Canadian Nuclear Society Toronto Branch
2011 March 28

Is Supply of More Nuclear Energy to the People of Ontario
Environmentally and Socially Acceptable?

Jerry M. Cuttler, DSc, Cuttler & Associates Inc.
Mississauga, Ontario
Myron Pollycove, MD, School of Medicine
University of California San Francisco

McMaster Prof. (retired) Bill Garland asked the CNS members to intervene, so I wrote an intervenor submission

Canadian Environmental Assessment Agency www.ceaa-acee.gc.ca

Darlington New Nuclear Power Plant Project

http://www.ceaa.gc.ca/050/05/index-eng.cfm?evaluation=29525

Hearing Documents

http://www.ceaa.gc.ca/050/05/documents-eng.cfm?evaluation=29525&type=2

11-P1.58A Written Submission by Cuttler & Associates Inc

http://www.ceaa.gc.ca/050/document-eng.cfm?document=47803

PMD 11-P1.58A

File / dossier : 8.01.07
Date: 2011-02-07
Edocs:3675003

Written submission from Cutter & Associates Inc.

Mémoire de Cuttler & Associates Inc.

In the Matter of

À l'égard de

Ontario Power Generation Inc.

Ontario Power Generation Inc.

Environmental Assessment pursuant to the *Canadian Environmental Assessment Act* of a proposal by Ontario Power Generation for a Project that includes site preparation, construction, operation, decommissioning and abandonment of up to four new nuclear power reactors at its existing Darlington Nuclear Site located near Oshawa, Ontario, in the Municipality of Clarington and a Licence to Prepare a Site application for the Project under the *Nuclear Safety and Control Act*.

L'évaluation environnementale, en vertu de la *Loi canadienne sur l'évaluation environnementale*, du projet d'Ontario Power Generation qui inclut la préparation de l'emplacement, la construction, l'exploitation, le déclassement et l'abandon de jusqu'à quatre nouveaux réacteurs nucléaires sur le site de la centrale nucléaire Darlington près d'Oshawa (Ontario), dans la municipalité de Clarington, et une demande de permis de préparation de l'emplacement, aux termes de la *Loi sur la sûreté et la réglementation nucléaires*.

Public Hearing

Audience publique

March 21, 2011

Le 21 mars 2011

Canada

Darlington New Nuclear Power Plant Project
Environmental Impact Assessment – Public Hearing beginning on March 21, 2011
Written Submission to the Joint Review Panel

Is the Supply of More Nuclear Energy to the People of Ontario Environmentally and Socially Acceptable?

By Dr. Jerry M. Cuttler, D.Sc., P.Eng.

Introduction

Since the Pickering A Nuclear Generation Station began supplying affordable electricity to the people of Ontario forty years ago, in 1971, our use of nuclear energy has grown substantially. In the 1990s, we had twenty working reactors that supplied two-thirds of our needs. Today, two of the Pickering A units have been shut down and two of the Bruce A units are being refurbished. The remaining 16 units now provide about 50 percent of our needs. Our nuclear plants have been ageing and their equipment is becoming increasingly obsolete. With the present concerns about environmental pollution from coal and gas-fired power plants and about the long-term availability of gas (methane) at an affordable price, it is very important that we refurbish our existing nuclear plants and build new ones. Many wind generators have been constructed in Ontario over the past five years, at great cost, to exploit this "renewable" form of energy; however, it is as unreliable as the wind itself. Windmills cannot supply a significant fraction of our vital needs without full backup from gas-fired generators. The August 14, 2003 blackout reminded us that "nothing works without electricity." The Canadian Nuclear Society provides an Internet website that shows where Ontario's electricity comes from at this hour (CNS 2011).

Nuclear Energy and the Environment

Nuclear energy has been very good for our environment. The air, water and land around nuclear plants are clean and healthy. Their design, construction, operation and decommissioning are performed carefully, based on many plant-years of shared knowledge and experience. Releases of radioactivity are typically a hundred times below the regulatory limits, which are far below any hazardous levels. The mining and processing of uranium into fuel are carried out under strict regulations. The used fuel is stored safely in deep water pools for five to ten years and then transferred into robust containers made from steel and reinforced concrete, which will remain leak tight for thousands of years. No containers have leaked, and no living organism is exposed to any harm from the used fuel.

Some people are concerned about the long-term management of our used fuel because some of the radionuclides in this material, including most of the original uranium, will remain radioactive after tens of thousands of years. They should be informed that less than one percent of the energy in this material has been released in our CANDU plants. When our low cost uranium resources become scare, future generations of Canadians will build nuclear energy plants of a

1781 Medallion Court, Mississauga, Ontario, L5J 2L6, 416 837 8865, jerrycuttler@rogers.com

Written Submission

Introduction

- Pickering started 40 years ago
- Nuclear supplied 2/3 of 1995 demand
- Now (old) nuclear supplies >50%
- Need to refurbish our nuclear plants and build new nuclear plants
- Concerns about carbon combustion (AGW); affordable methane
- Many windmills built at great cost, but unreliable like the wind itself
- Windmills need full back-up from gas-fired generation
- Nothing works without electricity
- CNS website link “Where Ontario’s electricity comes from this hour”

Nuclear Energy and the Environment

- Nuclear has been very good—the air, water and land: clean and healthy
- All nuclear activities based on many years shared info and experience
- Radioactivity releases > 100 times below regulatory limits
- Used fuel stored safely in deep pools and steel and concrete containers that will be leak tight 1000s years; no organisms exposed to any harm
- < 1% of U energy released in plants
- Future generations Canadian, smarter than us, will build breeder reactors and recycle our used fuel when low-cost uranium becomes scarce
- Long-lived nuclides turned into short-lived; final waste will be small
- Fission 1 atom of U and get 40 million times energy from 1 atom carbon

Comparing the Energy Release
Burn Carbon or Fission Uranium

Carbon + Oxygen → CO_2 + 4.1 eV

Uranium + n → 2FP + 2.5n + 160,000,000 eV

Nuclear energy is 40 million times more concentrated!

~ 40 million times less waste volume

Darlington Site

- Location for the new 4800 MW plant is already a licensed nuclear site
- The 3600 MW DNGS been operating economically for > 20 years without any significant adverse impact on the environment (included Bob Strickert's 1996 presentation to KAIF for CANDU 9 marketing)
- Site is near large load centres
- Adequate land and cooling water
- Share common facilities: roads, power lines, TRF, environmental info

Performance of Darlington (1995)

- Station Facts: Put in service 1990-3, 4 units rated 881 MW net, SDS1, SDS2, ECI, Containment, submerged water intake and discharge, 4 standby generators, 2 emergency generators, TRF, 1600 regular staff
- Superior safety: very few reactor trips, good safety system availability, low radiation dose to employees (below BWR, PWR)
- Competitive: prod. cost 1.05 cents/kWh includes corporate ovrhd, PUEC 0.89 ¢/kWh, Fuel 0.26 ¢/kWh includes permanent disposal provision of 0.09 ¢/kWh (Bruce B prod. cost 1.30 ¢/kWh in 1995) capacity factor 89.2%, net output 27.54 TWh
- Harmony with community and environment: radioactive waste is below target and stored at BNPD, fuel burn-up 194.3 MWh/kgU is above target and improving, radiological emissions are very low (< 5 microSv/y living at the fence) and published every 3 months, strong partnerships with community: open dialogue, participation in site planning, many benefits to local community

Type of Reactor for New Build

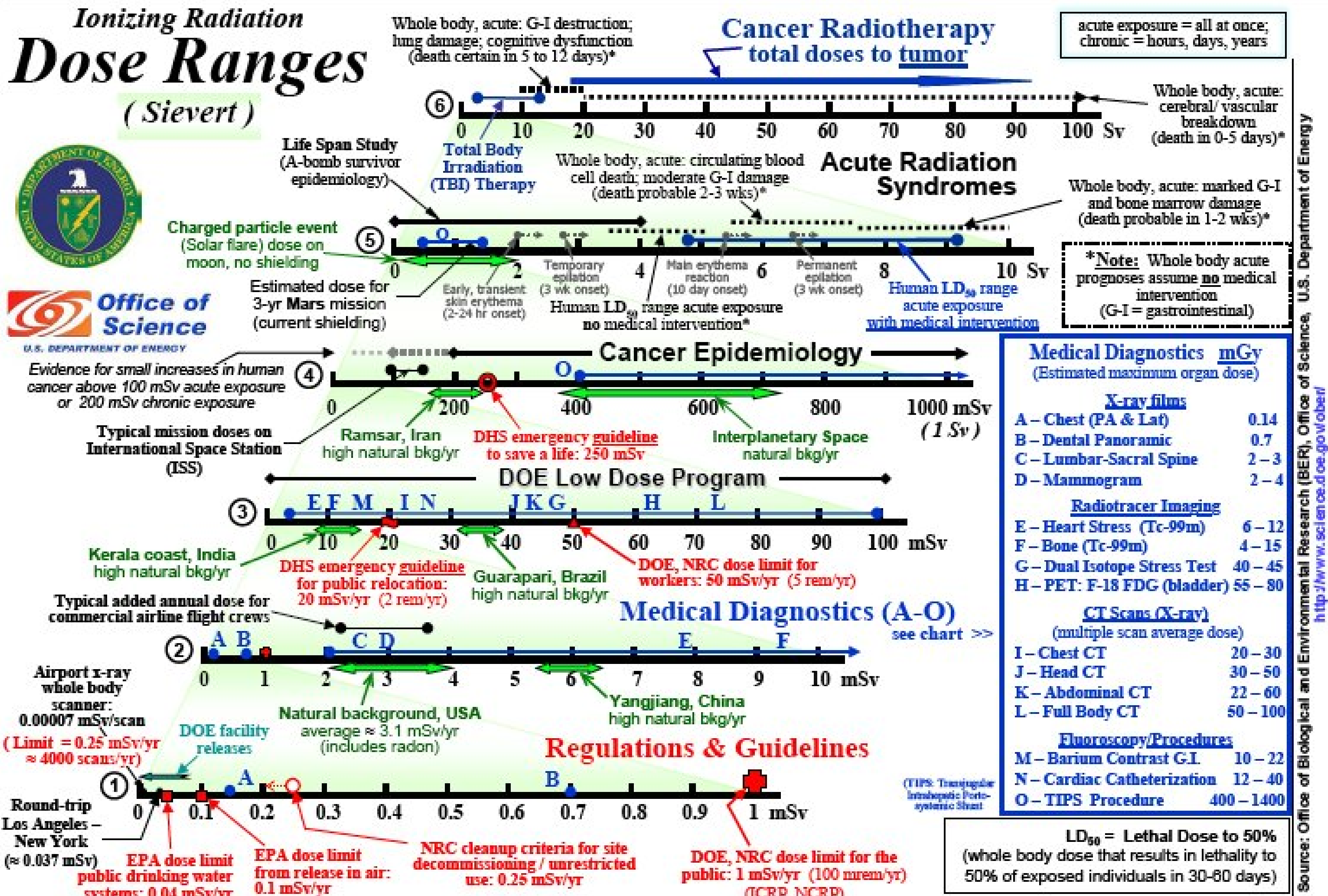
- CANDU 6 design like Qinshan reactors is available and licensable
- CANDU 6 was designed to load follow (normal mode of operation) from 60 to 100% FP; can increase nuclear share beyond the base load requirement to 75% of load
- CANDU 9 design, a Darlington-size reactor in a CANDU 6 type building, was prepared for Wolsong site and CNSC reviewed it.
- CANDU 9 is a better choice because it would provide more power and more commonality with existing Darlington equipment
- ACR more risky: uses enriched fuel, which adds cost and complexity; reactor performance uncertain; reliability of fuel bundle unproven
- We have knowledge and experience with conventional CANDU reactors; just as safe if not safer than any other reactor design
- We can build and operate CANDUs (vs. LWRs) at low project risk and high Canadian content for labour and materials

Social Acceptance

- Most Ontarians support current supply of electricity using Canadian nuclear technology
- Most would not oppose additional plants on Darlington site.
- This support is constrained by prevalent fear of nuclear radiation that has been exploited for many decades by well-organized lobby of anti-nuclear political activist groups.
- Raise radiation safety concerns; oppose nuclear plant construction, management of used fuel and transport of nuclear materials
- Widespread radiation scare created after nuclear weapons used in WW II, which led to testing of larger bombs and buildup of stockpiles
- New radiation dose idea introduced; changed safe dose threshold to linear no-threshold assumption; persistent cancer and genetic risk, to be minimized by ALARA
- Radiobiology became politicized → a heavy economic burden of regulatory scrutiny and licensing on radiation equipment/substances

Radiobiological Evidence

- Many researchers have been studying effects of low doses on health
- They found that low level radiation actually reduces the natural cell mutation rate in most living organisms by stimulating their protective mechanisms, which prevent cell damage, repair damaged cells and tissues and destroy/remove damaged cells including cancer cells
- Based upon human data, single whole-body dose of 150 mSv (15 rem) is safe. The high natural radiation level of 700 mSv/year (70 rem/year), corresponding to a 70-year lifetime dose of 49 Sv in Ramsar, Iran, is also safe. Both these single and continuous doses are also beneficial. This conclusion is applicable to humans of all ages and to sensitive, cancer-prone individuals.
- DOE radiation dose chart below shows some of the scientific knowledge developed over the past century

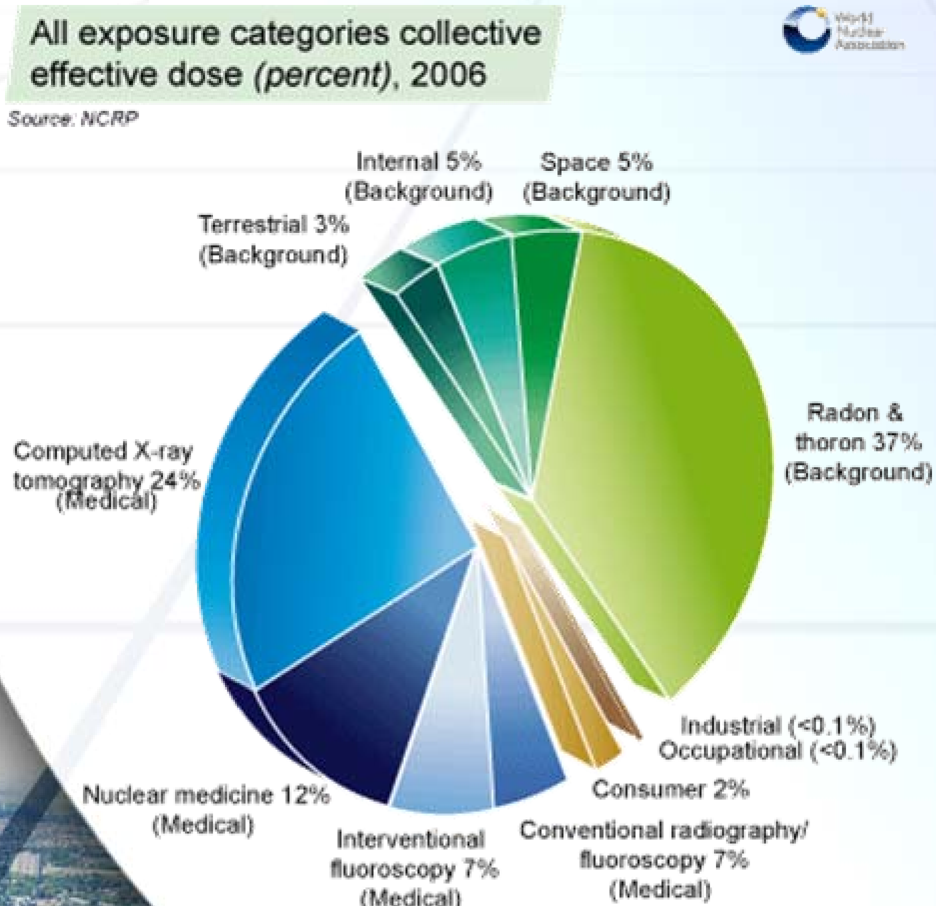


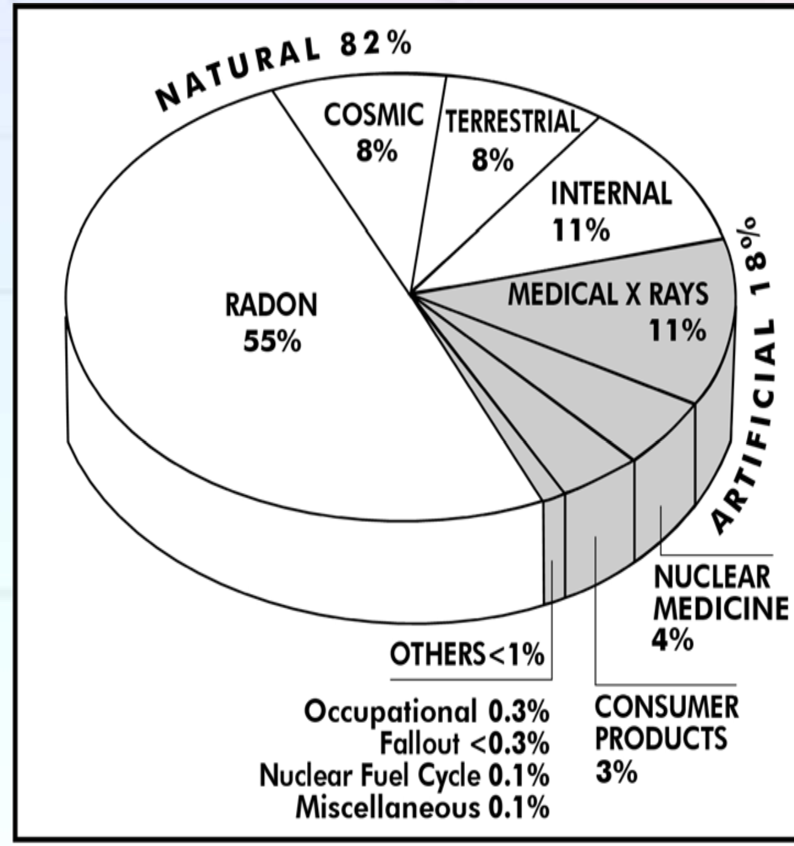
NOTE: This chart was constructed with the intention of providing a simple, user-friendly, "order-of-magnitude" reference for radiation exposures of interest to scientists, managers, and the general public. In that spirit, most quantities are expressed as "dose equivalent" in the more commonly used radiation protection units, the rem and Sievert. Medical diagnostics are expressed as estimated maximum organ dose; as they are not in "effective dose" they do not imply an estimation of risk (no tissue weighting). Dose limits are in effective dose, but for most radiation types and energies the difference is numerically not significant within this context. It is acknowledged that the decision to use these units is a simplification, and does not address everyone's needs. (NRC = Nuclear Regulatory Commission; EPA = Environmental Protection Agency; DHS = Department of Homeland Security)

Chart compiled by NF Metting, Office of Science, DOE/BER. "Orders of Magnitude" revised June 2010
http://www.lowdose.energy.gov/

Dose Equivalent: 1 Sievert = 100 rem
= (absorbed dose x radiation quality)
Absorbed Dose: 1 Gray = 100 rad
1 Sv ≈ 1 Gy for x- and gamma-rays
(" ≈ " stands for "approximately equal to")

Sources of Radiation in the United States 2006 vs 1980s



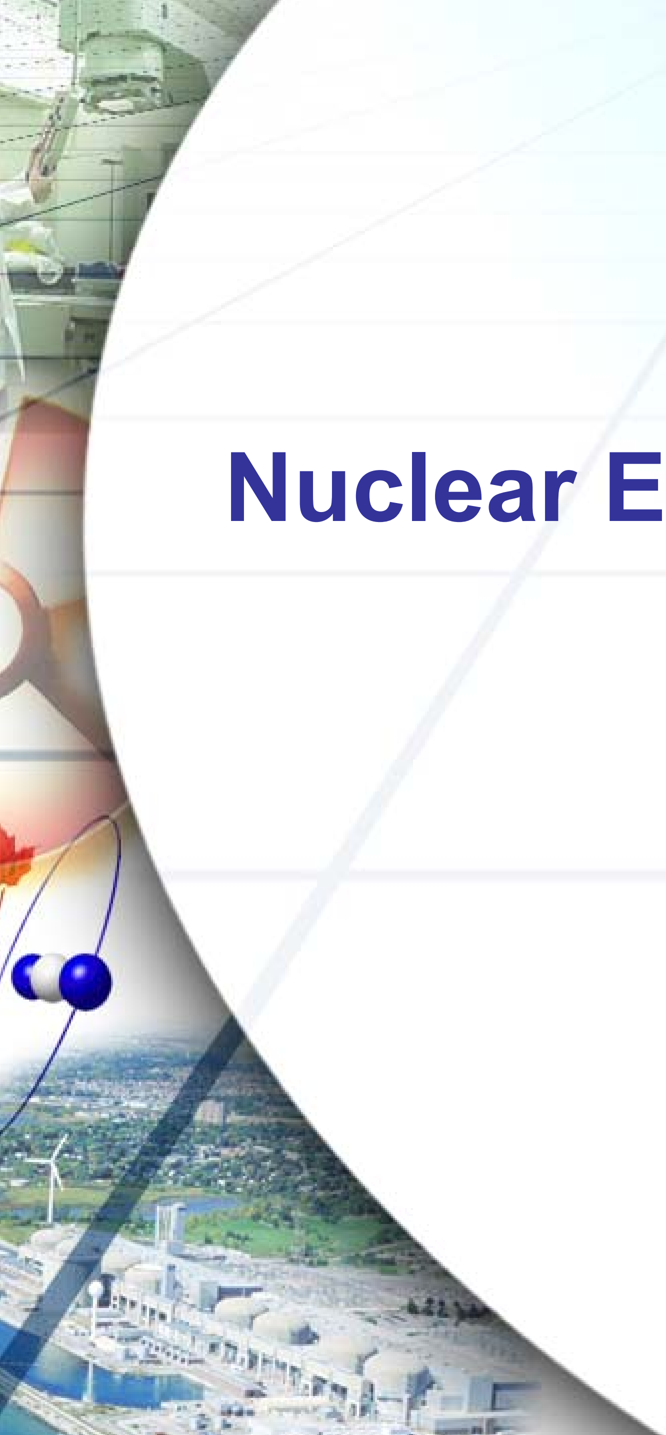


Source: NCRP, 1987

Recommendations

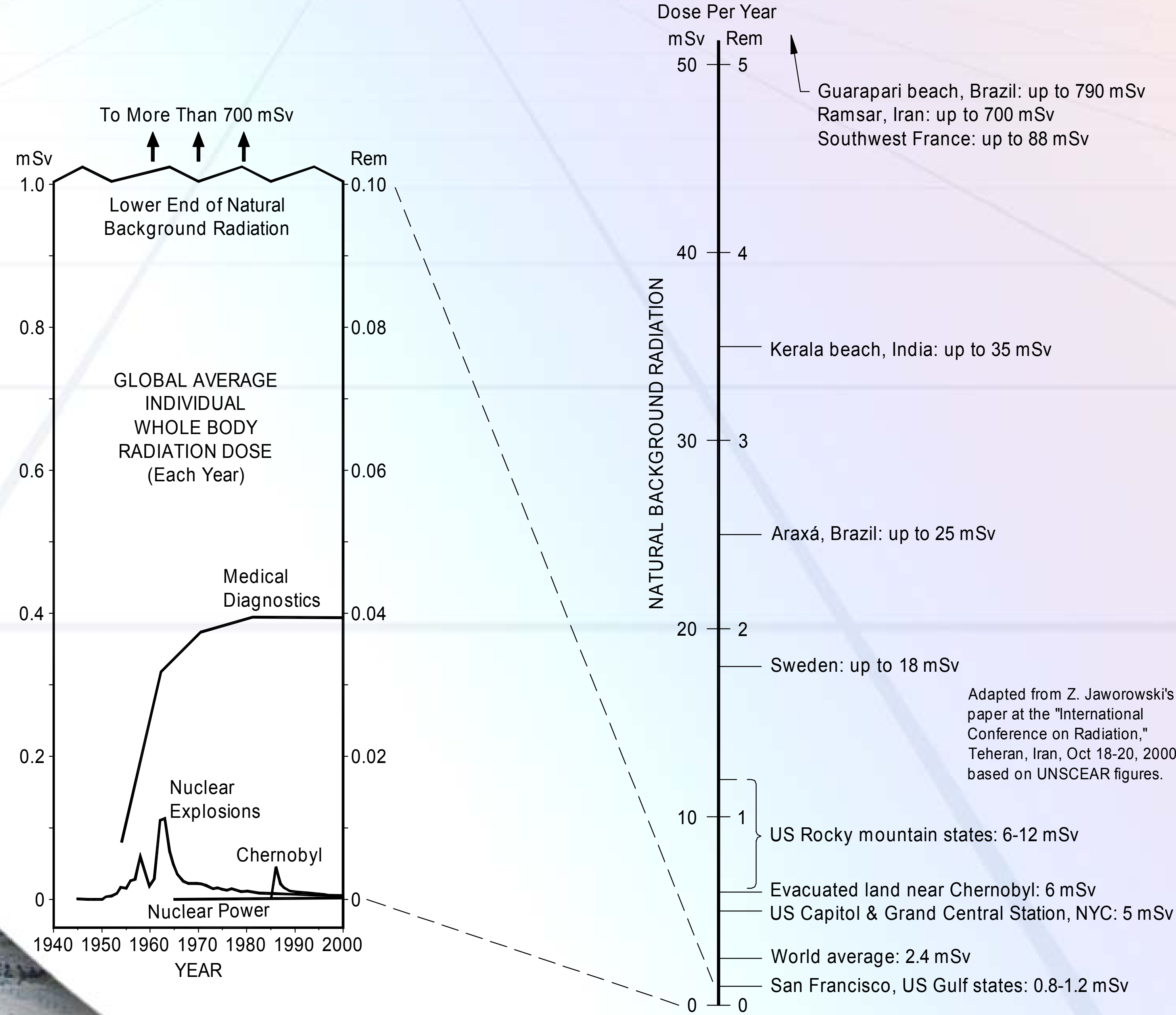
1. Ontario to proceed with plan to build additional nuclear plants at Darlington site. They are needed and are good for environment
2. Canadian government organizations that regulate use of ionizing radiations and nuclear technologies to study the recent scientific information about the health effects of low radiation doses and low level radiation, especially their beneficial effects. Radiobiologists, medical scientists and radiation protection organizations should do likewise.
3. Our government to prepare and implement a plan to communicate this factual information about radiation to the media and to all Canadians.

Result: 1. abundant new supply of affordable and sustainable electricity that is environmentally benign, 2. debunk the radiation scare, allowing Canada's nuclear energy industry to move forward again

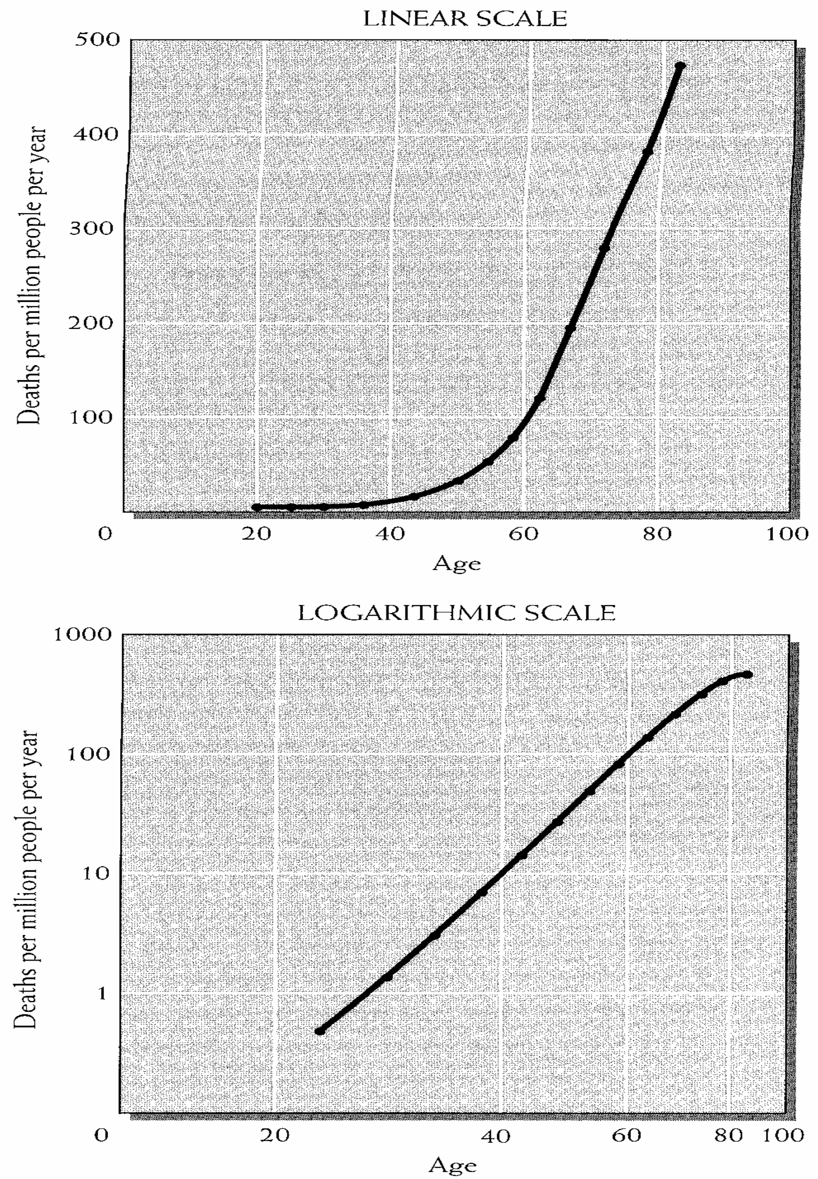


Nuclear Energy and Health Slides

Human-made vs. Natural Radiation



U.S. colon cancer death rate vs. age



Actual annual U.S. death rate from colon cancer in relation to age, 1986.

Medical Applications of Low Doses

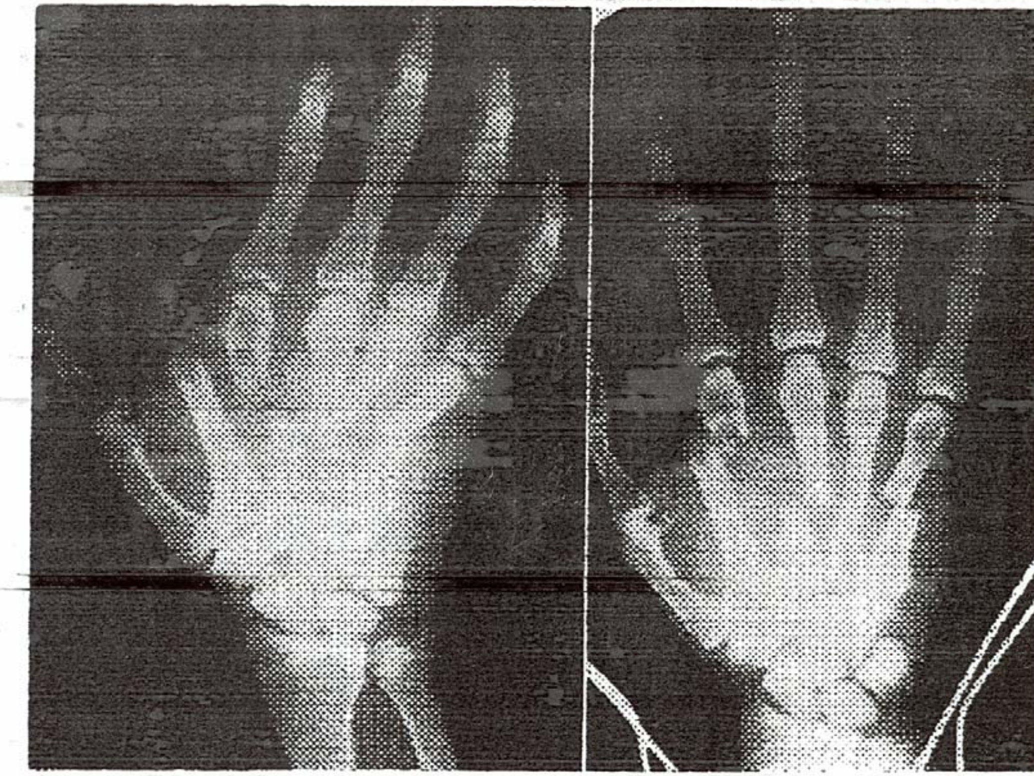
- Prevent cancer (DNA repair, cell apoptosis)
- Cure cancer (immune system stimulation)
- Treat diabetes, hypertension
- Delay aging, rejuvenate cells
- Relieve pain (arthritis, gout, cancer, etc.)
- Moderate stress (enzyme release)
- Cure infections (gas gangrene, skin)
- Enhance HDI tumor cell killing
- Enhance performance of chemotherapy

Appearance of db/db mice at 90th week of age

Irradiated Group

Control Group

Gas Gangrene Infections



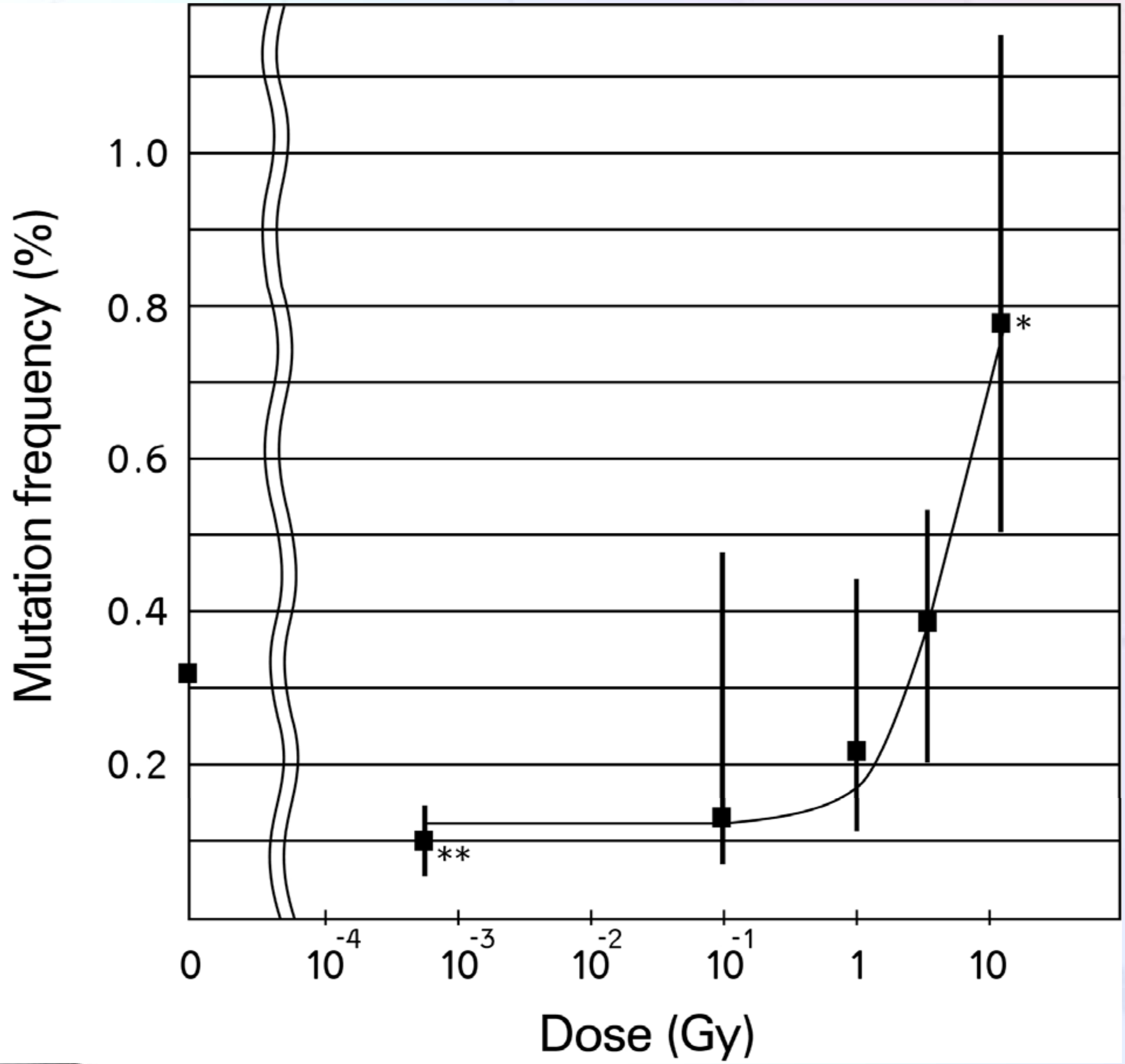
Figs. 7–8. Case 1: Severe hand injury, with multiple compound fractures and some gas in tissues (left). Fig. 8 (right) shows same hand a few days after prophylactic x-ray irradiation: no gas in the tissues, no infection, hand on way to complete recovery.

TABLE V: CASES WHICH RECEIVED PROPHYLACTIC IRRADIATION AND HAVE BEEN REPORTED IN THE LITERATURE

Cases Which

those which do not appear until three or four days have elapsed. It is evident from Figure 6 that the second, third, and

Mutation Frequency in Fruit Flies: CRIEPI vs. Muller



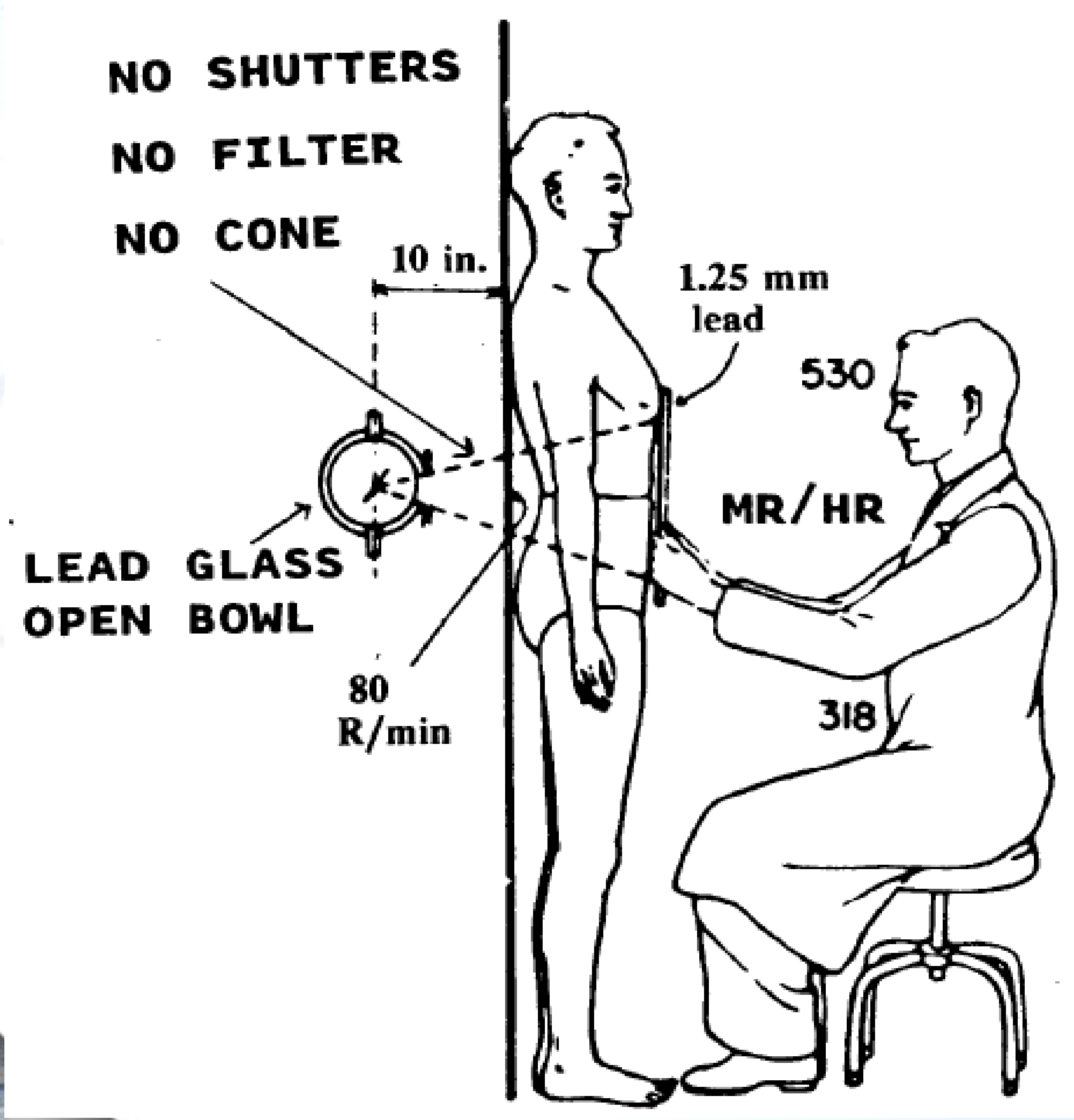
Radioiodine and Cancer Incidence/Mortality

Radioiodine is used as the first-line therapy for hyperthyroidism, having been employed for this purpose for more than 60 years. The on-going concerns about the risk of cancer led to a 7417-patient study (Franklyn et al. 1999) that demonstrated significant decreases in overall cancer incidence (0.83, 95% CI = 0.77-0.90) and mortality (0.90, CI = 0.82-0.98). “The decrease in overall cancer incidence and mortality in those treated for hyperthyroidism with radioiodine is reassuring.”

What makes this study so remarkable is the very large I-131 dose given to the patients: Mean = 308 MBq. A patient receives about 0.180 mGy/MBq total body and 1 Gy/MBq to the thyroid. These patients receive a mean total body dose of 54 mGy and a mean thyroid dose of 308 Gy. Other studies of such patients also have not confirmed an increase in cancer incidences, as noted below. …

Franklyn JA, Maisonneuve P, Sheppard M et al. “Cancer Incidence and Mortality after Radioiodine Treatment for Hyperthyroidism: a Population-based Study”. The Lancet 353:2111-2115 (1999)

Fluoroscopy



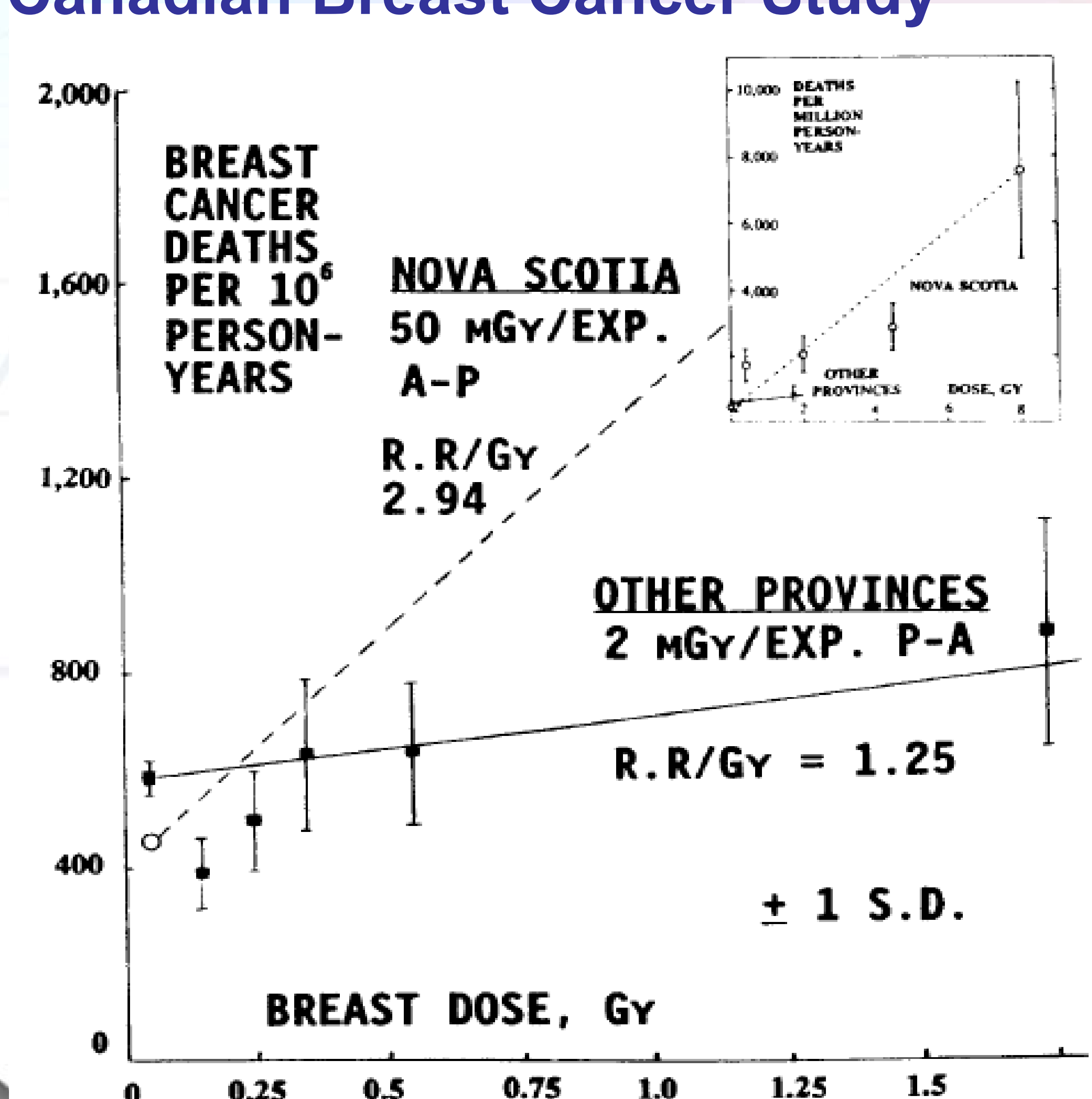
Canadian Breast Cancer Study

Table 1. Observed Rates of Death from Breast Cancer, According to the Dose of Radiation Received.

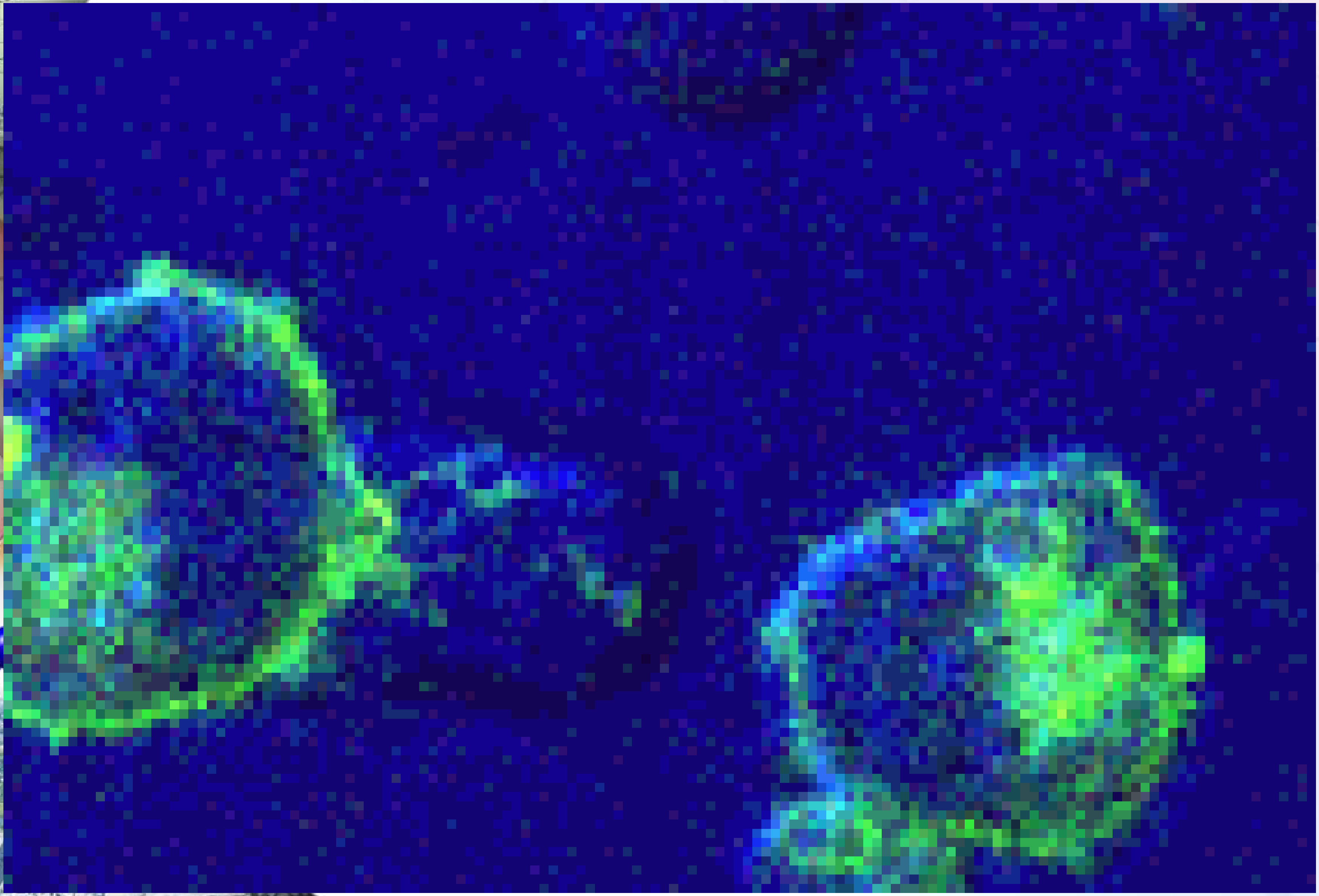
Dose (Gy)	Standardized Rate per 10^6 Person-Years*		
	Nova Scotia	Other Provinces	All Provinces
0–0.09	455.6 (13)	585.8 (288)	578.6 (301)
0.10–0.19		389.0 (29)	421.8 (32)
0.20–0.29		497.8 (24)	560.7 (26)
0.30–0.39	1709 (11)	630.5 (17)	650.8 (18)
0.40–0.69		632.1 (19)	610.0 (19)
0.70–0.99			1362 (13)
1.00–2.99	2060 (14)		1382 (17)
3.00–5.99	2811 (13)	873.1 (14)	2334 (14)
6.00–10.00	7582 (8)		8000 (9)
≥10.00	21,810 (12)		20,620 (13)

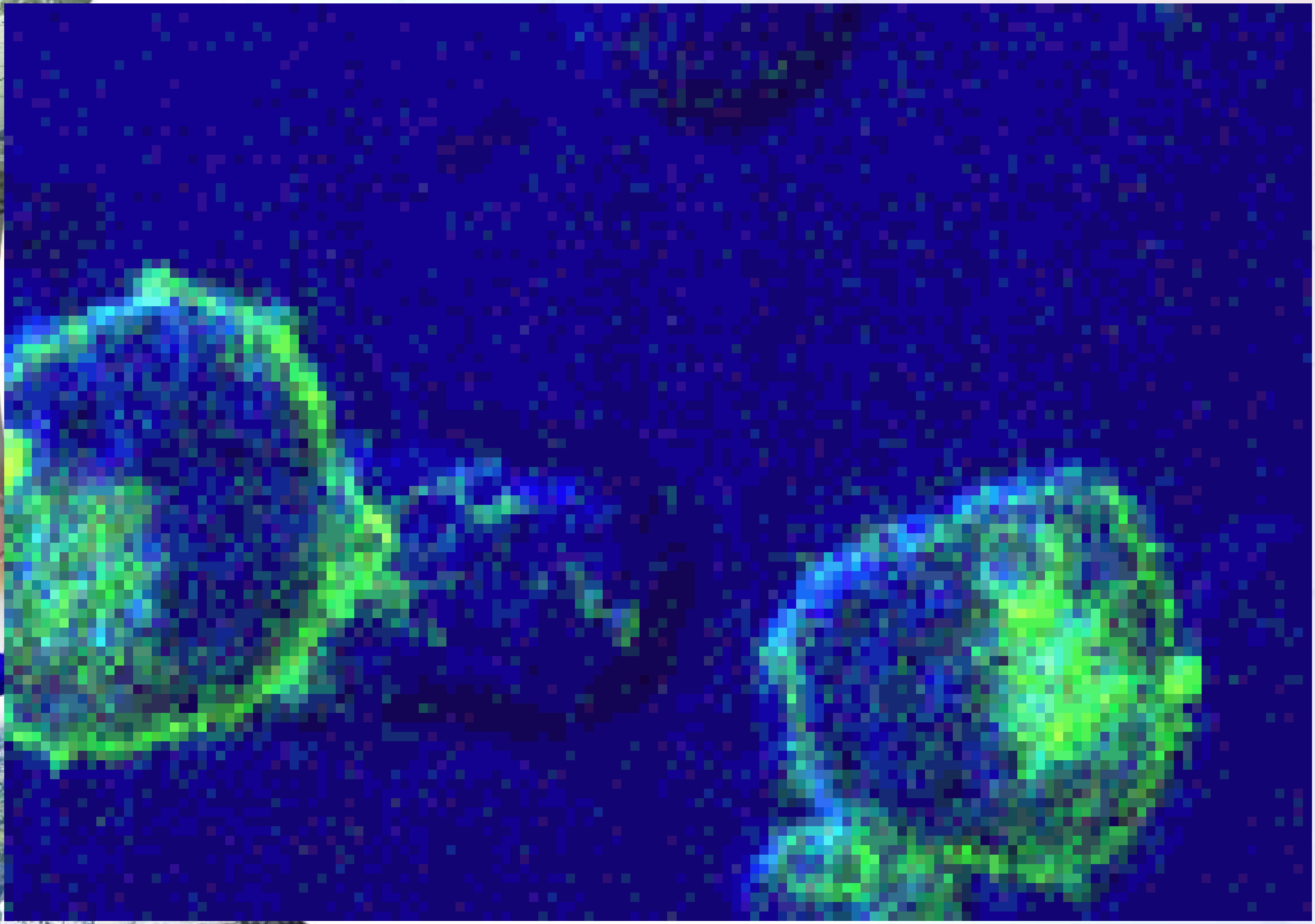
*The number of deaths is shown in parentheses. The calculations exclude the values for 10 years after the first exposure and have been standardized according to age at first exposure (10 to 14, 15 to 24, 25 to 34, and ≥35 years) and time since first exposure (10 to 14, 15 to 24, 25 to 34, and ≥35 years) to the distribution for the entire cohort.

Canadian Breast Cancer Study



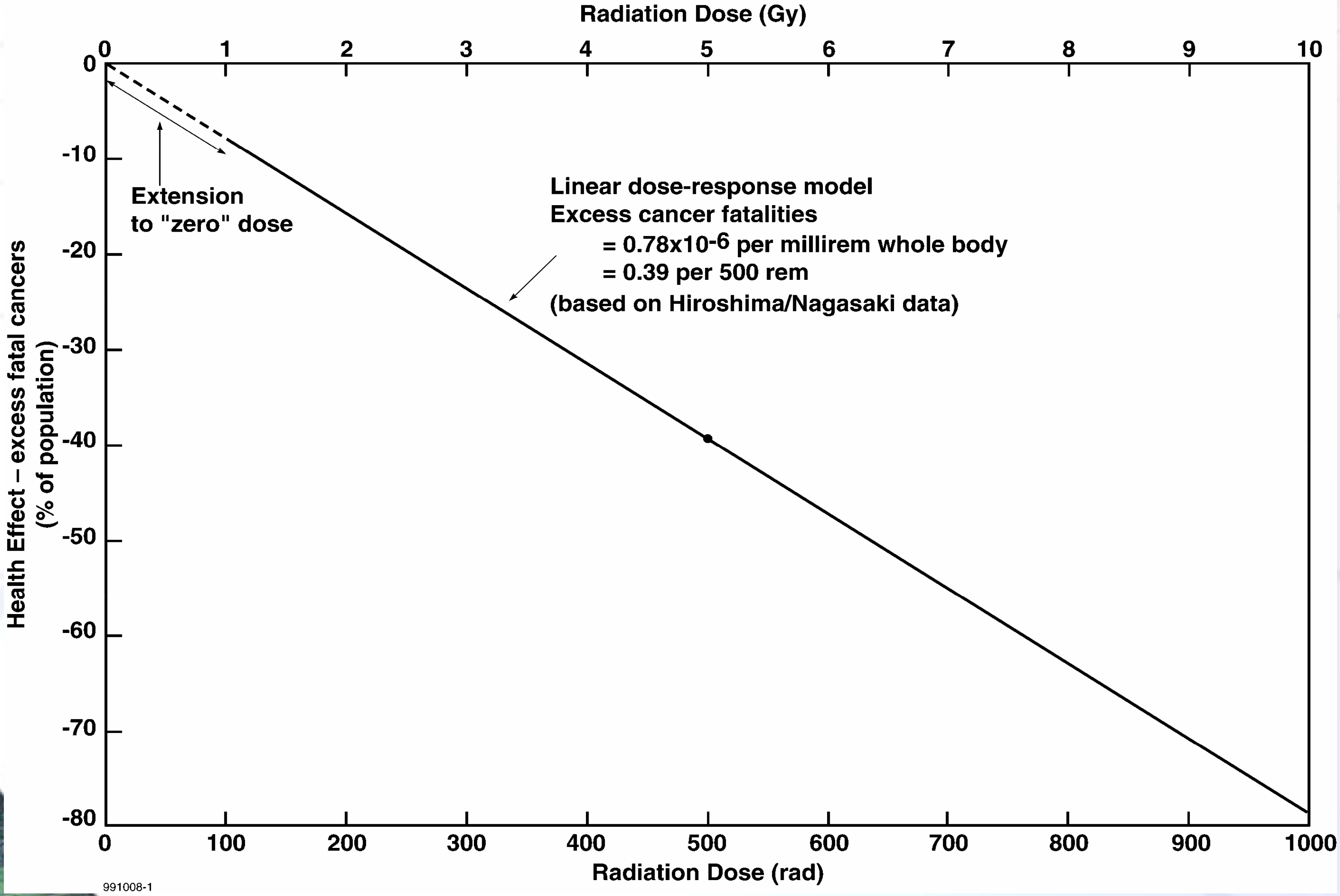
Immune System Killer T-cell vs. Cancer Cell



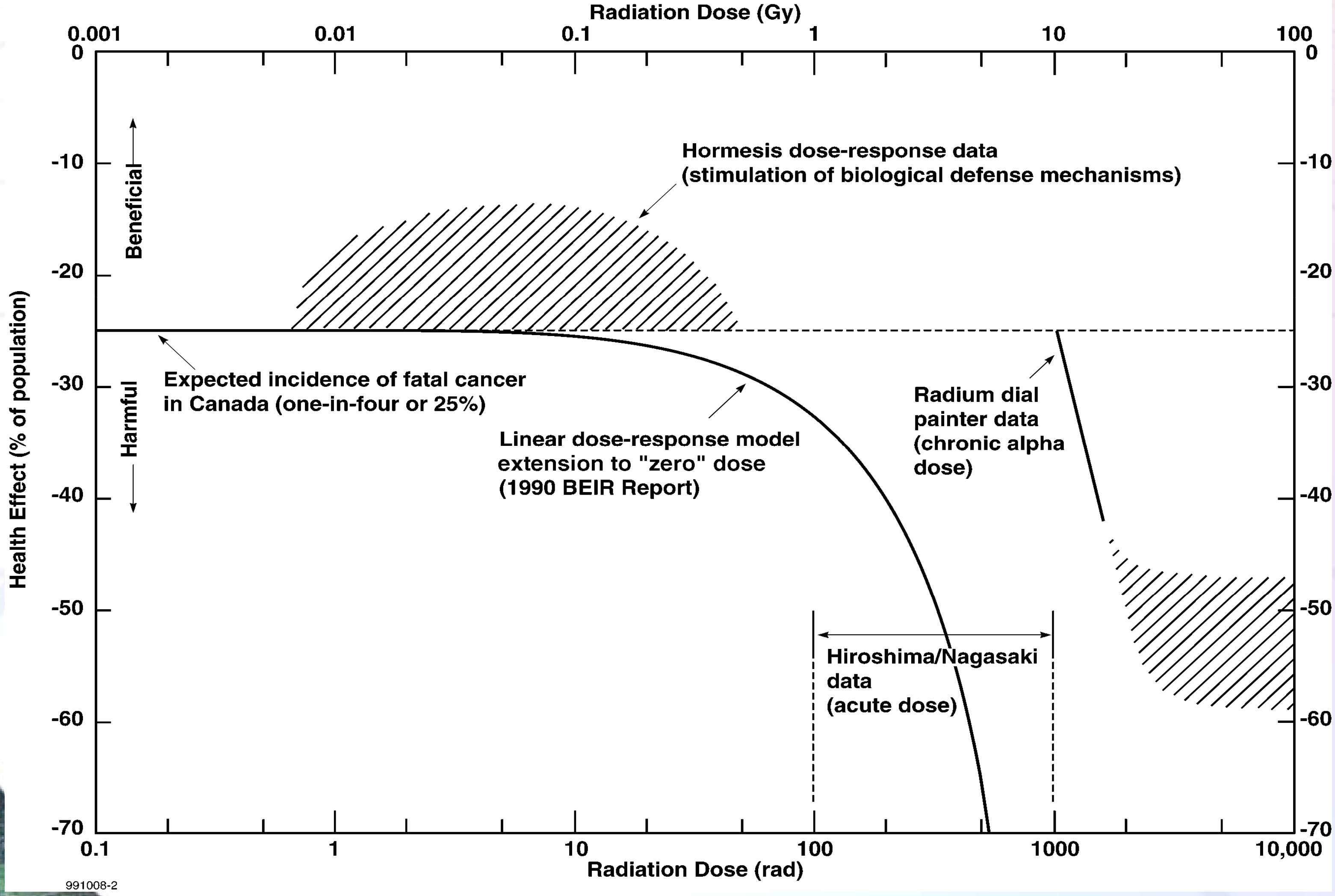


Shu-Zheng Liu and Jerry Cuttler at CVH

LNT Assumption



LNT Assumption (dose on log scale)



The LNT Hypothesis

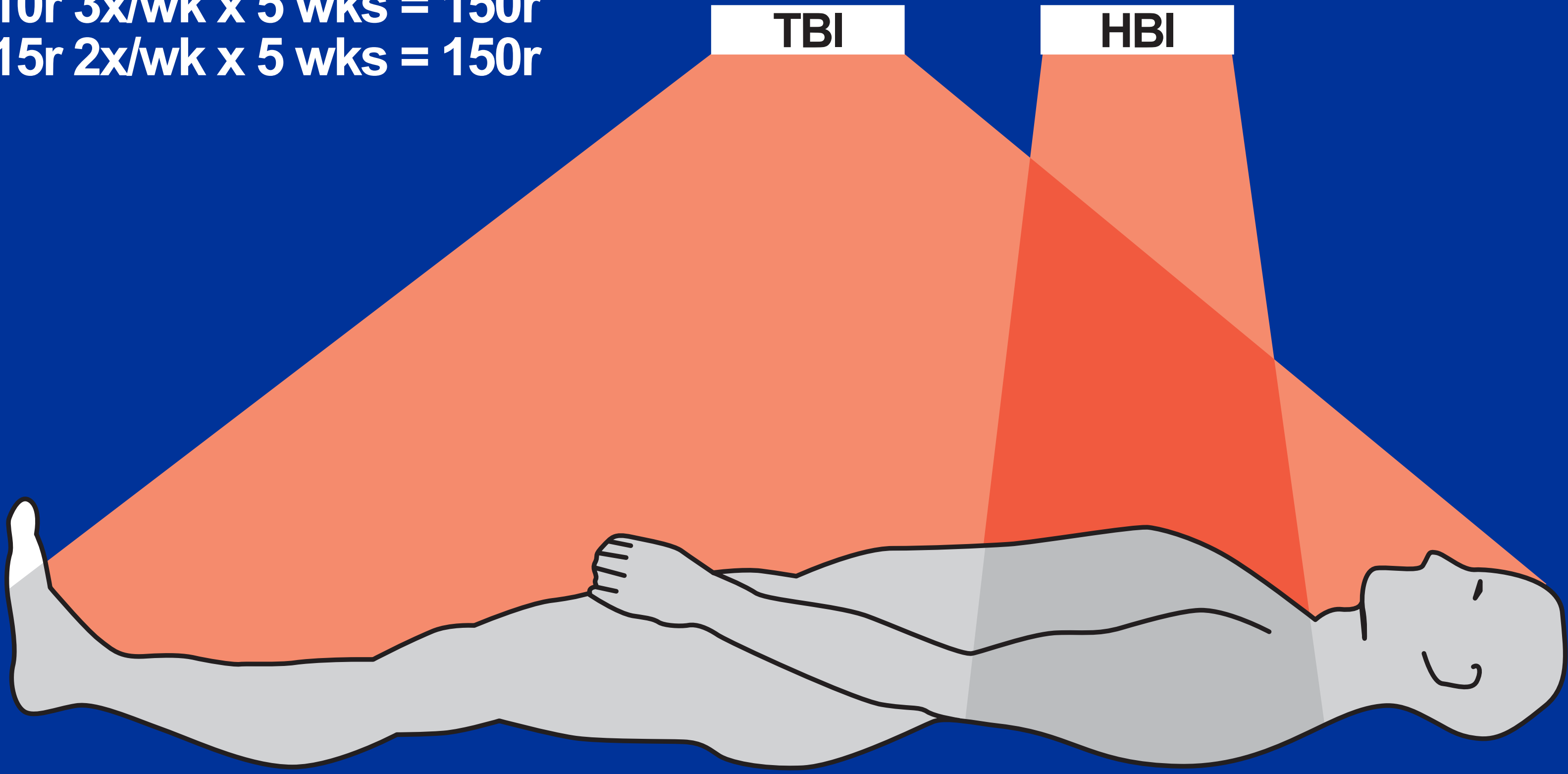
"The great tragedy of science is the slaying of a beautiful hypothesis by an ugly fact"

Thomas H. Huxley

Kiyohiko Sakamoto and Sadao Hattori

LOW DOSE IRRADIATION OF HALF BODY (HBI) OR TOTAL BODY (TBI) OF PATIENTS WITH NON-HODGKIN'S LYMPHOMA

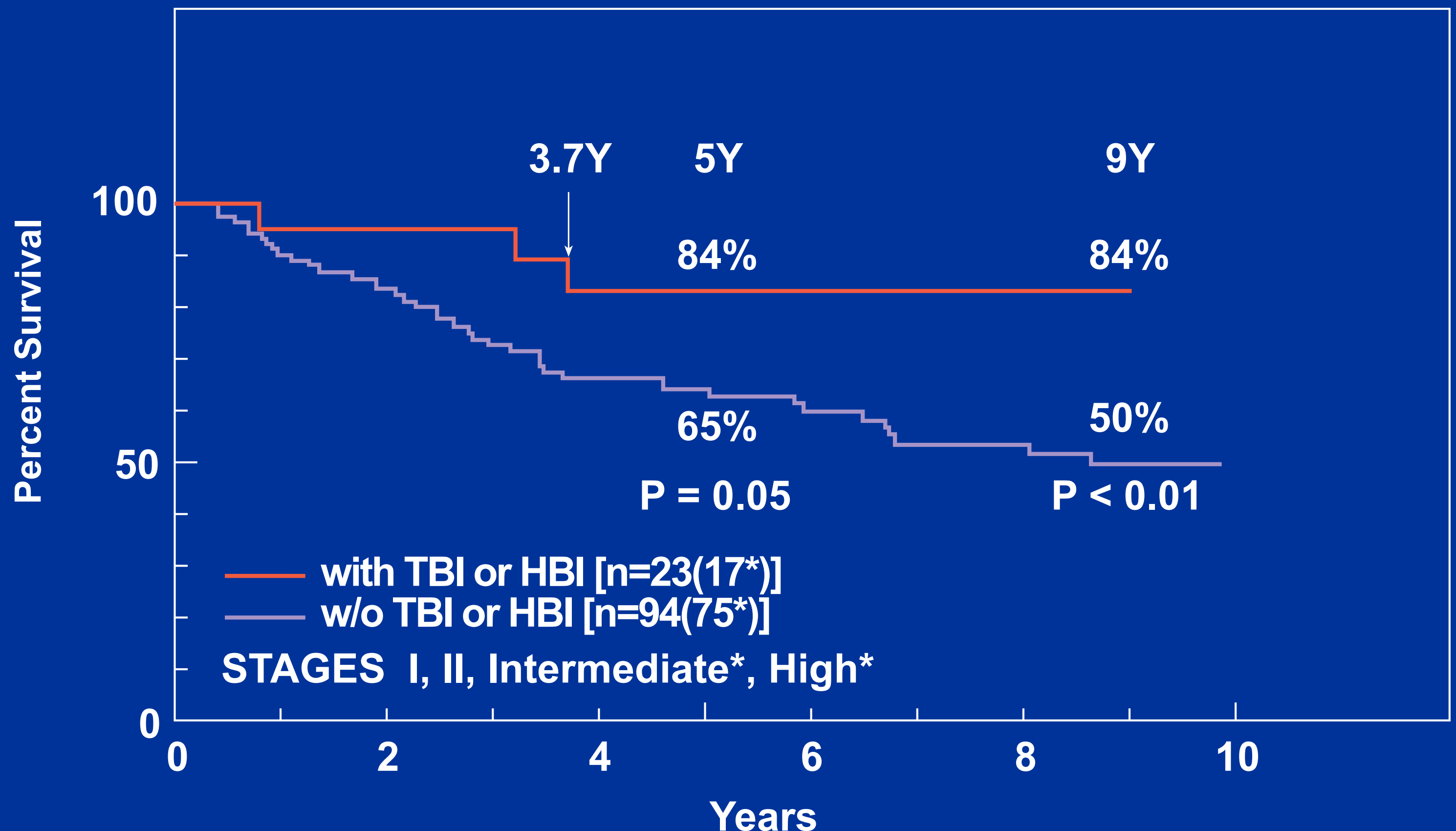
10r 3x/wk x 5 wks = 150r
15r 2x/wk x 5 wks = 150r



Sakamoto, et. al. J Jpn Soc Ther Radiol Oncol 9:161-175, 1997

COMPARISON OF LOW-DOSE IRRADIATION OF HALF BODY (HBI) OR TOTAL BODY (TBI) OF PATIENTS WITH NON-HODGKIN'S LYMPHOMA

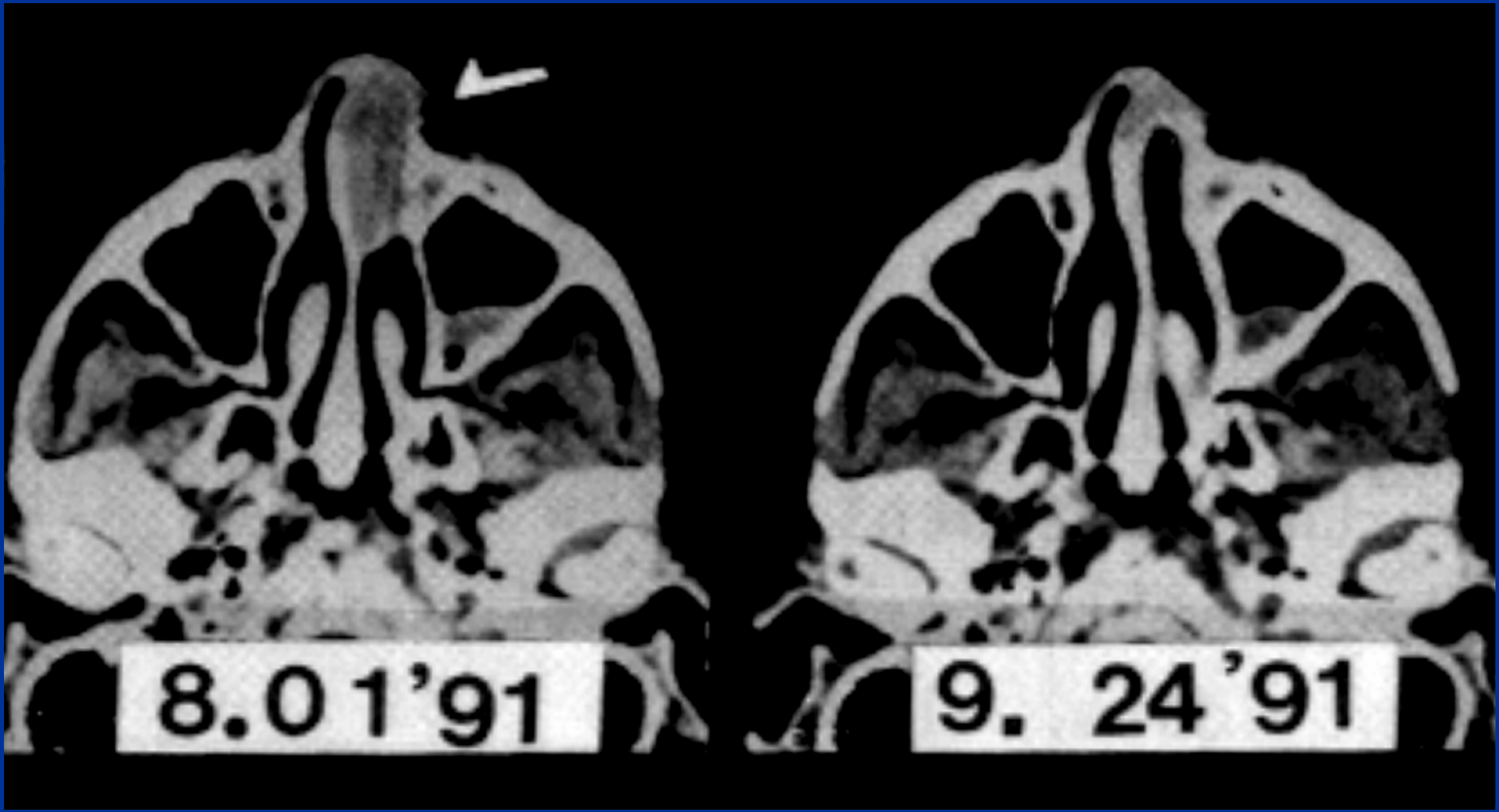
4 year survival: TBI-HBI 84% Chemotherapy 66% (79% of TBI-HBI Survival)
9 year survival: TBI-HBI 84% Chemotherapy 50% (60% of TBI-HBI Survival)



Patients in both groups received chemotherapy and localized tumor high-dose radiation.

Sakamoto, et. al. J Jpn Soc Ther Radiol Oncol 9:161-175, 1997

RAPID REGRESSION OF NON-HODGKIN'S LYMPHOMA TUMORS IN RESPONSE TO LOW-DOSE HBI OR TBI

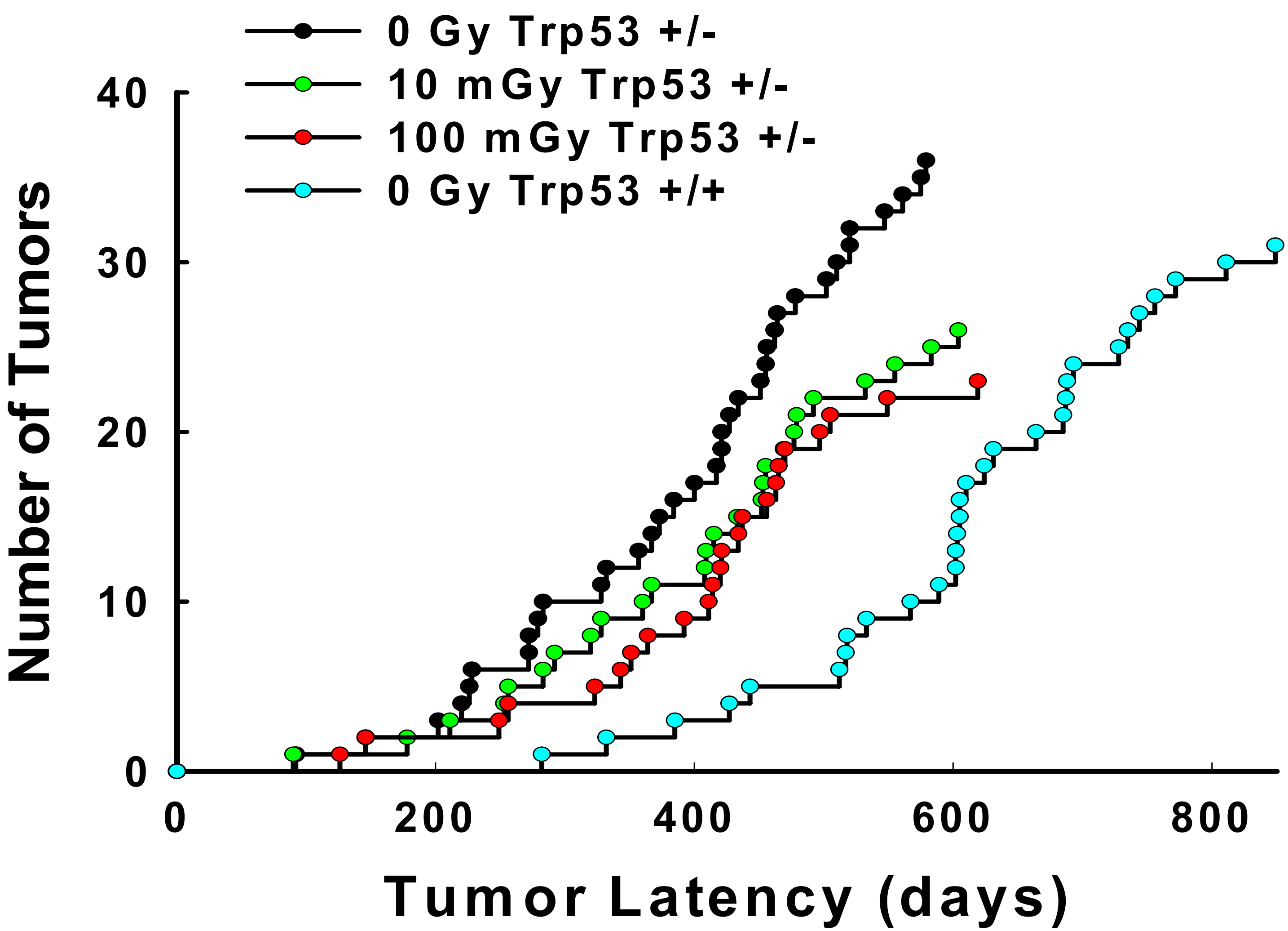


CT (computerized tomographic) scan of upper nasal cavity before and after half body irradiation (HBI). Nasal tumor, though outside HBI field, disappeared after low-dose HBI.

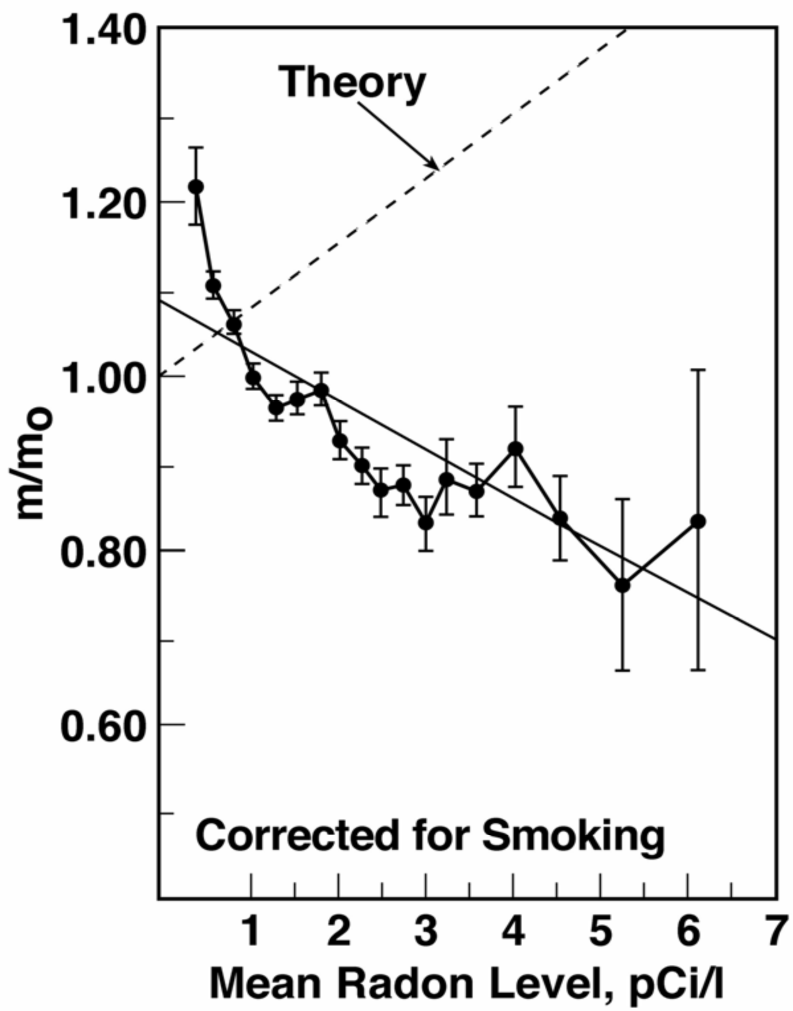
Takai Y, Yamada S, Nemoto K, et. al. (1992)

LDR Therapy for Hurthle Cell Carcinoma

Lymphoma Latency



Radon Exposure Study Disproves the LNT Hypothesis



Greatest natural radiation exposure is radon gas from uranium activity

Cohen tested the LNT model, as used, and clearly disproved it; lung cancer mortality *lower* where radon *higher*

Lung cancer *higher* where radon is *lower* than the average of 1.7 pCi/L

Instead of discarding LNT assumption, objection raised (ecological study). This is not applicable to test

Authorities still accept LNT assumption

Inhaled $^{239}PuO_2$ in Beagle Dogs, HPJ 2010 Sep

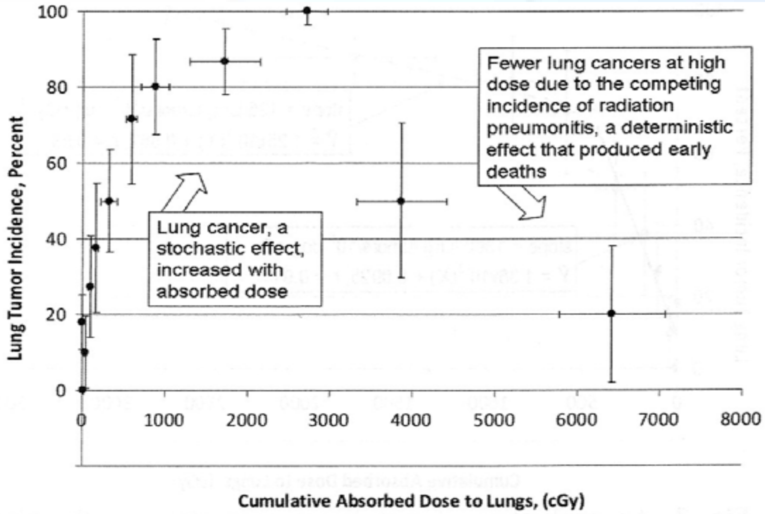


Fig. 1. Lung tumor incidence (percent) with absorbed dose to the lungs in 137 beagle dogs that inhaled $^{239}PuO_2$. The competing effect of radiation pneumonitis at high doses is shown.

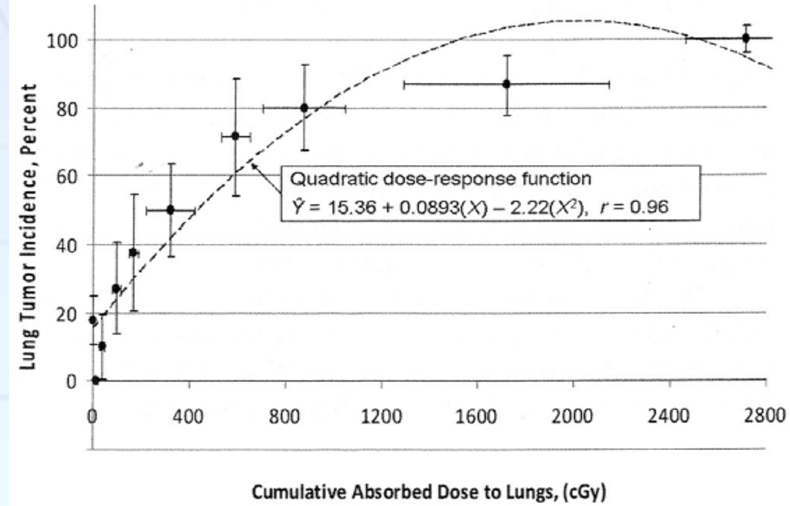


Fig. 2. A pure-quadratic equation fit by least-squares linear regression analysis to the lung tumor incidence with dose from inhaled $^{239}PuO_2$.

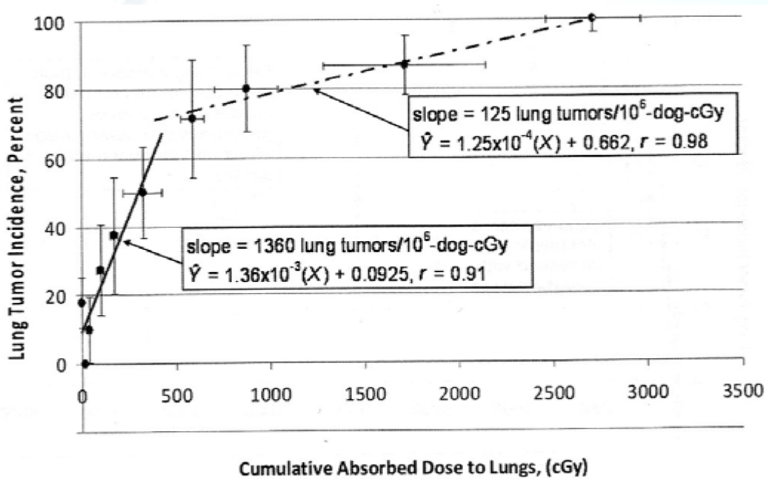
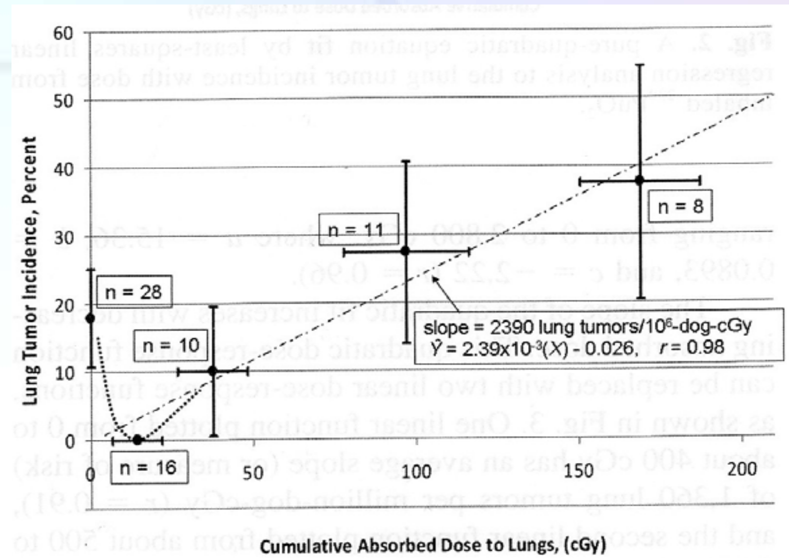
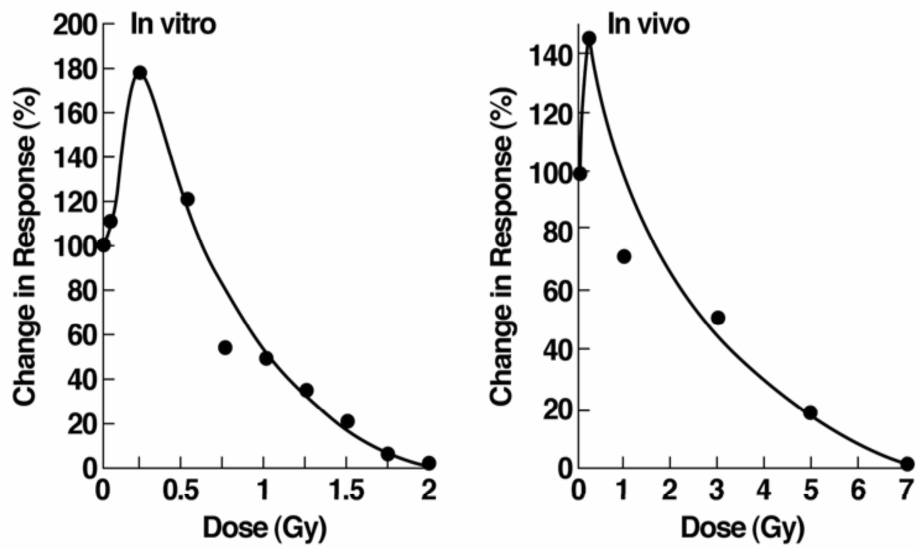
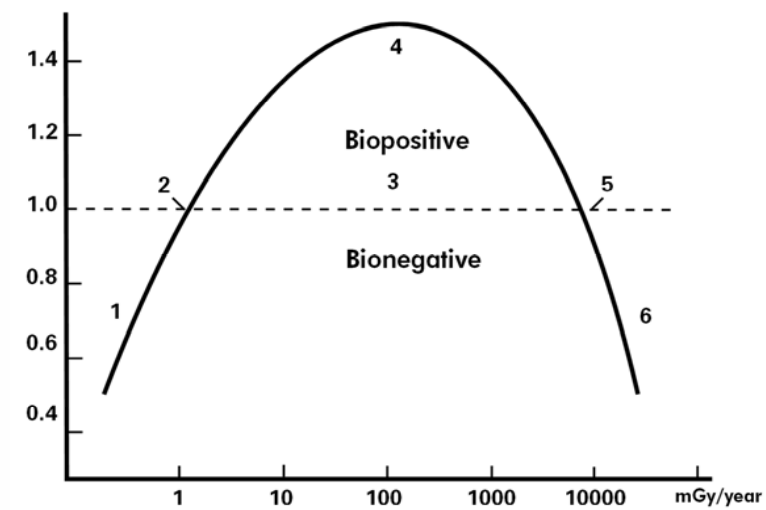


Fig. 3. An application of two linear components to the plot representing lung tumor incidence with dose from inhaled $^{239}PuO_2$. Compare to Fig. 2.



Radiation Hormesis





Organisms are stressed: radiation, plus physical, chemical and biological

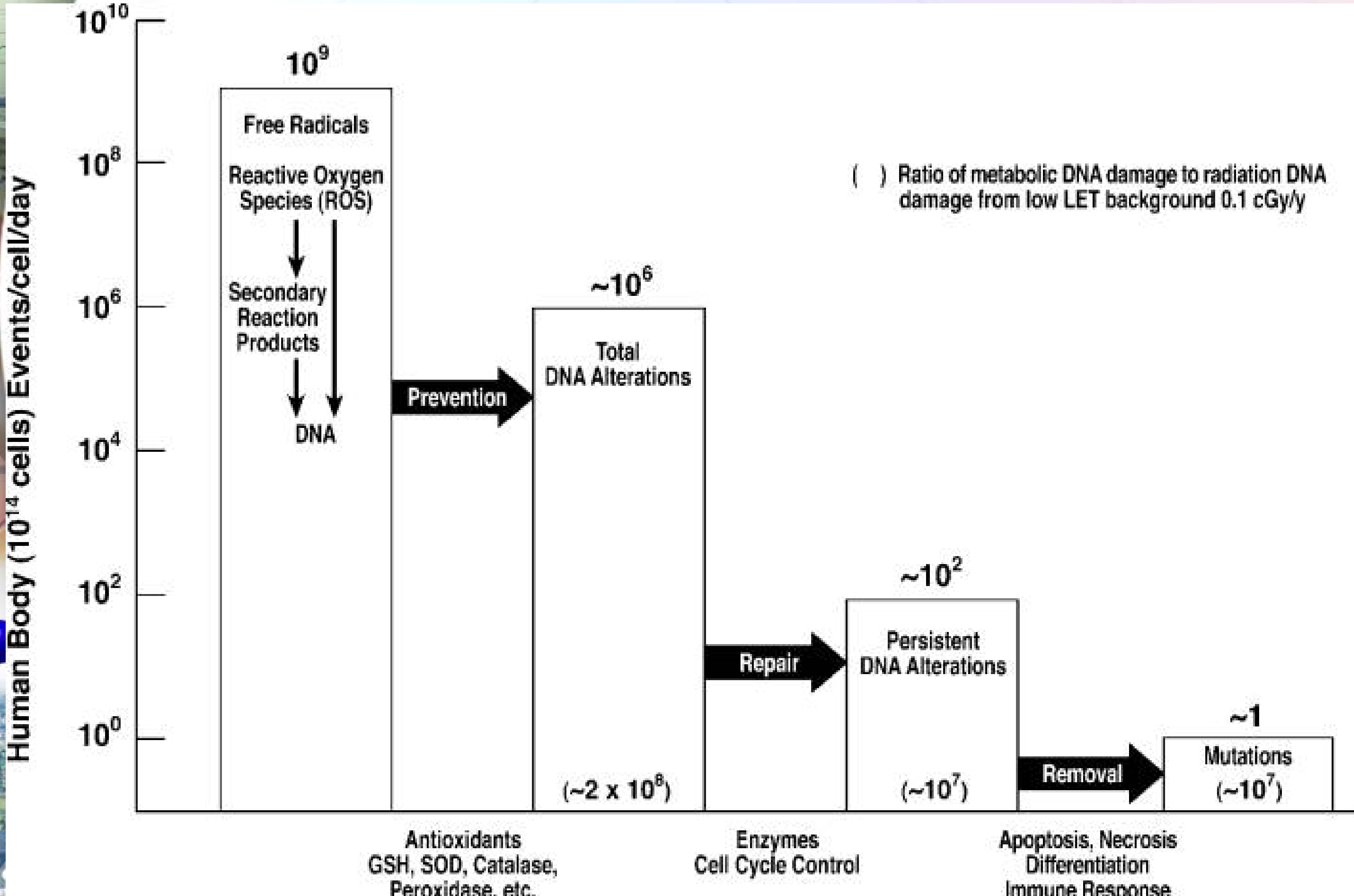
Environmental activity up to billions of years; intensity > 100 times average of 2.4 mSv/y

Paracelcus said: "nothing is without poison; only the (low) <u>dose</u> makes something not poison"

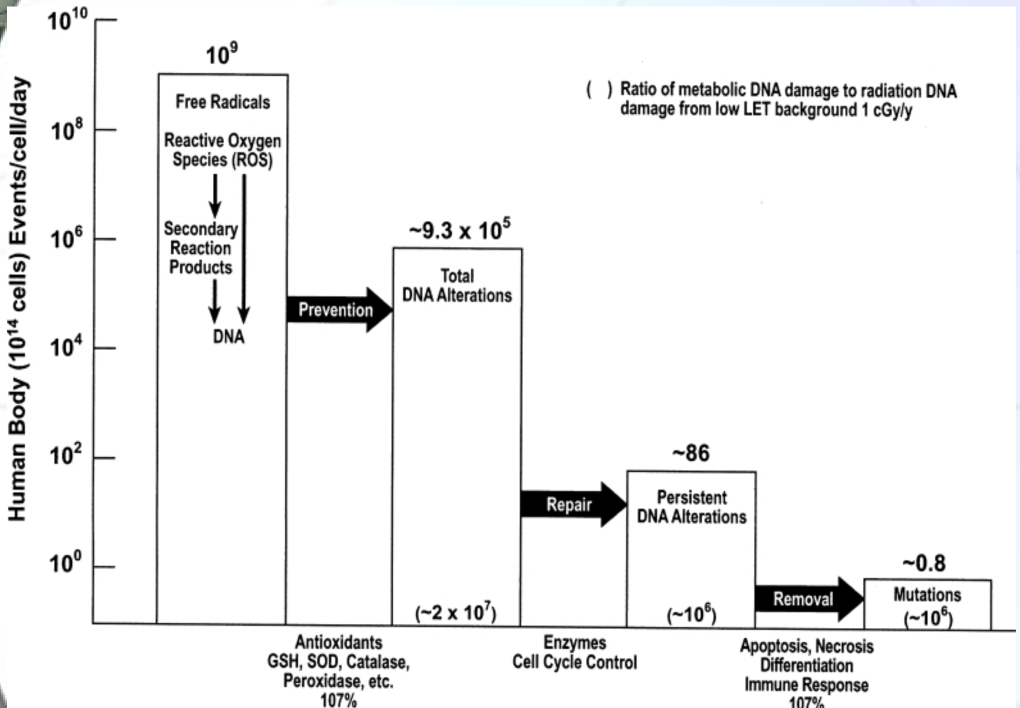
Radiation perturbs; organisms adapt

Low dose <u>reduces</u> cancer; <u>stimulates</u> prevention of <u>endogenous</u> DNA damage, DNA repair, damaged cell removal and replacement

Model for DNA mutations



Radiation Hormesis



Stimulates: ***antioxidants*** etc., ***repair*** of DNA damage, killer T cell ***destruction*** of damaged cells, and p53 ***self-destruction***

Metabolic DNA damage rate is ~10 million x bkgnd radiation DNA damage rate (0.1 cGy/y)

x 10 increase bkgnd radiation reduces mutation rate by 20%

Low dose stimulates defences: prevents, repairs, removes DNA alterations due to natural metabolic leakage of reactive oxygen species

Accumulation of mutations is linked to cancer mortality

Ron Mitchel article in CNS Bulletin 2006 Dec

Summary implications for radiation protection system

- Conceptual basis for present system appears to be incorrect
- Belief that the current system and the LNT assumption are precautionary appears to be incorrect
- Concept of dose additivity appears to be incorrect
- Effective dose (Sv) and the weighting factors appear to be invalid
- There may be no constant and appropriate value of DDREF for radiological protection dosimetry
- Use of dose as a predictor of risk needs to be re-examined
- Use of dose limits as a means to limit risk needs to be re-evaluated

“Willful blindness” to radiobiological facts

- caused enormous suffering, “vegetative vascular dystonia” (post-traumatic stress syndrome) in the populations that have been exposed to low dose radiation (200,000 Chernobyl clean-up workers)
- has been impairing patients’ access to CT scans, nuclear medicine and low dose x-ray treatments for diagnosis and treatment of serious illnesses
- has created barriers, delays and enormous costs for nuclear energy projects – a sustainable and affordable source of clean energy for humanity

Nuclear Energy and Health Conclusions

- Need sustainable energy for good health
- Burning H-C supplies > 85% of our energy needs
- It yields only 3-4 eV per atom
- U fission yields ~160,000,000 eV per atom, and is an abundant, safe, affordable, clean, portable, reliable and continuous source
- Power blackouts are a serious health risk

- Nuclear energy is blocked by activists who communicate myths on health, economics while advocating alternative “green” solutions that cannot supply the need
- Radiation scare is not debunked by anyone
- Nuclear regulations are overprotective and very expensive in costs and time
- Chernobyl victims suffered not from cancer, but from stress (“vegetative dystonia).”

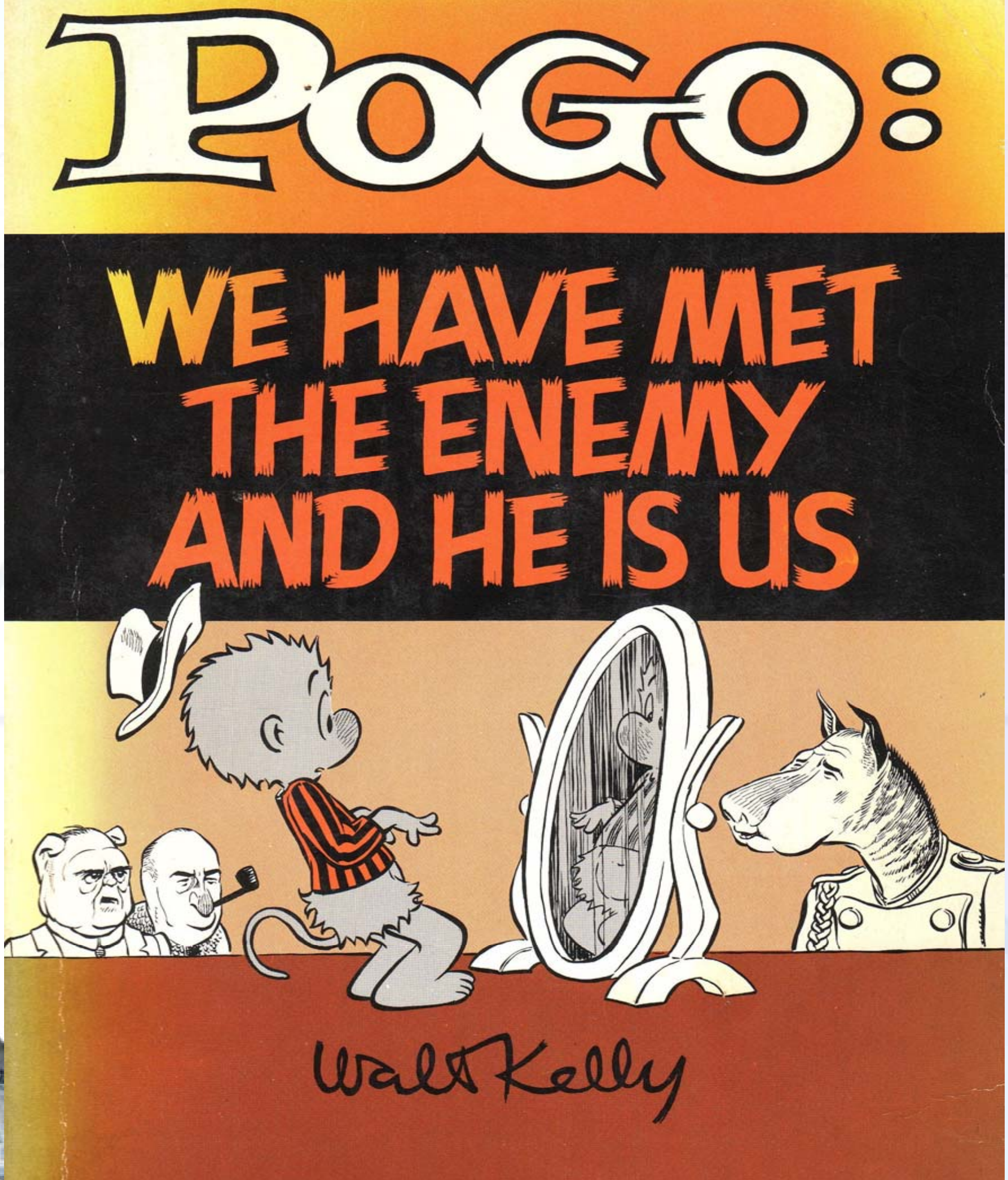
- Based on human data:
  - a single whole-body dose of 150 mSv is safe
  - a continuous exposure of 700 mSv/y is safe
  - both dose levels are also beneficial
- Radioiodine is not a cause of cancer
- Total-body low-dose radiation therapy can prevent cancers and eliminate metastases.

Nuclear Energy and Health Recommendations

- Nuclear scientific societies should organize events to discuss radiation and health
- Regulatory bodies and health organization should examine the scientific evidence
- Stop regulating harmless radiation sources
- Develop public communication programs
- Recycle used fuel instead of geo. disposal
- Stop calculating nuclear safety cancer risk

Radiation Protection Activity

Cuttler Tubiana Pollycove Sakamoto


POGO:
WE HAVE MET THE ENEMY AND HE IS US
Walt Kelly