

For a nuclear accident, what is the appropriate radiation level for evacuating people?

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COMMENTARY ON THE APPROPRIATE RADIATION LEVEL FOR EVACUATIONS¹

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This commentary reviews the international radiation protection policy that resulted in the evacuation of more than 90,000 residents from areas near the Fukushima Daiichi NPS and the enormous expenditures to protect them against a hypothetical risk of cancer. The basis for the precautionary measures is shown to be invalid; the radiation level chosen for evacuation is not conservative. The actions caused unnecessary fear and suffering. An appropriate level for evacuation is recommended. Radical changes to the ICRP recommendations are long overdue.

Keywords: radiation protection, evacuation, nuclear accident, spontaneous DNA damage, stimulated biodefences

THE EARTHQUAKE

March 11, 2011, 14:46 JST

Magnitude 9 earthquake lasting approximately 3.5 minutes with 3 major energy releases at depth of 24 km

Aftershocks on 11th March

7.0	15:06 JST	Sanriku Oki

7.4 15:15 JST Ibaraki-ken Oki

7.2 15:26 JST Sanriku Oki

6.1 15:57 JST Ibaraki-ken Oki

6.8 16:15 JST Fukushima-ken Oki

6.6 16:29 JST Sanriku Oki

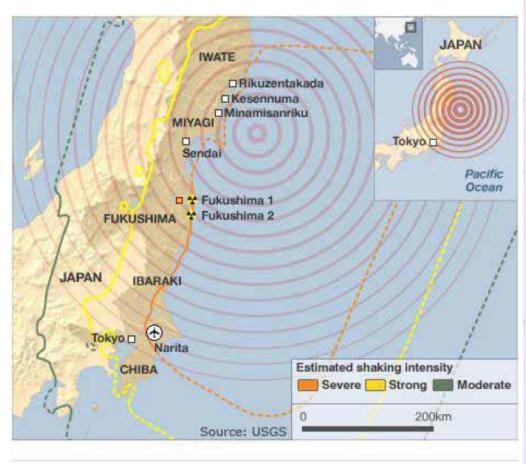
6.7 17:19 JST Ibaraki-ken Oki

6.0 17:47 JST Fukushima-ken Oki

6.4 20:37 JST Iwate-ken Oki

6.1 21:13 JST Miyagi-ken Oki

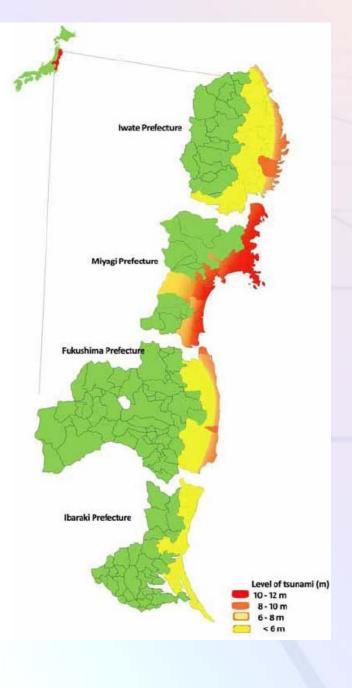
6.0 21:16 JST Iwate-ken Oki



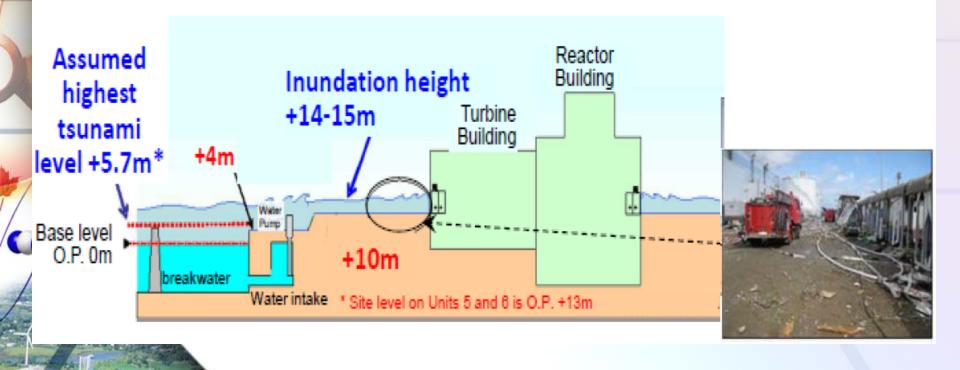


THE TSUNAMI

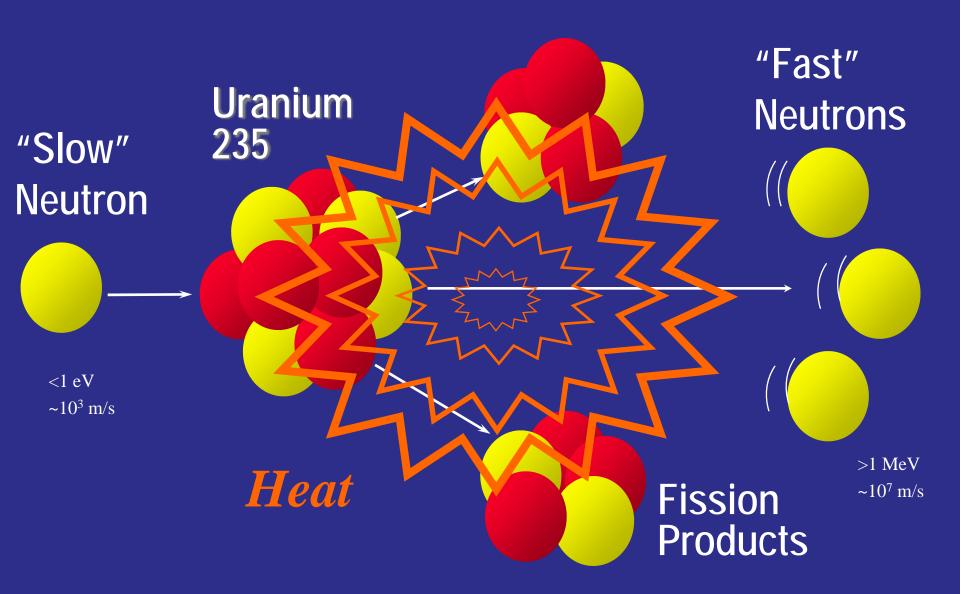
- Within 30 min to 1 hour after the earthquake a series of tsunami waves hit the coast affecting primarily 4 prefectures.
- Tsunami wave height accentuated by the coast line subsiding ≈1 m with horizontal shift between 3 and 4 m
- Net tsunami wave height at Fukushima Daiichi was 14 m
- Units 1-4 at a nominal elevation of 10m above sea level; Units 5 &6 at elevation of 13m



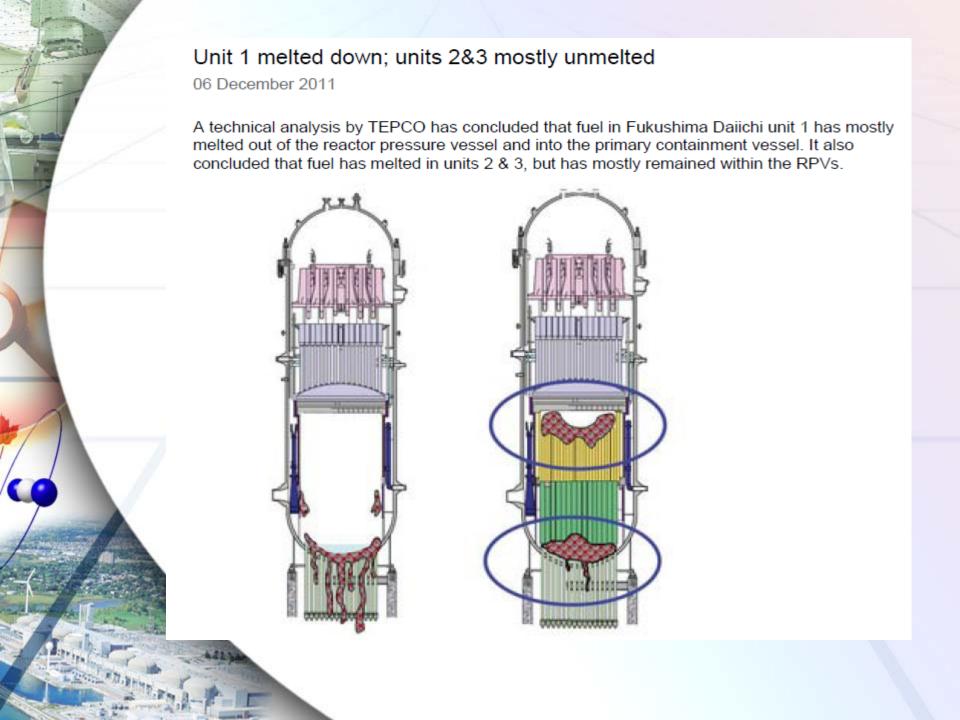
TSUNAMI INUNDATION UNITS 1 – 4

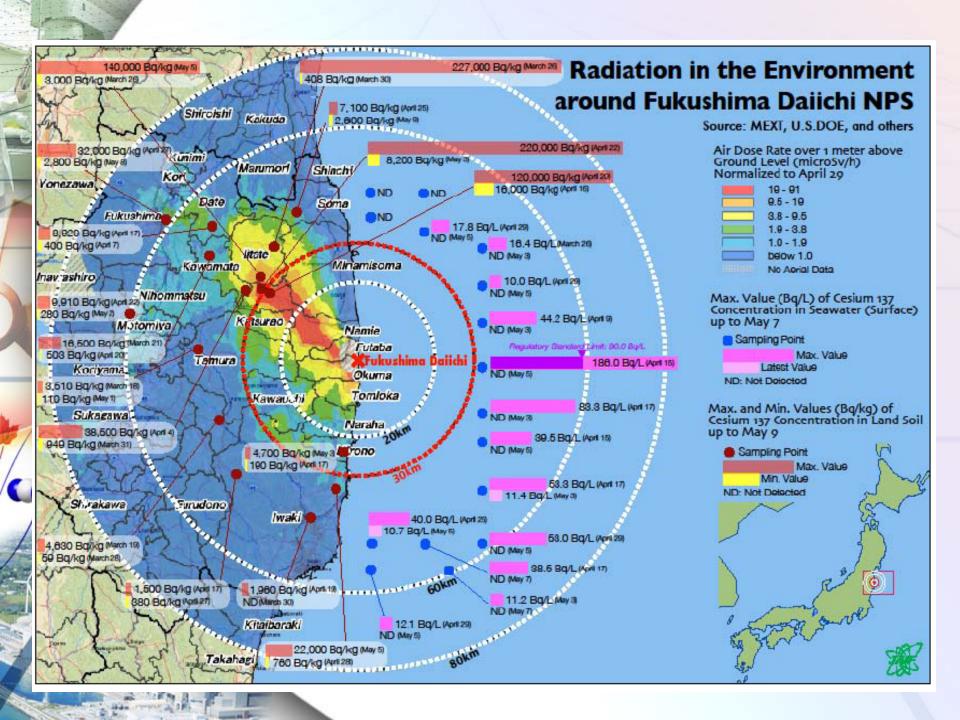


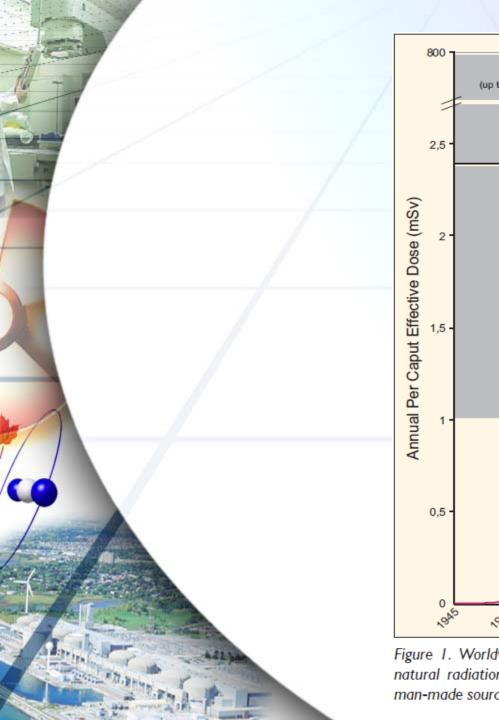
Nuclear fission











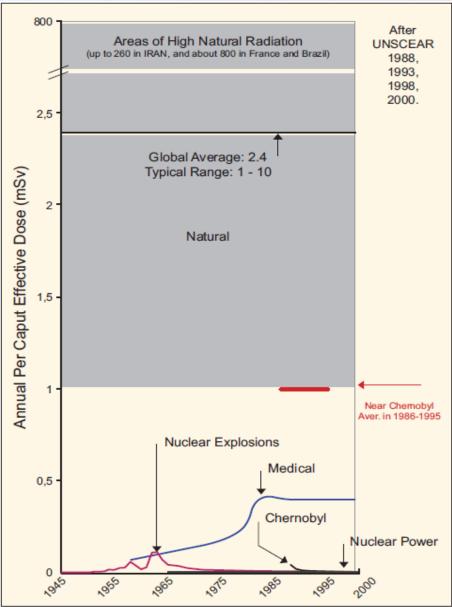
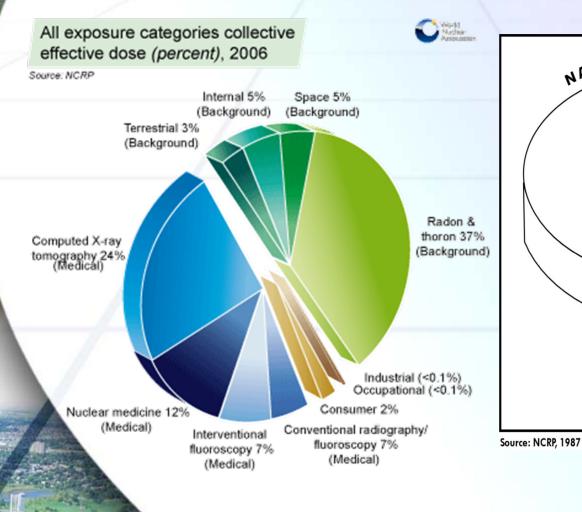
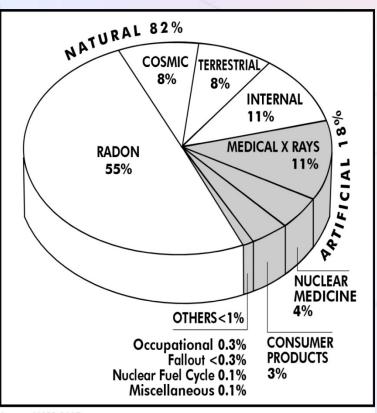


Figure 1. Worldwide and local (near Chernobyl and in areas of high natural radiation) average annual radiation doses from natural and man-made sources. Based on UNSCEAR (1988, 1993, 1998, 2000b).

Sources of Radiation in the United States 2006 vs 1980s





Mortality of 1338 British Radiologists 1897-1976

		Observed (O) and expected (E) numbers of deaths							
Cause of death	I	Entry prior to 1921			Entry after 1920				
2	О	E	O/E	O	E	O/E			
All causes	319	(1) 334.42	0.95	411	541.77	0.76***			
		(2) 308.03	1.04		461.14	0.89*			
		(3) 327.97	0.97		469.97	0.87**			
All neoplasms	62	(1) 49.11	1.26*	72	114.93	0.63***			
F		(2) 43.07	1.44**		91.07	0.79*			
		(3) 35.39	1.75***		68.65	1.05			
Other causes	257 †	(1) 285.31	0.90*	339†	426.84	0.79***			
	'	(2) 264.96	0.97	'	370.07	0.92			
		(3) 292.58	0.88*		401.32	0.84**			

- (1) Based on rates for all men in England and Wales.
- (2) Based on rates for social class 1.
- (3) Based on rates for medical practitioners.
- † includes one death with unknown cause.

*P < 0.05 One sided in direction of difference.

Smith and Doll Study published 1981



In September 1924, at a meeting of the American Roentgen Ray Society, Arthur Mutscheller was the first person to recommend this "tolerance" dose rate for radiation workers, a dose rate that could be **tolerated indefinitely** (Inkret et al 1995).

The level was **0.2 roentgen (R) per day** in 1931, based on applying a factor of 1/100 to the commonly accepted average erythema dose of 600 R, to be spread over one month (30 days).

This level is equivalent to 680 mSv/year.

Calabrese 2009, ICRP's Road to Linearity

Tolerance dose - safe level to avoid radiation harm: 0.2 r/d in 1931 (erythema = 600 r x 1%/30 d = 0.2 roentgen/day = 680 mSv/year

Three drivers for change from 'safe level' to low-dose linearity

- Theory of eugenics (geneticists very keen to protect human population gene pool)
- Muller's 1927 Science paper on radiation-induced mutations in fruit flies; dose > 2.7 Gy!
- Fallout radiation scare, promoted by renowned scientists to stop the nuclear arms race

By 1955 ICRP policy changed (Muller Nobel Prize, political activities)

- Rejected permissible dose concept
- Adopted concept of cancer and genetic <u>risks</u>, kept small compared to other risks in life
- Believed that radiation-induced DNA damage is cumulative (no repair) and harmful and linearly proportional to dose, down to zero dose
- "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."

As Low As Reasonably Achievable (ALARA)

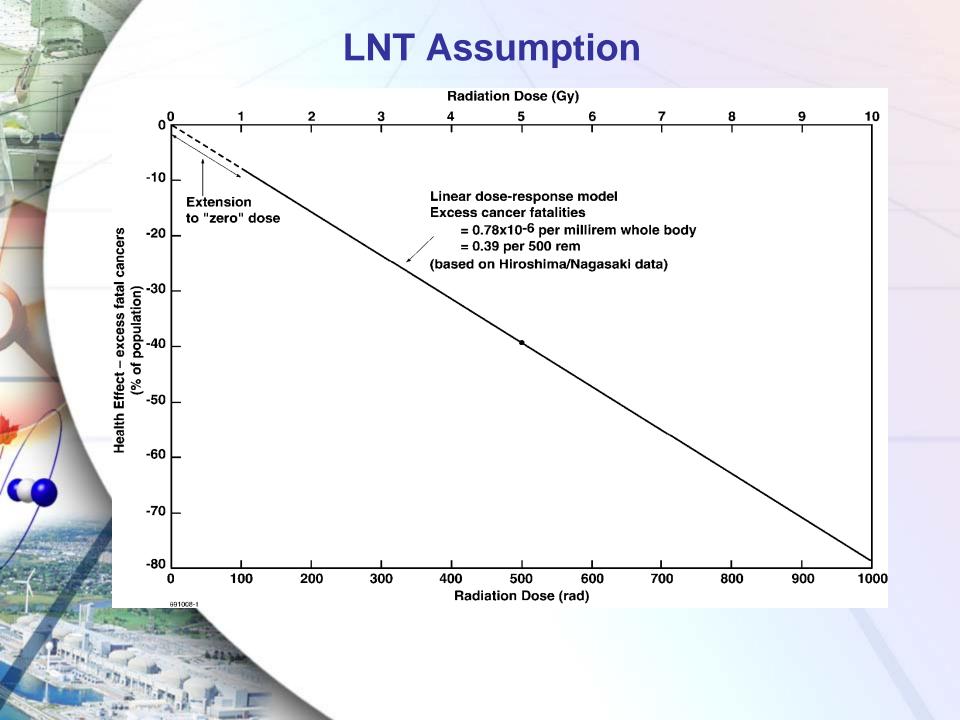
Hiroshima-Nagasaki Life Span Study

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)]	Standard Deviation $\sqrt{(1) + (2)}$	
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	
0.5-1.0	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)





COMMENTARY

Spontaneous DNA Damage and Its Significance for the "Negligible Dose" Controversy in Radiation Protection

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BILLEN, D. Spontaneous DNA Damage and Its Significance for the "Negligible Dose" Controversy in Radiation Protection. *Radiat. Res.* 124, 242–245 (1990). © 1990 Academic Press, Inc.

One of the crucial problems in radiation protection is the reality of the negligible dose or *de minimus* concept (1-4). This issue of a "practical zero" and its resolution is central to our understanding of the controversy concerning the existence of a "safe" dose in radiological health. However, for very low levels of environmental mutagens and carcinogens including low doses of low-LET radiations (less than 1 cGy or 1 rad), spontaneous or endogenous DNA damage may have an increasing impact on the biological consequences of the induced cellular response. It is this issue that is addressed in this communication.

The following discussion is intentionally limited to a comparison of low-LET radiation since its effects are due primarily to indirect damage in cellular DNA brought about modification events occur per hour in each mammalian cell due to intrinsic causes.

The current radiation literature will be interpreted to show that ~100 (or fewer) measurable DNA alterations occur per centigray of low-LET radiation per mammalian cell. Therefore every *hour* human and other mammalian cells undergo at least 50–100 times as much spontaneous or natural DNA damage as would result from exposure to 1 cGy of ionizing radiation. Since background radiation is usually less than 100–200 mrem (1–2 mSv)/y, it can be concluded, as discussed by Muller and Mott-Smith (15), that spontaneous DNA damage is due primarily to causes other than background radiation.

"INTRINSIC" OR "SPONTANEOUS" DNA DAMAGE

DNA is not as structurally stable as once thought. On the contrary, there appears to be a natural background of chemical and physical lesions introduced into cellular DNA by thermal as well as oxidative insult. In addition, in the

Daniel Billen in Radiation Research 1990

DNA is not as structurally stable as once thought

Natural background of lesions: thermal and oxidative insult

Cells have mechanisms to bypass or repair these lesions

- Spontaneous DNA alteration rate = 2 x 10⁵/cell/day
- Radiation-induced DNA alterations: 10-100 per cell/cGy

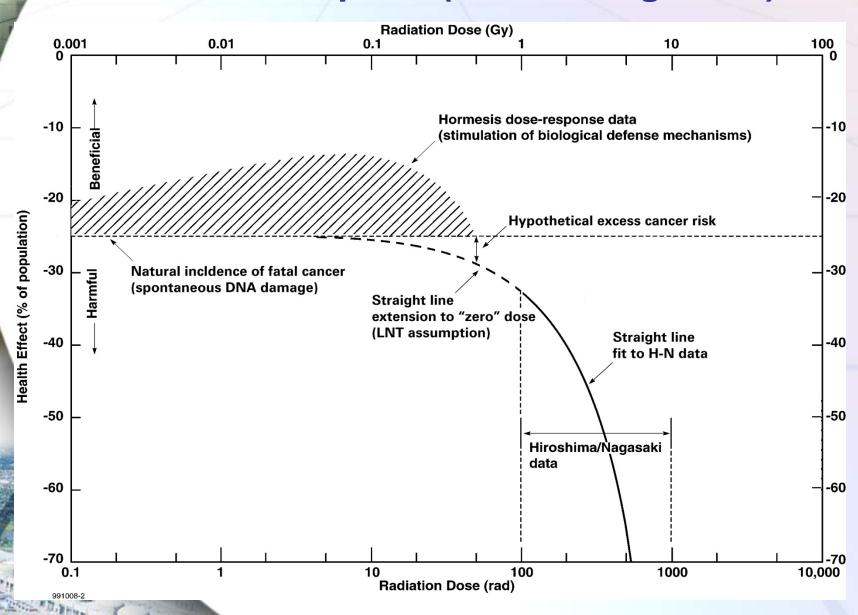
1 mGy/y radiation level < 3 x 10⁻² DNA alteration/cell/day

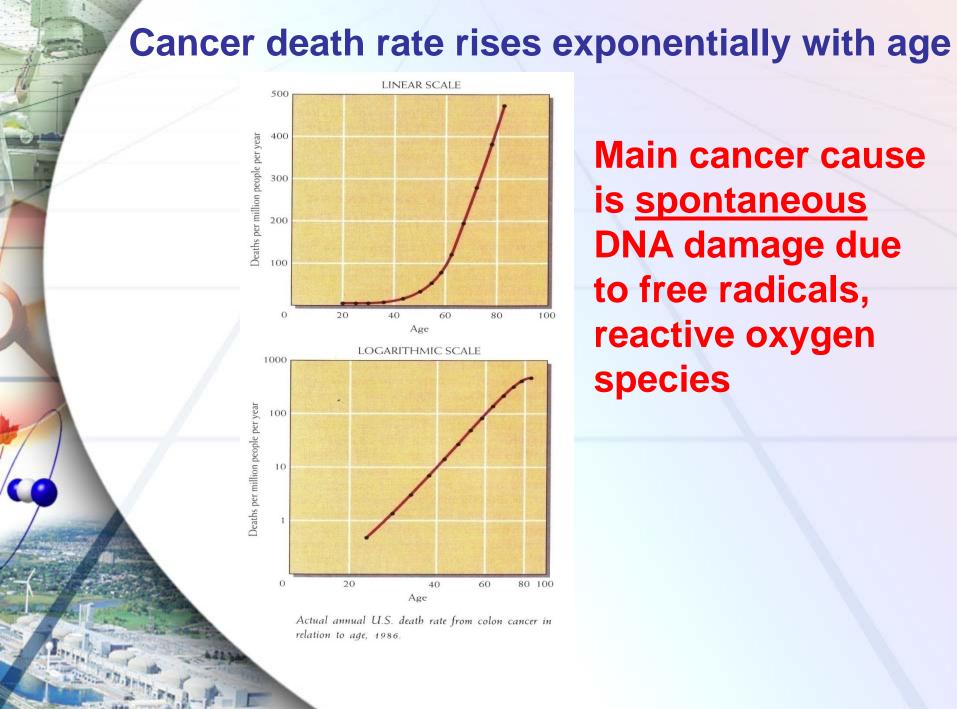
This is > 6 million times lower than spontaneous rate!!!

So radiation is <u>not</u> a significant <u>cause</u> of cancer.

We've known this for more than 20 years!!!

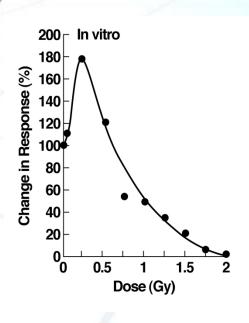
LNT Assumption (dose on log scale)

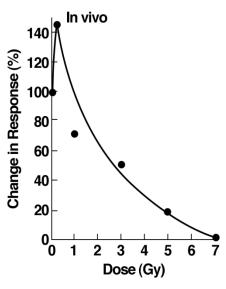


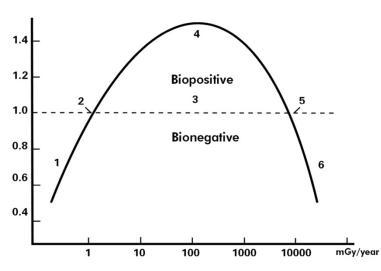


Main cancer cause is spontaneous **DNA** damage due to free radicals, reactive oxygen species

Radiation Hormesis







Organisms are stressed: physical, chemical, biological, radiation

Organisms adapt to stress

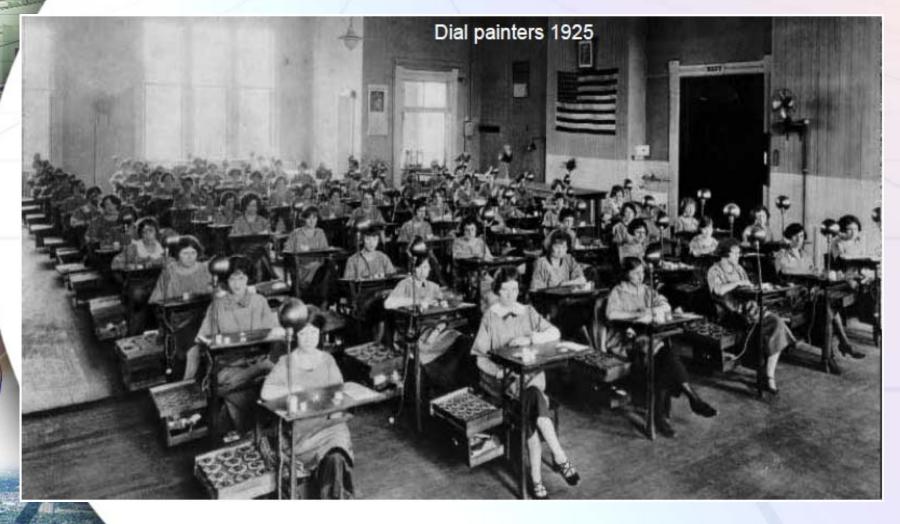
Radiation modulates organism's defenses

Low radiation dose/dose-rate reduces cancer incidence because it stimulates:

- prevention of DNA damage
- repair of DNA damage
- removal of damaged cells and <u>removal</u> of cancer cells

High radiation dose/level has opposite effects

4133 Identified Radium Dial Painters in USA



Bone cancer threshold at 10 Gy or 1000 rad of radium alpha radiation

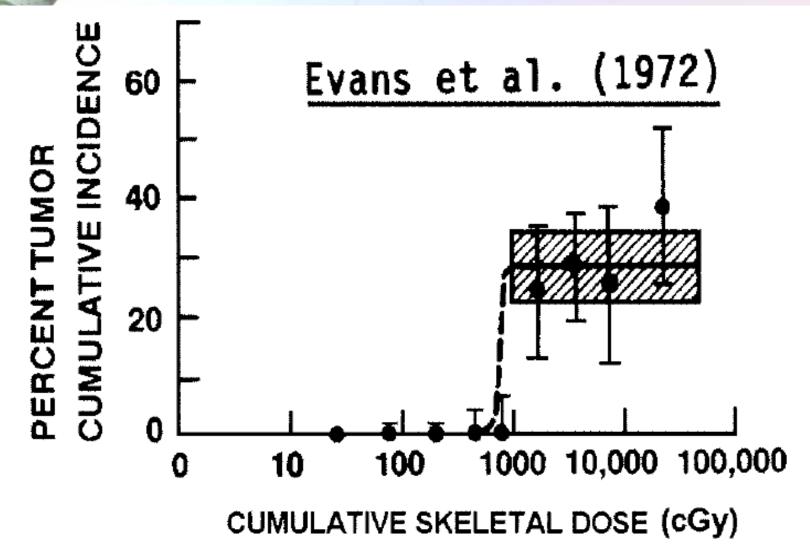
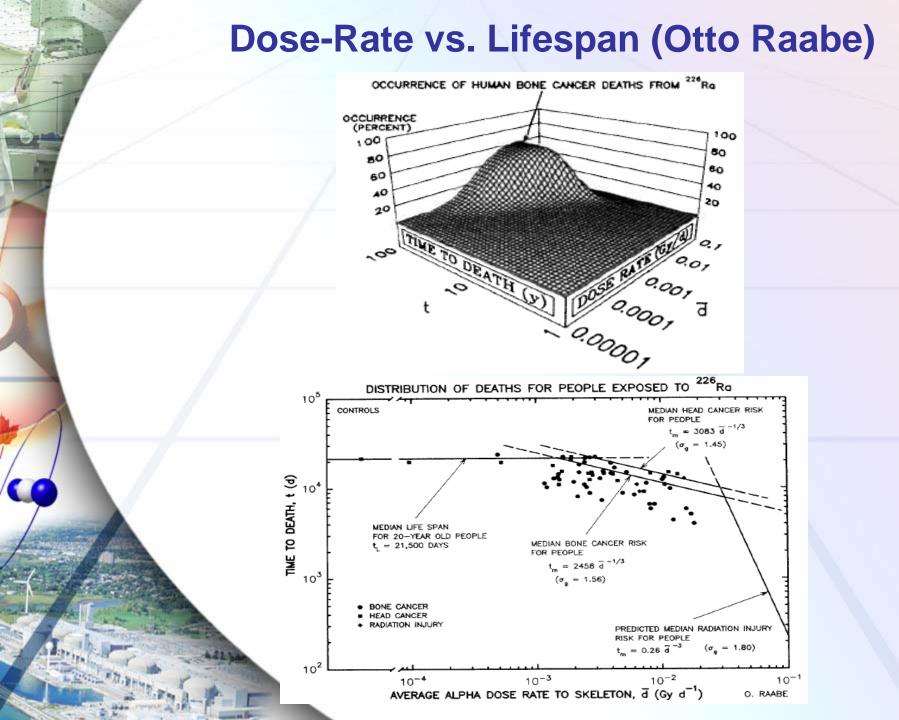
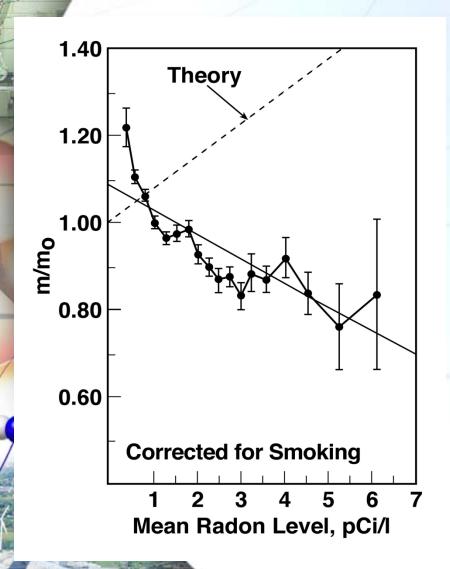


Fig. 11. Cumulative bone sarcoma incidence in people exposed to ²²⁶Ra as a function of cumulative dose to the skeleton as reported by Evans et al. (1972).



Radon Exposure Study Disproves the LNT Hypothesis



Greatest natural radiation exposure is radon gas from uranium activity

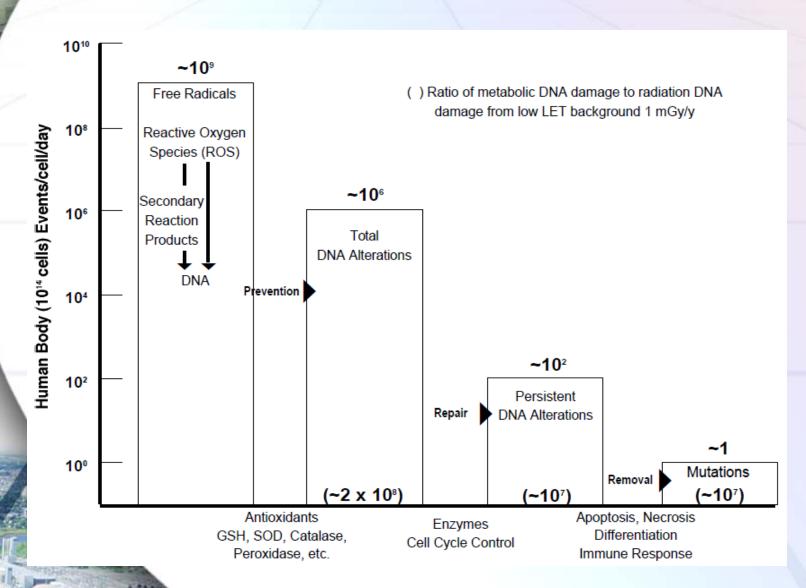
Cohen tested the LNT model, as used, and clearly <u>disproved</u> it; lung cancer mortality *lower* where radon *higher*

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 relevant to testing model

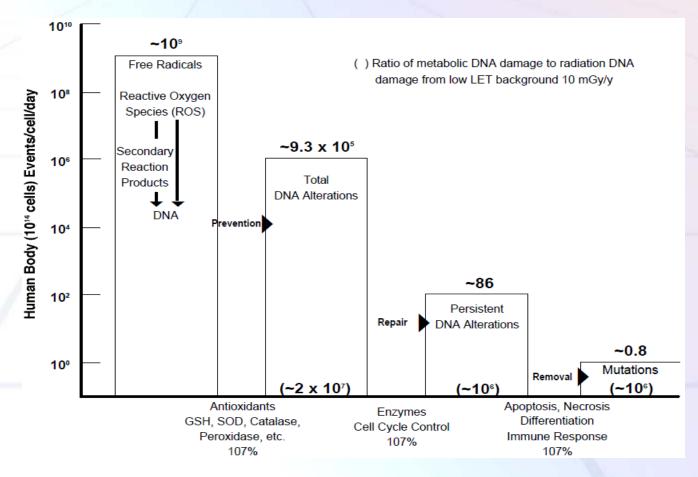
Authorities still accept LNT assumption

Model for Spontaneous DNA mutations



Pollycove-Feinendegen, BELLE, Feb 2003, pg 2-21

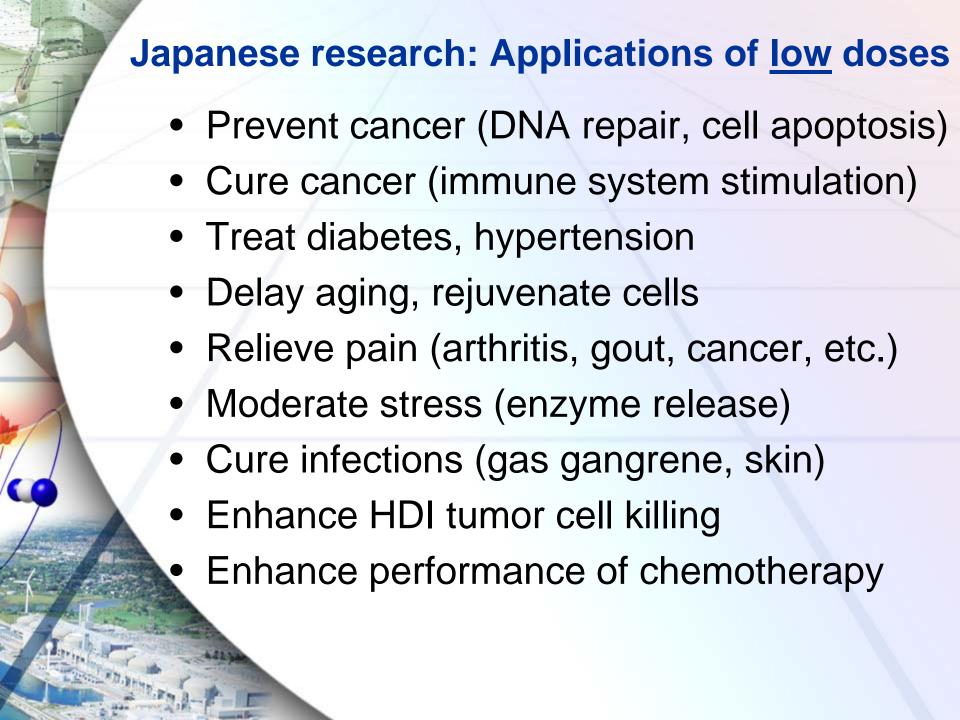
Radiation Hormesis - Stimulation of Defences



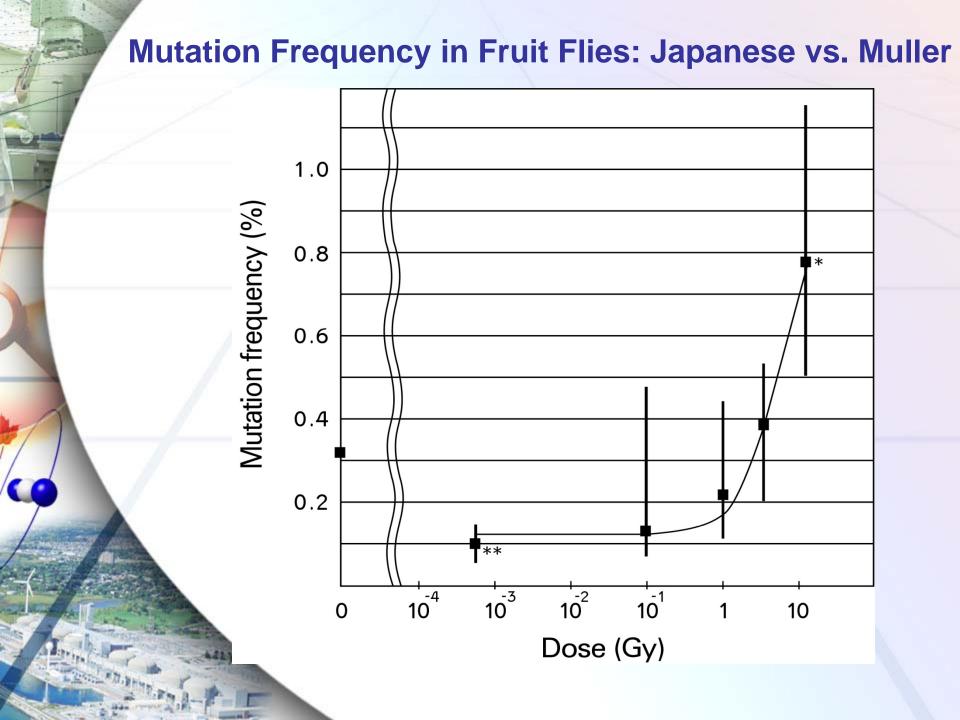
Low dose stimulates defences:

to prevent, repair & remove spontaneous DNA alterations due to thermal and oxidative processes (leakage of ROS)

Spontaneous DNA damage rate is ~10 million times greater than radiation DNA damage rate x10 increase background radiation gives ~20% lower mutation rate







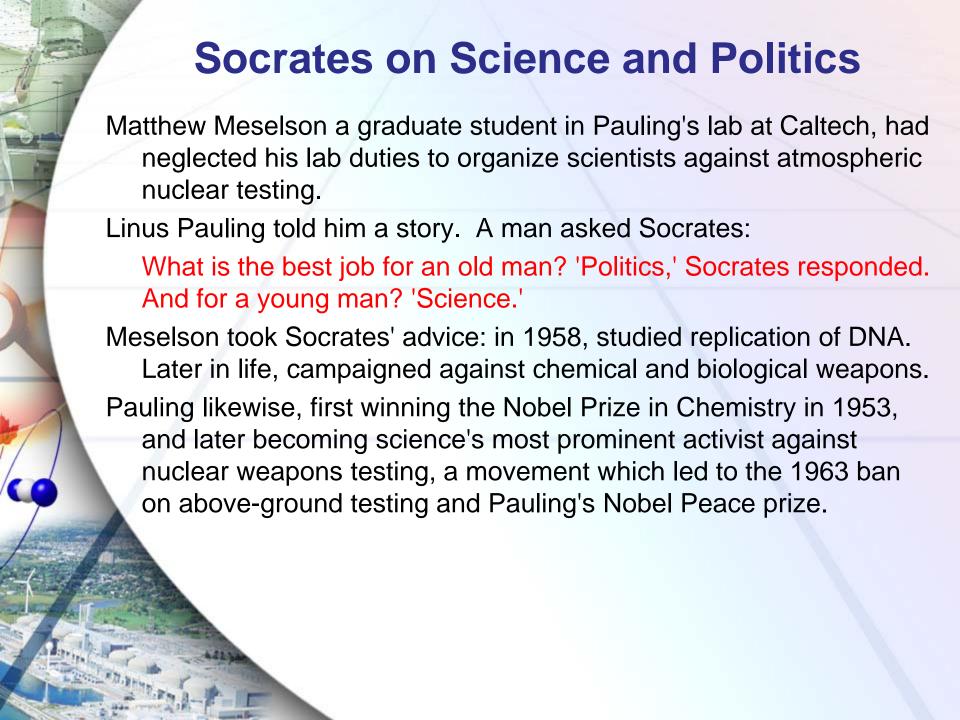


http://www.sciencedaily.com/releases/2011/09/110920163320.htm

No Safe Level of Radiation Exposure? Researcher Points to Suppression of Evidence On Radiation Effects by Nobel Laureate

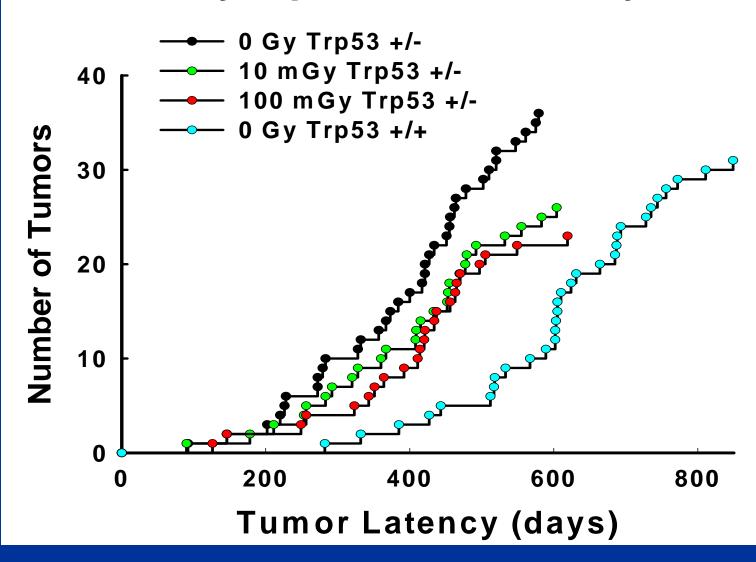
ScienceDaily (Sep. 20, 2011) — University of Massachusetts Amherst environmental toxicologist Edward Calabrese, whose career research shows that low doses of some chemicals and radiation are benign or even helpful, says he has uncovered evidence that one of the fathers of radiation genetics, Nobel Prize winner Hermann Muller knowingly lied when he claimed in 1946 that there is no safe level of radiation exposure.

Calabrese's interpretation of this history is supported by letters and other materials he has retrieved, many from formerly classified files. Published findings in three articles, in scientific journals

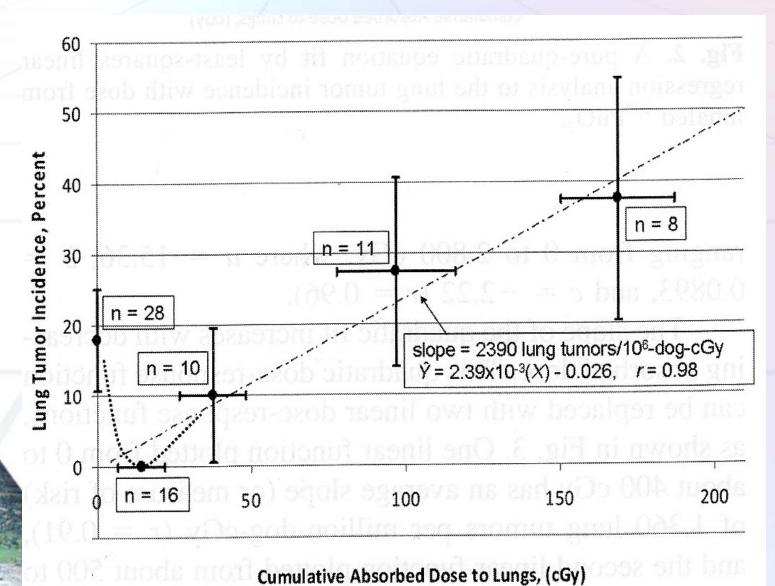


March 1962 Night Letter Duham DC Robinst WW. To President Kennedy, White House! Are you going to give an order that will cause you to go down in history as one of the most immorral men of all time and one of the greatest enemies of the human mace? In a letter to The Now York Times I state that nuclear tests duplicating the Soviet 1961 tests would seriously damage over 20 million unborn children, including those caused to have gross physical or mental defect and also the stillbirths and embryonic, reonataland childhood deaths from the radioactive fission products and carbon 14. Are you going to be quilty of this monstrous immorality, matching that of the Soviet leaders, for the political surpose of increasing the still imposing lead of the United States over the Soviet Union in nuclear weapons technology? (agd) Linus Fauling To Du Jarome Wiesner , Mr Wagesuge Bundy St. Glenn Sealing I have sent the following telegrique to President

Lymphoma Latency



PuO₂ in Beagle Dog Lungs

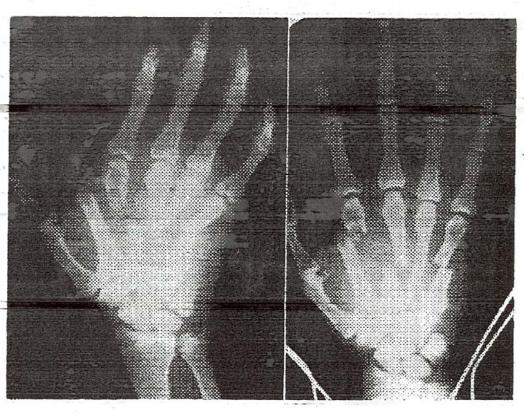


Gas gangrene infection

430

JAMES F. KELLY AND D. ARNOLD DOWELL

October 1941



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

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

Cacar Which

Nasal Radium Irradiation

US CDC estimate: up to 2,600,000 children received NRI from 1945-1961 as a standard medical practice to shrink adenoids. Typical Navy protocol: four 10 minute irradiations 2-4 weeks apart. Contact gamma dose = 2000 rad (20 Gy); 1 cm depth dose = 206 rad (2 Gy) Beta dose 68 rad (0.7 Gy) from each applicator. Excess lymphoid tissue at Eustachian tube openings tended to prevent pressure equalization, aggravation middle ear problems.

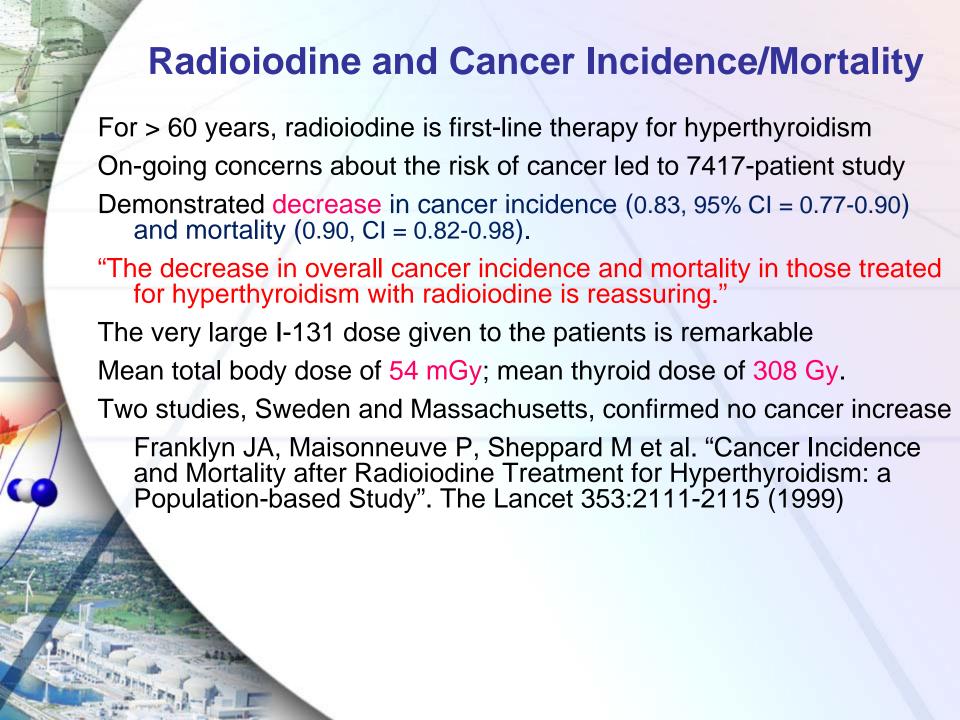


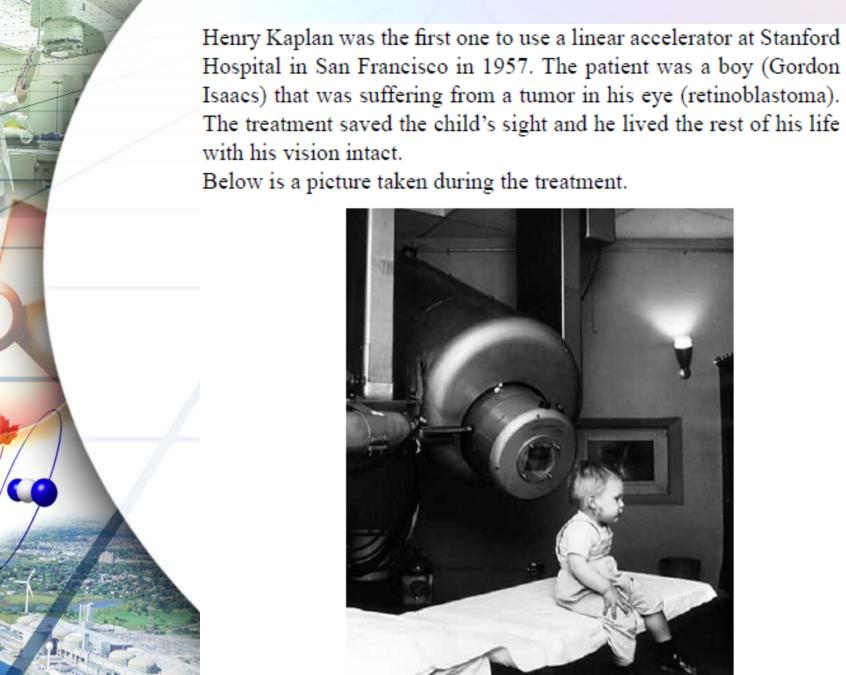
Position of the child patient during treatment

Anesthesia with cocaine precedes introduction of the applicator which is then left in place for twelve minutes on each side (From Proctor, D.F., "The Tonsils and Adenoids in Childhood", p. 17, Charles C. Thomas, Publisher, 1960)



Radiation and Children Children of atomic bomb survivors in Japan; no genetic effects, i.e. No increase in congenital abnormalities, mortality (childhood cancers) chromosome aberrations or mutations in genes Study of 14,351 infants after radiotherapy for skin abnormality revealed total of 17 thyroid cancer deaths Evaluation of 7 major studies by Ron et al. 1995 (58,000 exposed and 61,000 non-exposed children): "many issues are unresolved because of insufficient data." Includes 10,834 children who received x-ray therapy for ringworm in scalp; 60 thyroid cancers, but pituitary gland irradiation cause? Screening Chernobyl children, 1992-2002, revealed 4000 thyroid cancers; 15 of treated patients died. Local incidences does not correlate with I-131 deposition levels Natural occurrence of thyroid cancer is very high. Can we really link radioiodine or other radiation exposures to thyroid cancer?





Second Malignant Neoplasms

5000 childhood cancer survivors after 29 y (average)

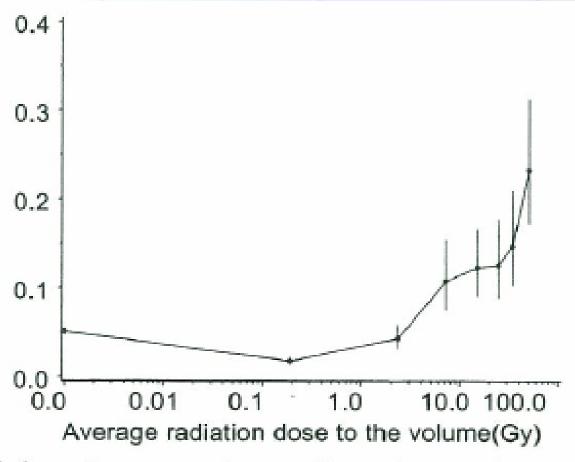


Fig. 1. Second cancers per kg according to the mean dose received in volume All SMN/kg.

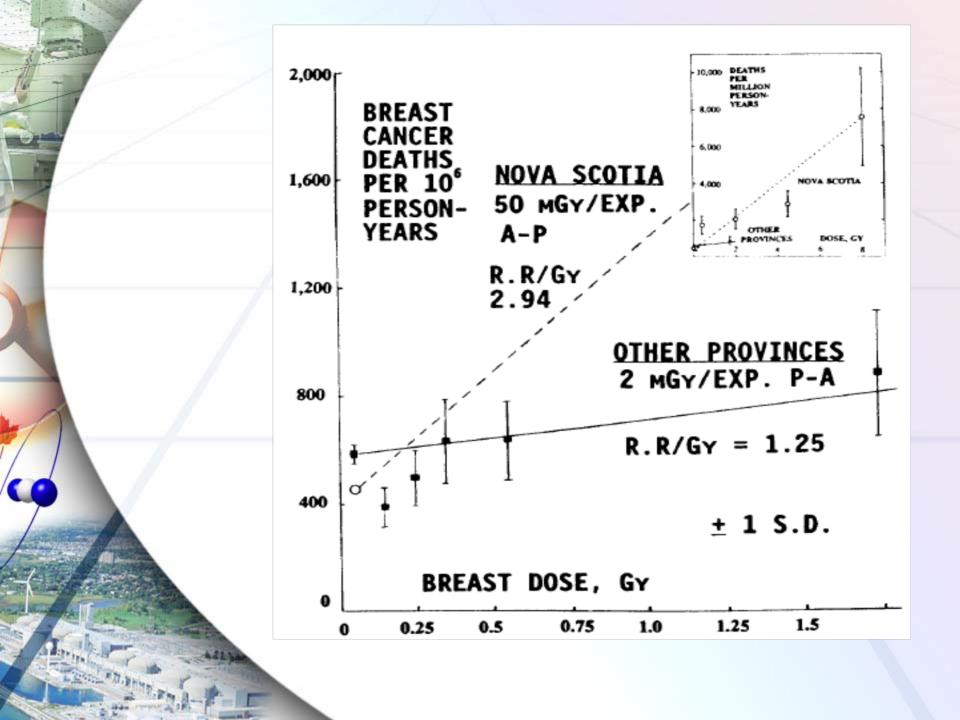
Fluoroscopy for TB NO SHUTTERS NO FILTER NO CONE 1.25 mm lead MR/HR LEAD GLÁSS BOWL OPEN 80 318 R/min

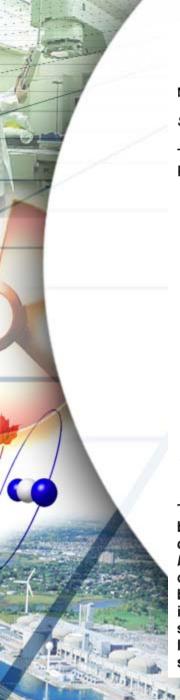
Canadian Breast Cancer Study

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

Dose (Gy)	STANDARDIZED RATE PER 10 ⁸ PERSON-YEARS*		
	NOVA BOOTIA	OTHER PROVINCES	ALL PROVINCES
0-0.09	455.6	585.8	578.6
	(13)	(288)	(301)
0.10-0.19		389.0	421.8
		(29)	(32)
0.20-0.29		497.8	560.7
		(24)	(26)
0.30-0.39 }	1709	630.5	650.8
ABOUNT A	(11).	(17)	(18)
0.40-0.69		632.1	610.0
	. 1.	(19)	(19)
0.70-0.99 J			1362
			(13)
1.00-2.99	2060		1382
	(14)	Brogorea y de de en diger	(17)
3.00-5.99	2811		2334
设备 化氯化物 医多种	(13)	; is a (14) . s ten	(14)
6.00-10.00	7582		8000
	(8)		(9)
≥10.00	21,810	androne in the particles. So as Barbaran as on a same	20,620
	(12)		(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.





Authors' Misrepresentations of their Data in Attempts to Support The Linear No Threshold Hypothesis

Myron Pollycove*

School of Medicine, University of San Francisco, San Francisco, CA USA

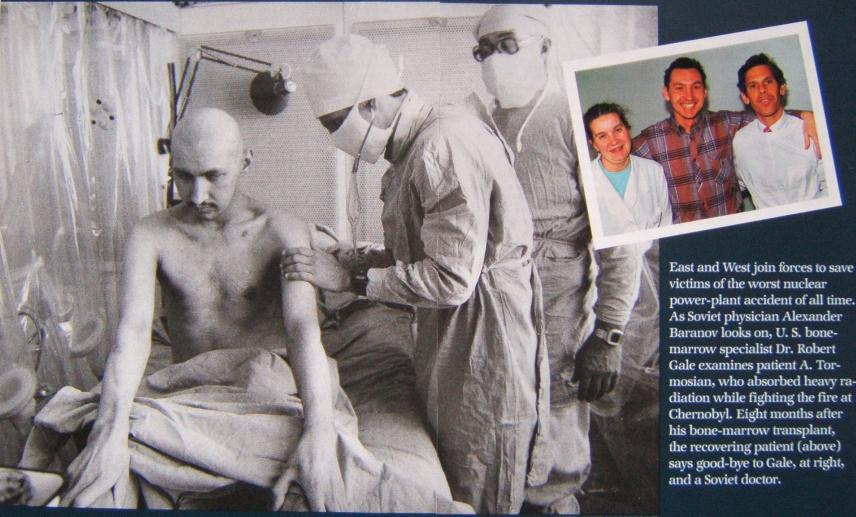
The current status of LNT theory is summarized in National Council on Radiation Protection and Measurements Report 121 on Collective Dose^f:

`...essentially no human data can be said to prove or even to provide direct support for the concept of collective dose with its implicit uncertainties of nonthreshold, linearity and dose-rate independence with respect to risk. The best that can be said is that most [sic] studies do not provide quantitative data that, with statistical significance, contradict the concept of collective dose.

Ultimately, confidence in the linear no threshold dose-response relationship at low doses is based on our understanding of the basic mechanisms involved. [Cancer] could result from the passage of a single charged particle, causing damage to DNA that could be expressed as a mutation or small deletion. It is a result of this type of reasoning that a linear nonthreshold doseresponse relationship cannot be excluded. It is this presumption, based on biophysical concepts, which provides a basis for the use of collective dose in radiation protection activities."

The LNT hypothesis was proposed tentatively more than 40 years ago and has since become firmly established, though still without any supporting low-dose data and contradicted by statistically significant epidemiologic and biologic data. Nevertheless, a biophysical presumption is considered sufficient justification for using LNT as the basis for current policy of protecting against levels of radiation far below the variations of natural background. Studies initiated with the expectation of demonstrating statistically significant increased risk of cancer at low doses of radiation have failed to do so; some even have shown statistically significant decreased risks. Consequent efforts to support the LNT have led to suppression and misrepresentation of their own contradictory data by authors of several studies:

Chernobyl - One Year After By MIKE EDWARDS NATIONAL GEOGRAPHIC SENIOR WRITER Photographs by STEVE RAYMER Paintings by PIERRE MION NATIONAL GEOGRAPHIC PHOTOGRAPHER Paintings by PIERRE MION



power-plant accident of all time. As Soviet physician Alexander Baranov looks on, U.S. bonemarrow specialist Dr. Robert Gale examines patient A. Tormosian, who absorbed heavy radiation while fighting the fire at Chernobyl. Eight months after his bone-marrow transplant, the recovering patient (above) says good-bye to Gale, at right,

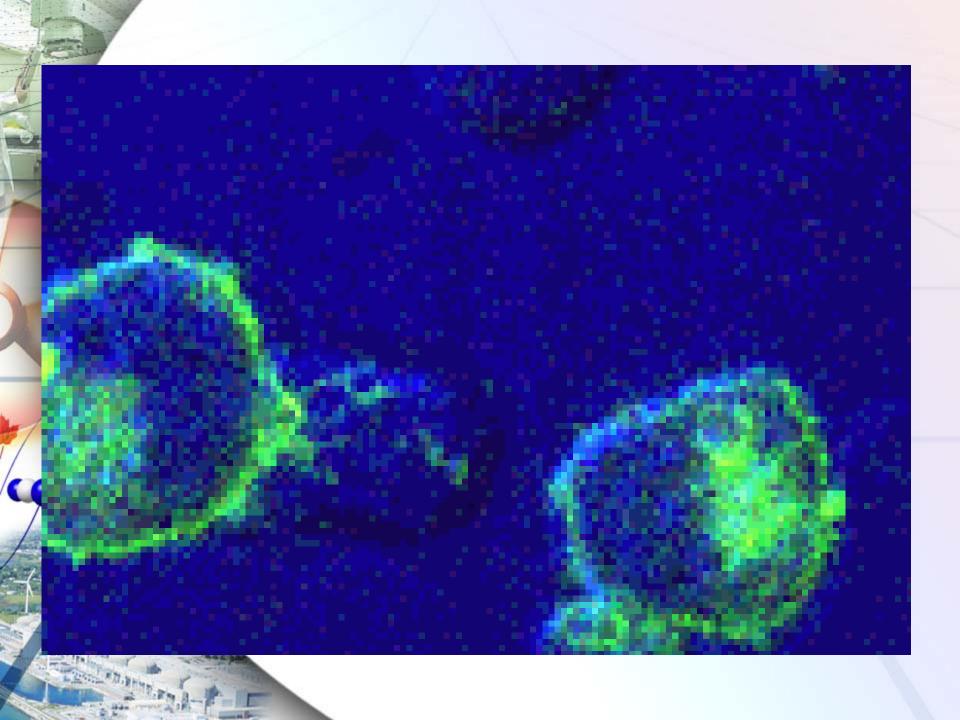
ARS Patients: 134 workers; Deaths: 28; Recovered: 106

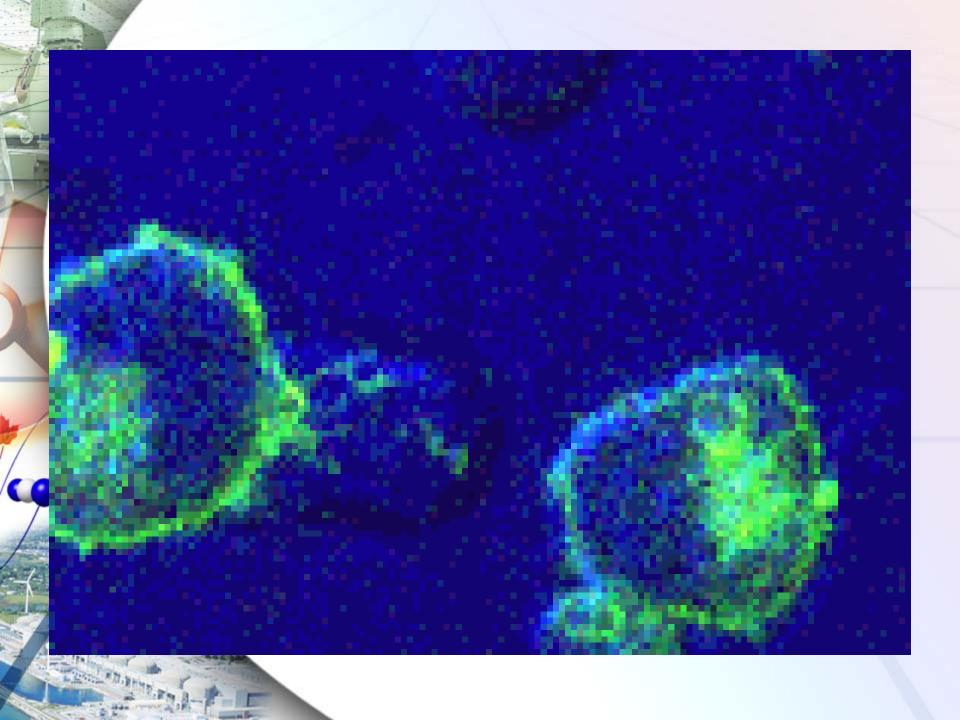
COMMENTS OF DR. ZBIGNIEW JAWOROWSKI REPRESENTATIVE OF REPUBLIC OF POLAND IN UNSCEAR "CHERNOBYL'S LEGACY: HEALTH, ENVIRONMENTAL AND SOCIOECONOMIC IMPACTS" THE CHERNOBYL FORUM

1. GENERAL COMMENTS:

The apparent aim of the document is to dispel irrational psychosis of fear among the population in the three countries most affected by the Chernobyl accident, and among the public elsewhere. Except for 31 early fatalities, psychosis is the most grave and wide impact of this accident, both at the regional and global scale. It caused the greatest medical, economic and societal harm. The document rightly (although not explicitly) stresses that in the contaminated areas the vast majority of about 5 million inhabitants receives now irradiation from the Chernobyl fallout corresponding to a lifetime dose less than 70 mSv, which is lower than the average global natural lifetime radiation dose of 170 mSv, and many times lower than the natural doses in many regions of the world, and that therefore most of the excessive restrictions imposed during the past twenty years should be removed. The statements about lack of increase of solid cancers, leukaemia, the number of stillbirths, adverse pregnancy outcomes and delivery complications, refuting the false information on disastrous medical effects of Chernobyl accident, disseminated en masse over the past twenty years, are also valuable. There is no need to list here many other statements which are right and most helpful. We shall limit our comments to these parts of the text that need correction and to items that are lacking.



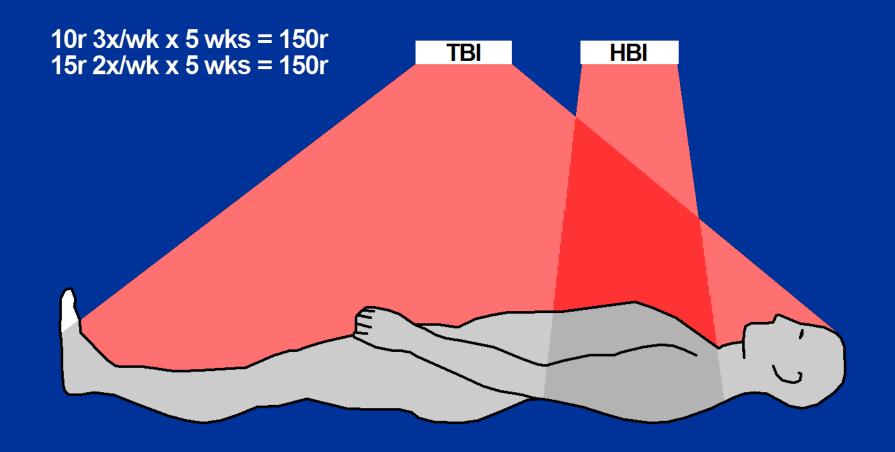




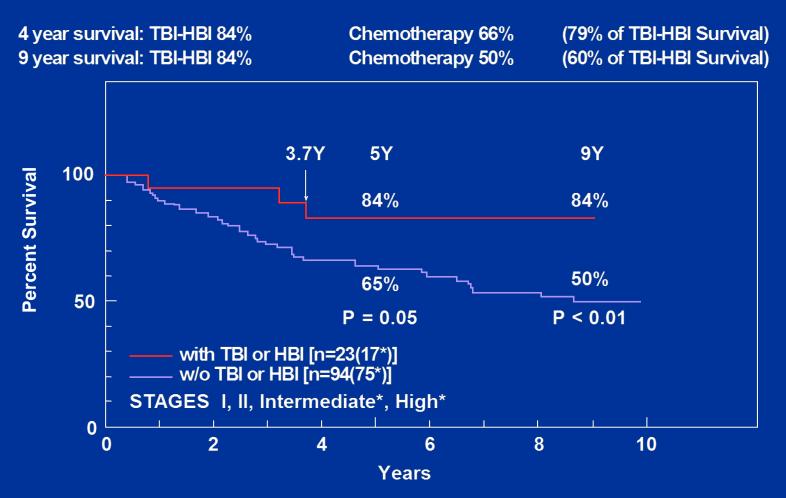




LOW DOSE IRRADIATION OF HALF BODY (HBI) OR TOTAL BODY (TBI) OF PATIENTS WITH NON-HODGKIN'S LYMPHOMA



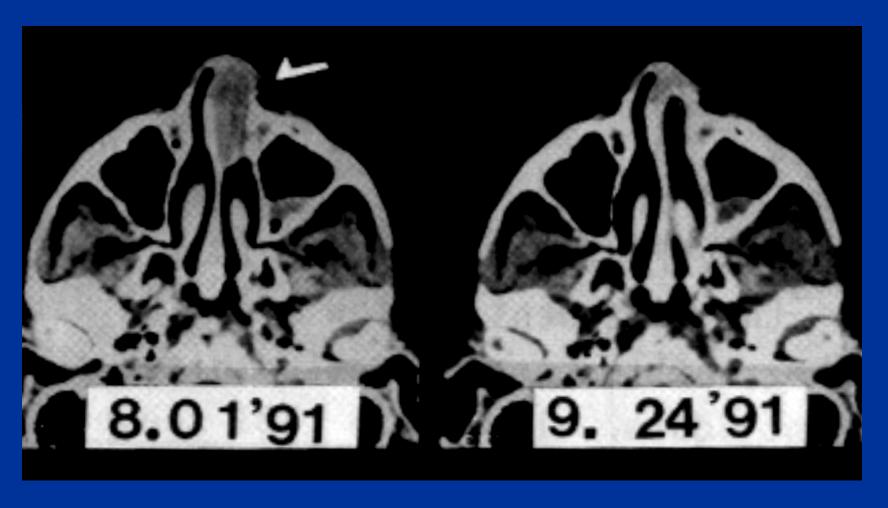
COMPARISON OF LOW-DOSE IRRADIATION OF HALF BODY (HBI) OR TOTAL BODY (TBI) OF PATIENTS WITH NON-HODGKIN'S LYMPHOMA



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

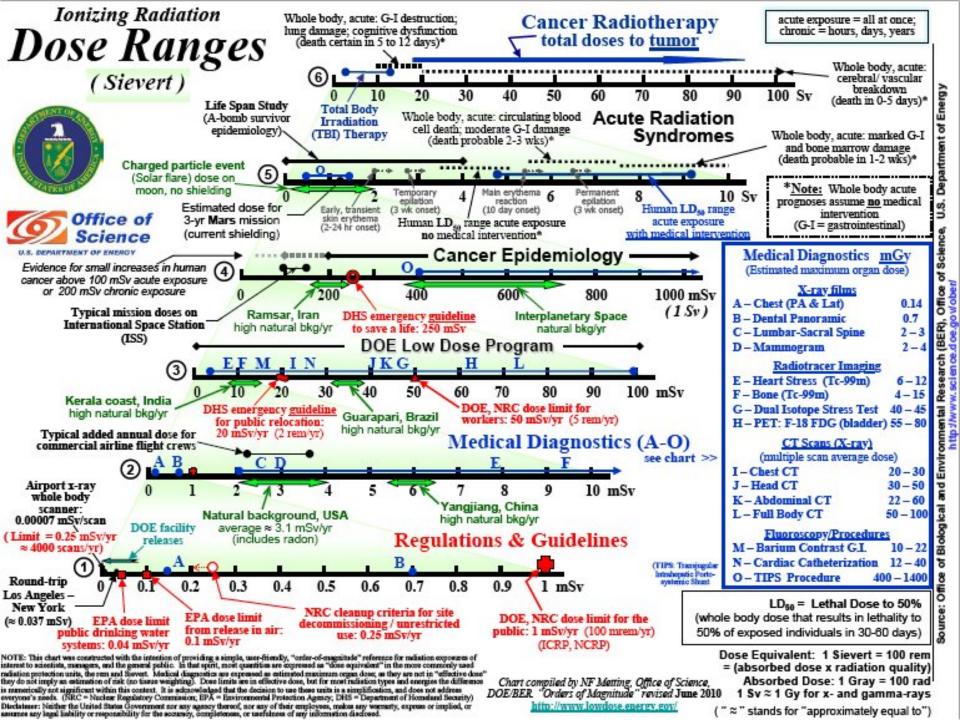
Sakamoto, et. al. J Jpn Soc Ther Radiol Oncol 9:161-175, 1997

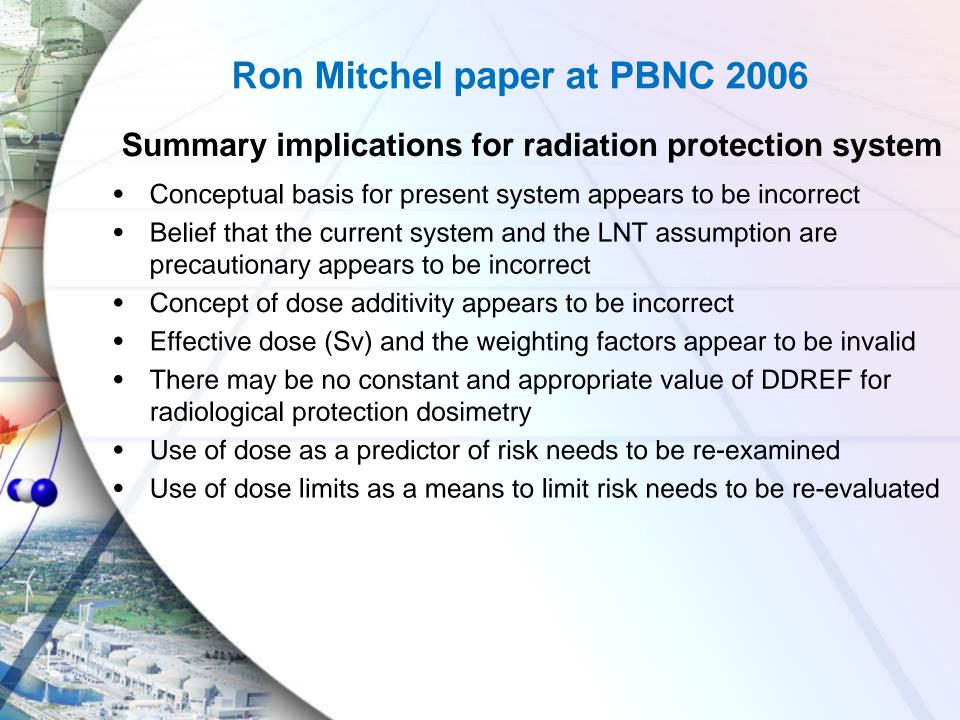
RAPID REGRESSION OF NON-HODGKIN'S LYMPHOMA TUMORS IN RESPONSE TO LOW-DOSE HBI OR TBI



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)





Dose-Response, 7:52-89, 2009

Formerly Nonlinearity in Biology, Toxicology, and Medicine

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NUCLEAR ENERGY AND HEALTH

And the Benefits of Low-Dose Radiation Hormesis

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Myron Pollycove

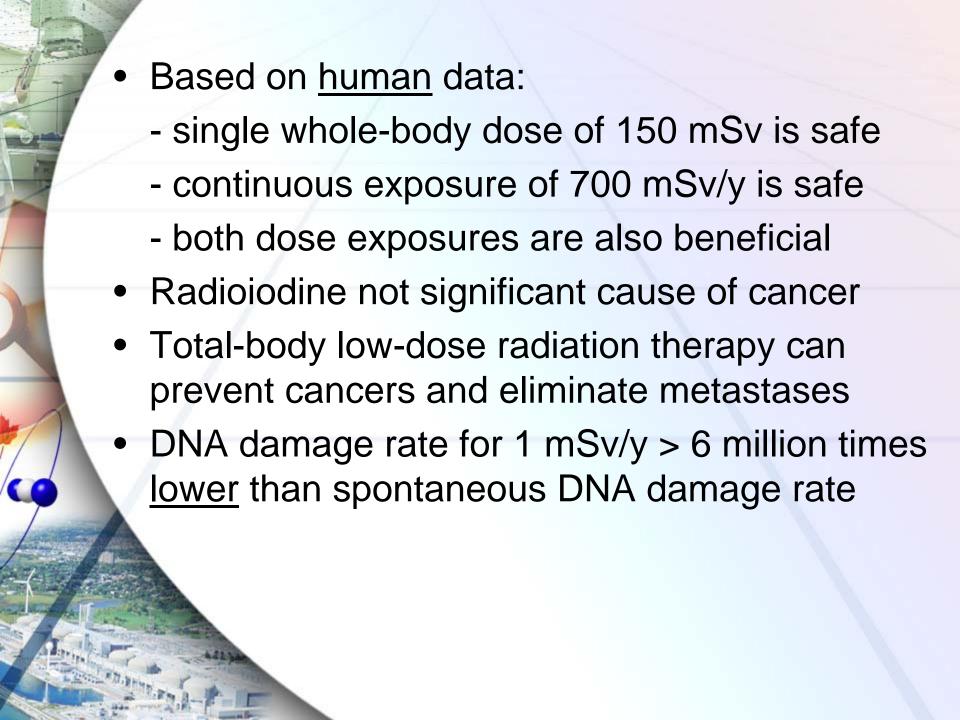
School of Medicine, University of California San Francisco, San Francisco, CA

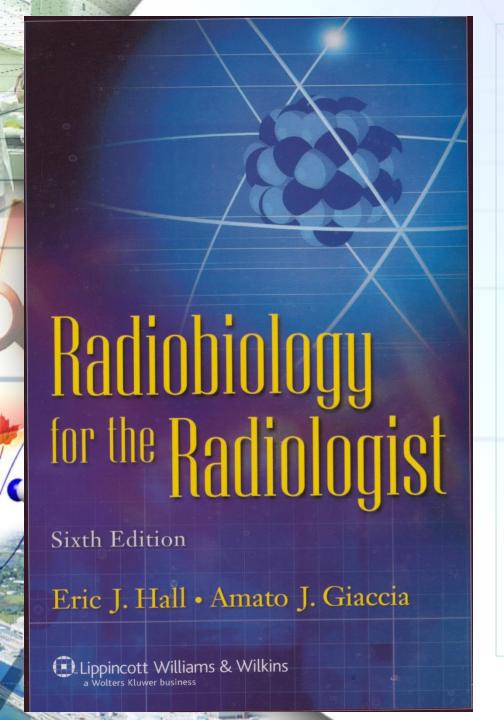
□ Energy needs worldwide are expected to increase for the foreseeable future, but fuel supplies are limited. Nuclear reactors could supply much of the energy demand in a safe, sustainable manner were it not for fear of potential releases of radioactivity. Such releases would likely deliver a low dose or dose rate of radiation, within the range of naturally occurring radiation, to which life is already accustomed. The key areas of concern are discussed. Studies of actual health effects, especially thyroid cancers, following exposures are assessed. Radiation hormesis is explained, pointing out that beneficial effects are expected following a low dose or dose rate because protective responses against stresses are stimulated. The notions that no amount of radiation is small enough to be harmless and that a nuclear accident could kill hundreds of thousands are challenged in light of experience: more than a century with radiation and six decades with reactors. If nuclear energy is to play a significant role in meeting future needs, regulatory authorities must examine the scientific evidence and communicate the real health effects of nuclear radiation. Negative images and implications of health risks derived by unscientific extrapolations of harmful effects of high doses must be dispelled.

Conclusions

- Nuclear energy is blocked by antinuclear activists who communicate myths about cancer
- Radiation scare is not debunked by anyone, and there is no outrage from professionals
- Nuclear regulations are overprotective and very costly in dollars and time
- Chernobyl victims suffered not from cancer, but from "vegetative vascular dystonia" (depression)

"psychosis of fear"

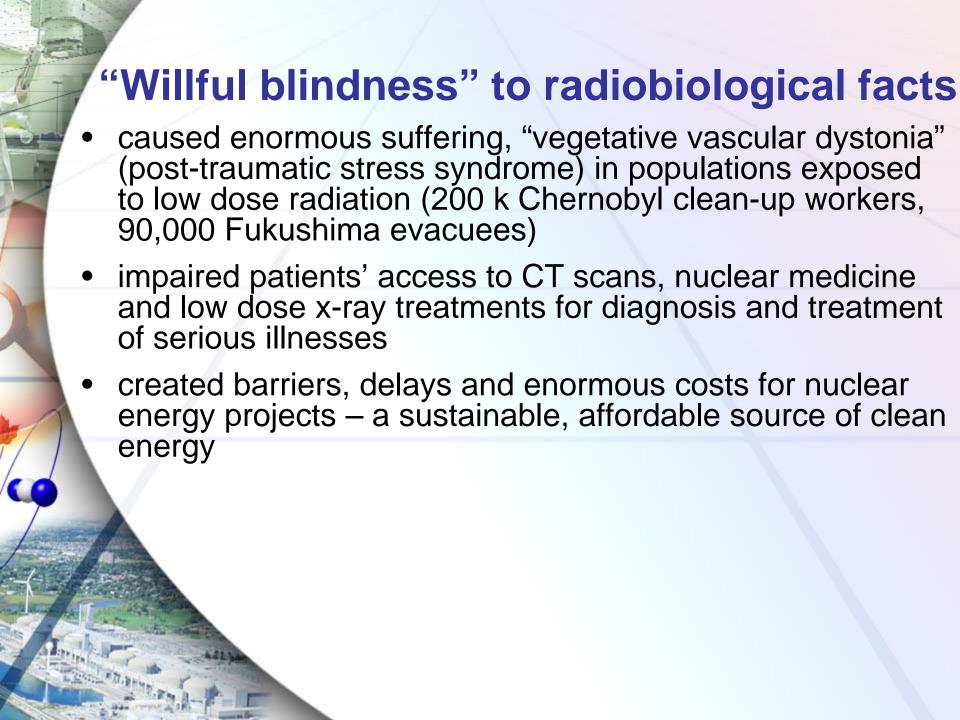




All physicians are carefully taught that any amount of ionizing radiation, down to zero dose, brings a risk of fatal cancer -- the LNT Hypothesis.

Error of Omission: Book does <u>not</u> mention radiation hormesis. It totally ignores the enormous amount of scientific data, e.g. UNSCEAR 1994, Addendum B (192 papers) showing that low doses and low dose rate radiation provide beneficial health effects (decreased cancer mortality).

Also see British Journal of Radiology, "Mortality from cancer and all causes among British radiologists" by Smith and Doll, 1981



Radiation Exposures of 18,846 Plant Workers 2011 March 11 to November 30

Workers vs Dose since Mar 11

139 100 to 150 mSv

23 150 to 200 mSv

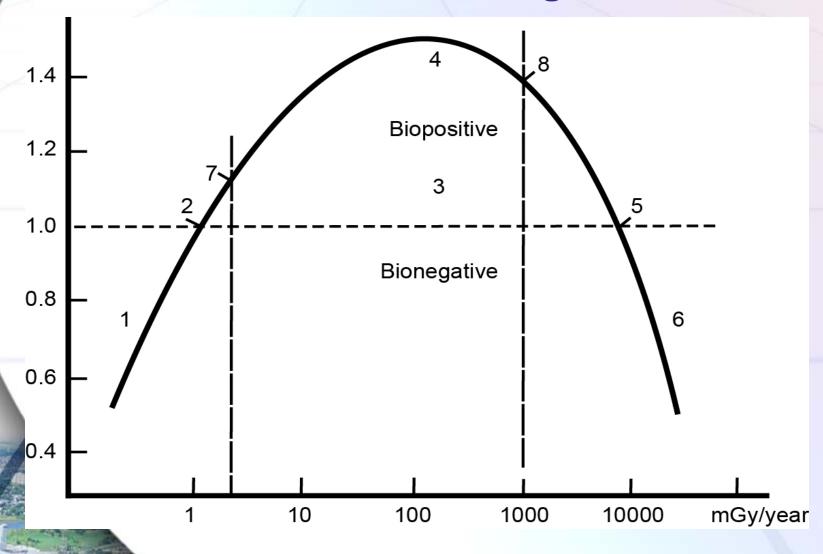
3 200 to 250 mSv

6 309 to 678 mSv

171 total, more than 100 mSv

Compare 678 mSv with TBI LDI therapy: $150 \text{ mGy} \times 2/\text{wk} \times 5 \text{ wk} = 1500 \text{ mGy}$

Radiation Stimulates Biological Defences



As High As Reasonably Safe (AHARS)

http://search.japantimes.co.jp/cgi-bin/nn20111010a1.html

The Japan Times

Monday, Oct. 10, 2011

Prefecture to use ultrasound on 360,000 kids Fukushima begins child thyroid checks

Kyodo

FUKUSHIMA — Fukushima started ultrasonic thyroid exams Sunday for the prefecture's 360,000 children aged up to 18 as part of efforts to monitor the health conditions of young people amid the Fukushima No. 1 nuclear plant crisis.



