in the Chernobyl screening, were *not* caused by radiation.

The UNSCEAR report concludes that no increases in cancer incidence or mortality have been observed that could be attributed to ionizing radiation; that the risk of leukemia does not appear to be elevated, even for the clean-up workers; and that there is no evidence of other non-malignant disorders that are related to radiation.

There were many psychological reactions to the accident, the UNSCEAR report states, but these were caused by fear of the radiation, not the actual radiation. In other words, there is no need for anyone to live in fear of serious health consequences from the Chernobyl accident. For the most part people were exposed to radiation levels comparable to, or only a few times higher than, the average natural background level.

Policies and Myths

Policies and myths that were created half a century ago by the International Commission on Radiation Protection (ICRP) have convinced many people that radiation is harmful in any amount. The regulatory authorities, and many research scientists, continue to ignore statistically significant evidence that contradicts this linear no-threshold view of radiation. They simply ignore both the evidence that shows there are no adverse effects from high levels of natural radiation in many regions, and the evidence that low doses of radiation received by nuclear workers and medical patients (including cancer patients) provide significant overall beneficial health effects.

The ethics of the International Commission on Radiation Protection's behavior is being questioned and debated in the scientific community,[37, 38] but there is enormous bureaucratic resistance to any change that would disturb the billions of dollars of research money and clean-up funding flowing as a result of the linear no-threshold myth.[40]

Most damaging is the public fear that this myth perpetuates, making it difficult for many scientists to present the real evidence of the beneficial effects of low-level radiation that have been observed on humans and other living things. It is, therefore, not surprising that the very important UNSCEAR 2000 Report received very little publicity.

So, the myths about cancer and abnormal babies will continue, as scientists carry out more and more politically correct and politically funded research on the response of cells and mice to radiation.

The linear no-threshold myth blocks efforts to supply reliable, environmentally friendly nuclear energy, to power the world economies. It also blocks the widespread use of low-dose radiation therapy to cure or control cancer and other diseases. In the name of "protection," it is actually causing harm.

How long will it be before concerns about energy supplies and cancer death rates will cause people to pay attention to the actual scientific results, discount the myths, and take action to reap the great societal benefits?

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