Polish Radiation Research Society Symposium: Applications of low radiation doses in medical diagnosis and therapy

Kielce, Poland, September 17-18, 2019

Application of low doses of ionizing radiation in medical therapies

Jerry M. Cuttler D.Sc.

Cuttler & Associates Inc

Toronto, Canada

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Introducing the speaker

Dr. Jerry M. Cuttler

He graduated Engineering Physics from U of Toronto in 1964, and received M.Sc. in Nuclear Engineering and D.Sc. in Nuclear Sciences from Israel Institute of Technology in 1968, 1971.

From 1974 until 2000, Cuttler was employed by Atomic Energy of Canada Limited in the design, construction and operation of more than 25 CANDU reactors in Canada and abroad. Since 2000, he has been providing services and participating in 10 international organizations.

In 1995, Dr. Cuttler began working with renowned medical scientists and radiobiologists to understand the health effects of low doses of ionizing radiation. He is an author of 43 articles; most are in peer-reviewed journals. He and his colleagues have been sharing scientific evidence and studying the mechanisms of radiation-induced beneficial health effects.

In 2015-2018, he saw evidence of a significant benefit in a patient with severe Alzheimer's dementia and another with Parkinson disease, after they received X-ray CT scans of the brain. He is participating in a pilot study in Toronto to replicate the treatments given to the patient with Alzheimer's dementia, to determine whether the partial recovery can be observed again. He is also collaborating with medical scientists in Japan who treat patients with radon therapy.

Radiation and Risk—a hard look at the data

https://fas.org/sgp/othergov/doe/lanl/pubs/00326631.pdf Los Alamos National Lab 1995

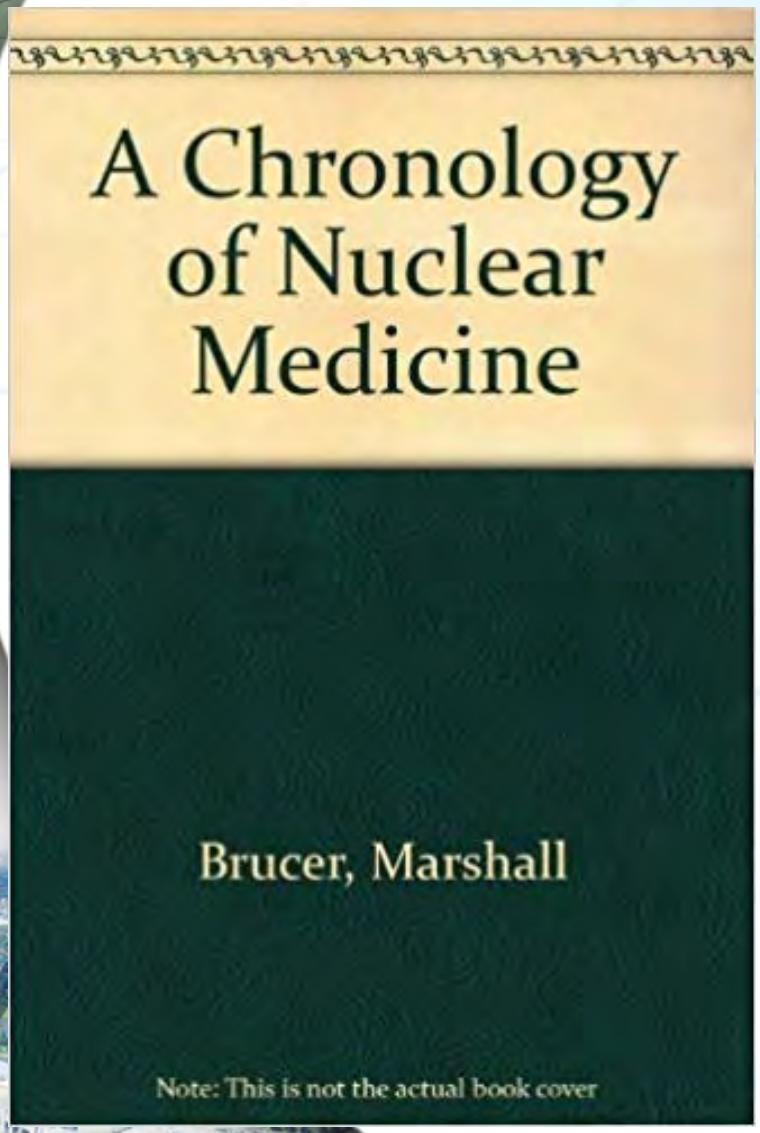
A Brief History of Radiation

Wilhelm Röntgen discovered X-rays in 1895

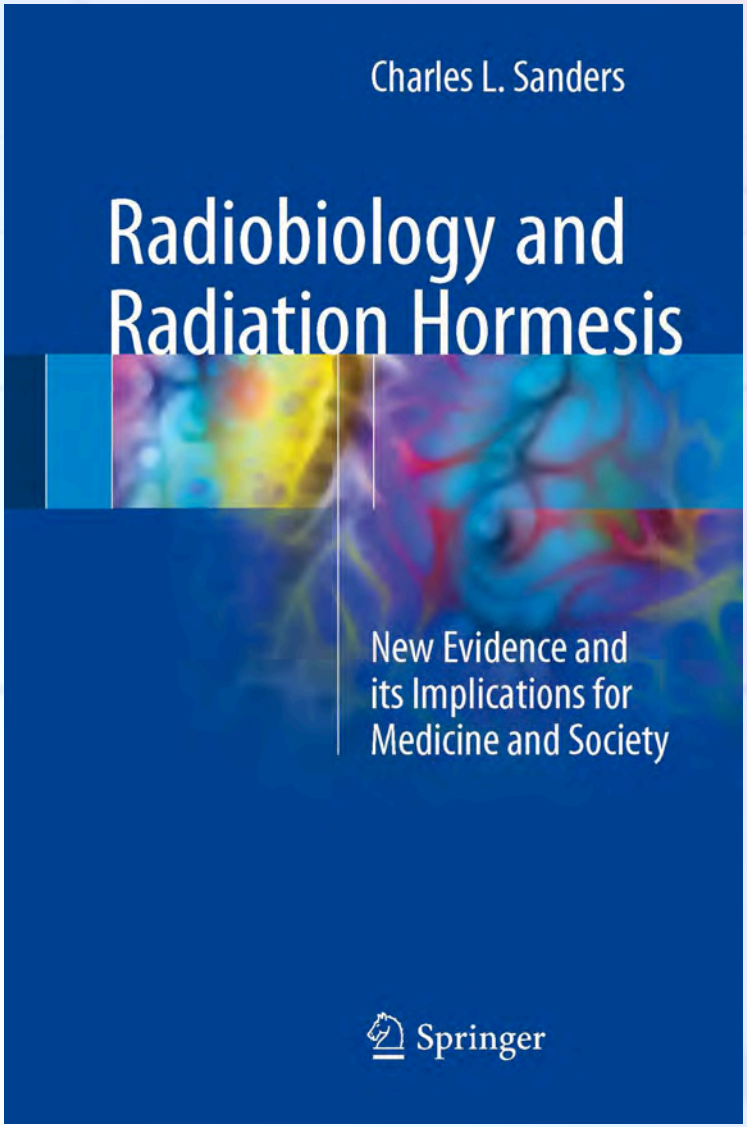
Health physics is concerned with protecting people from the harmful effects of ionizing radiation while allowing its beneficial use in medicine, science, and industry. Since the discovery of radiation and radioactivity 100 years ago, radiation protection standards and the philosophy governing those standards have evolved in somewhat discrete intervals. The changes have been driven by two factors—new information on the effects of radiation on biological systems and changing attitudes toward acceptable risk. The earliest limits were based on preventing the onset of such obvious effects as skin ulcerations that appeared after intense exposure to radiation fields. Later limits were based on preventing delayed effects such as cancer that had been observed in populations of people receiving high doses, particularly from medical exposures and from the atomic-bomb exposures in Hiroshima and Nagasaki.

During the evolution of standards, the general approach has been to rely on risk estimates that have

1990


A Chronology of Nuclear Medicine
Brucer, Marshall
Note: This is not the actual book cover

2017


Charles L. Sanders
Radiobiology and Radiation Hormesis
New Evidence and its Implications for Medicine and Society
Springer

Radium discovered by Marie Skłodowska Curie, 1898

http://www.osti.gov/bridge/servlets/purl/10114798/

ANL/ER-3
UC-408

Radium in Humans

A Review of U.S. Studies

by
R.E. Rowland
Environmental Research Division

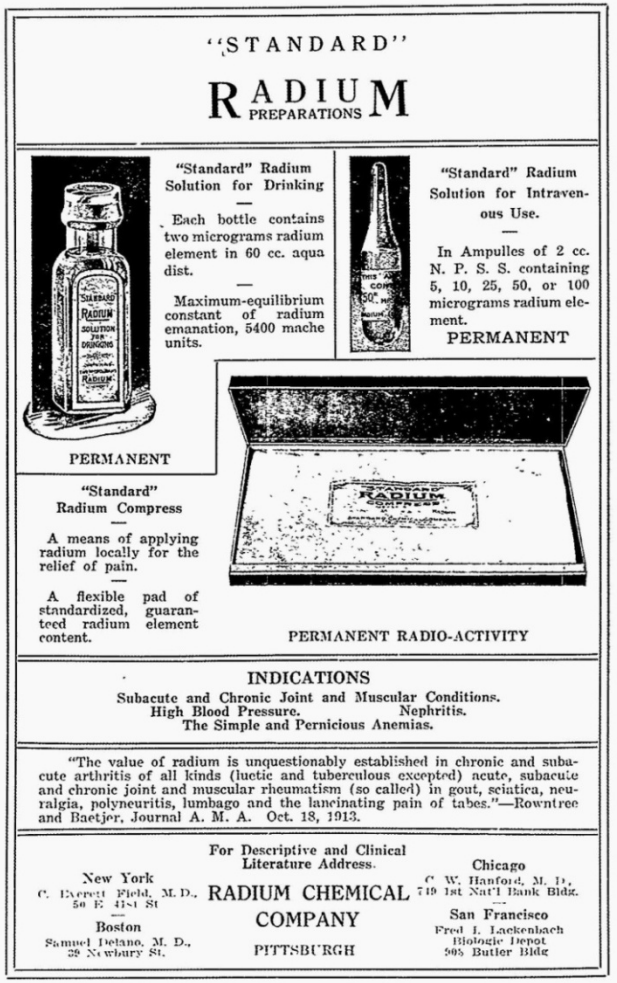
Argonne National Laboratory
9700 South Cass Avenue
Argonne, Illinois 60439

September 1994

MASTER

Work supported by the United States Department of Energy,
Office of Energy Research, Office of Health and Environmental Research,
and Assistant Secretary for Environment, Safety, and Health,
Office of Epidemiology and Health Surveillance

400,000 bottles sold over the counter



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For Descriptive and Clinical Literature Address.

New York
C. Everett Field, M.D.,
50 E. 41st St

Boston
Samuel Delano, M. D.,
29 Newbury St.

RADIUM CHEMICAL COMPANY
PITTSBURGH

Chicago
C. W. Hanford, M. D.,
719 1st Nat'l Bank Bldg.

San Francisco
Fred I. Lackenbach
Biologic Depot
505 Butler Bldg

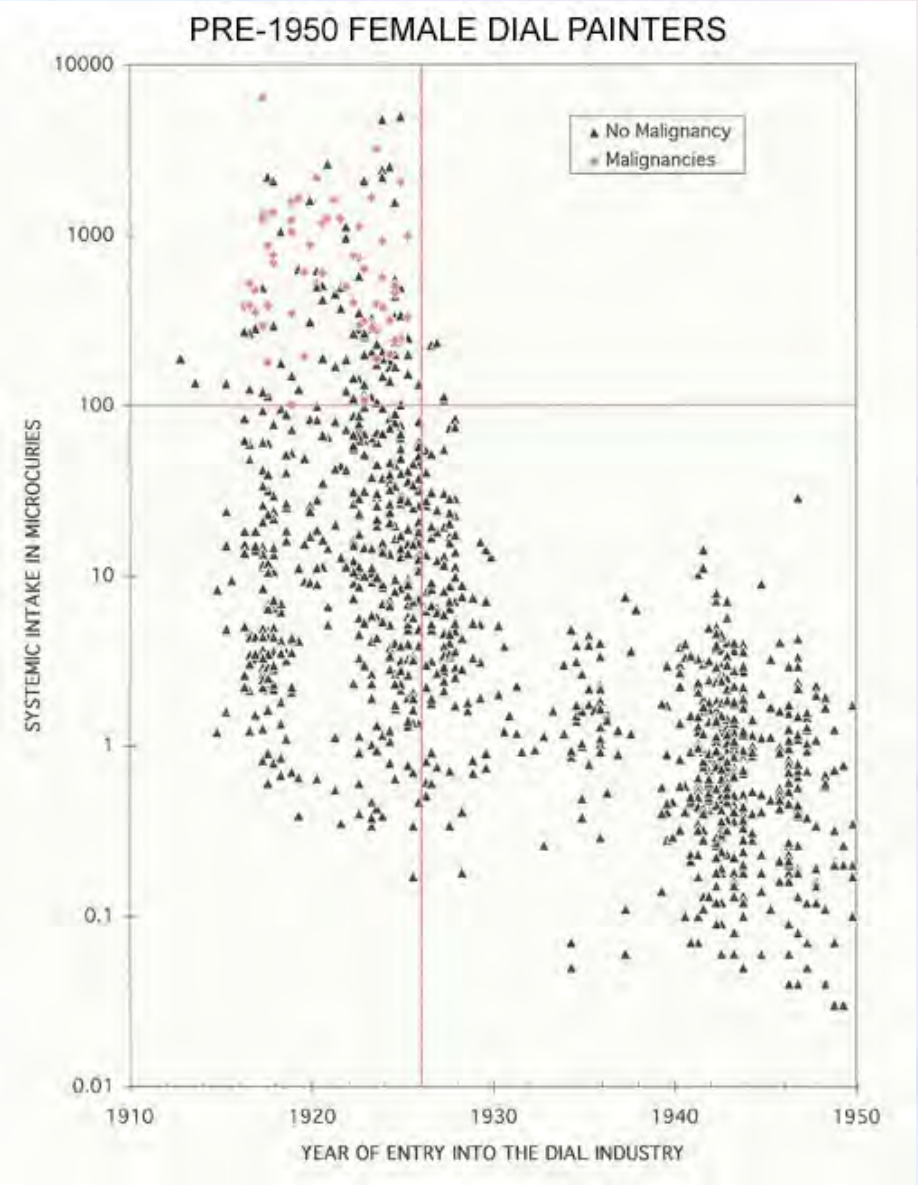
FIGURE 3 This advertisement for radium preparations to be used internally and externally appeared in the June 1916 issue of the journal *Radium*.

4133 radium dial painters identified in USA

How much radium is harmful?

Intake threshold for malignancies is 100 µCi (100 µg) of radium

56 malignancies in **1468** dial painters



10 Gy threshold radium-induced bone cancer

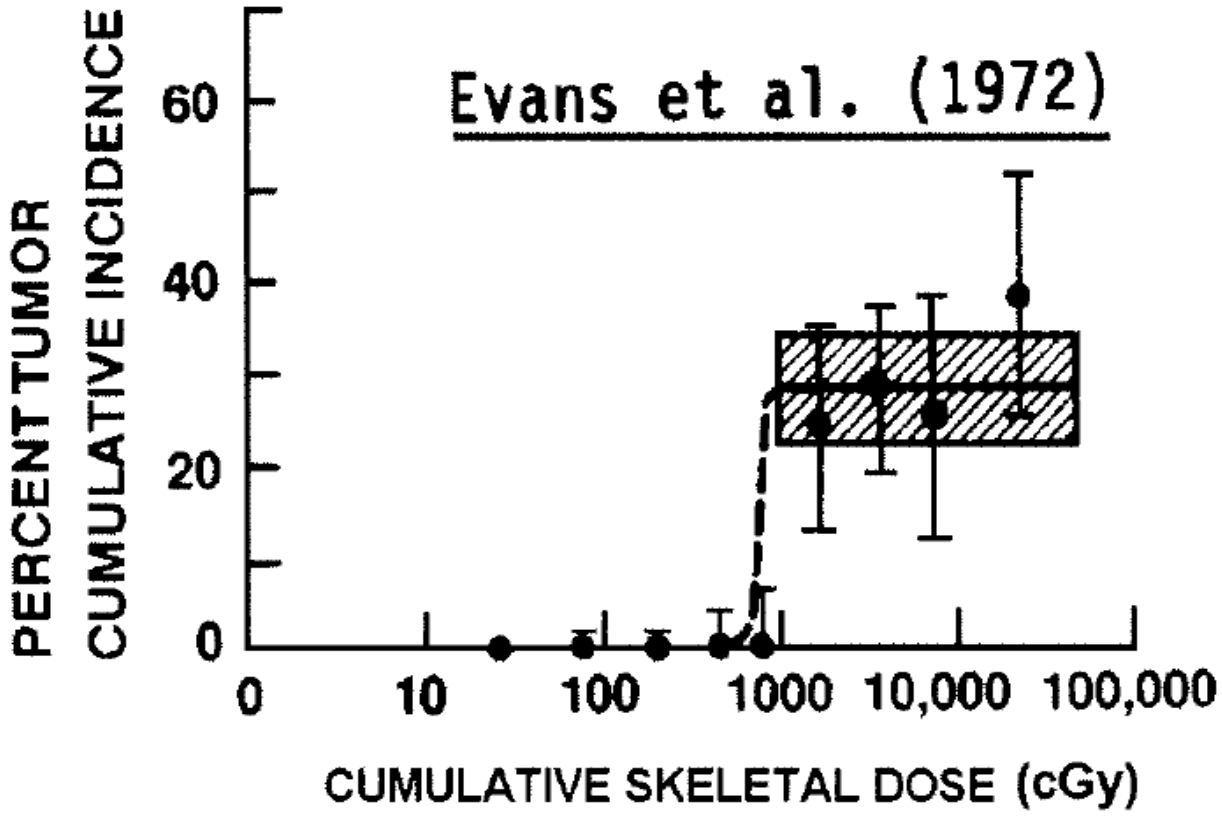


Fig. 11. Cumulative bone sarcoma incidence in people exposed to ^{226}Ra as a function of cumulative dose to the skeleton as reported by Evans et al. (1972).

Low-dose radiation treatments for >120 years

Long ago: 1896-1970, physicians used X-rays and radium to

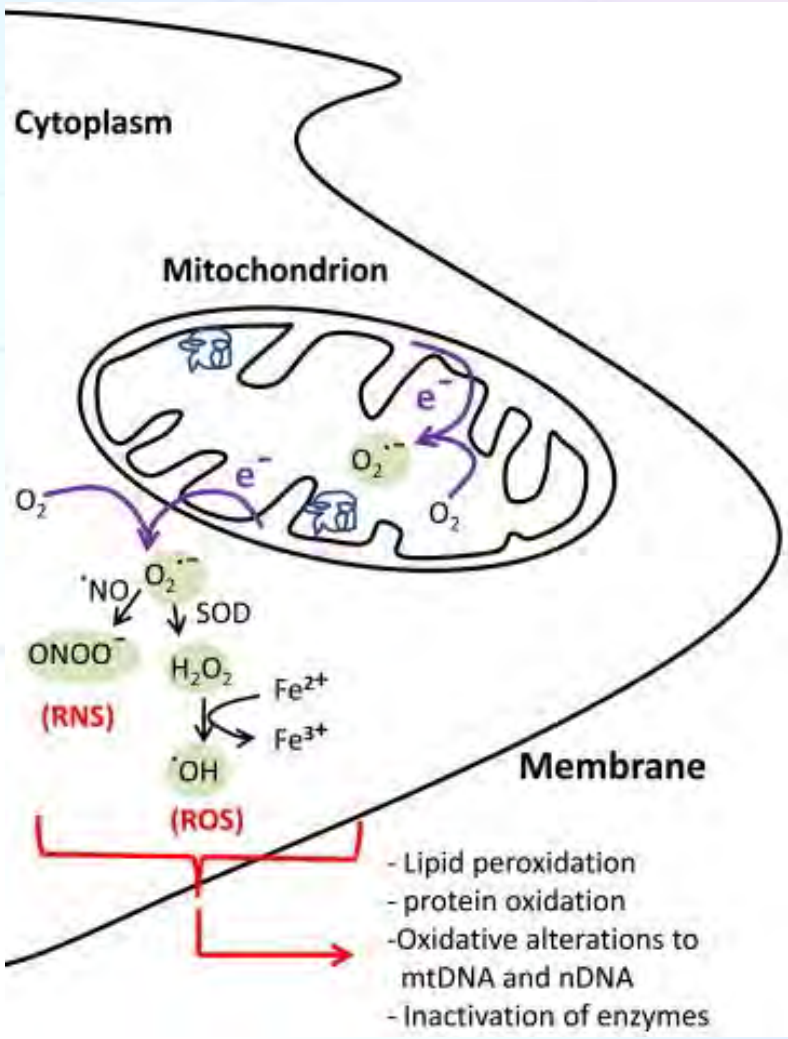
- **treat cancer, slow its progression, eliminate metastases**
- **heal wounds faster**
- **stop infections: gas gangrene, carbuncles and boils, sinus, inner ear, whooping cough, pneumonia, etc.**
- **relieve arthritis and other inflammatory conditions, lymph glands, adenoids in children**
- **treat asthma, autoimmune diseases, Type-I diabetes**
- **Little evidence reported of increased cancer in patients**

What is the mechanism for beneficial effects? Organisms deal with toxic oxygen and radiation

- Aerobic (air-breathing) organisms react oxygen for energy
- Oxygen leaks and damages DNA and all other biomolecules
- Very powerful natural protection systems in every organism prevent, repair and remove DNA damage from all sources
- These systems are essential for survival, but they become progressively weaker as each organism ages
- Radiation dose causes a burst of "hits" and radiolysis of H_2O makes reactive oxygen species (ROS); ~75% of tissue is H_2O
- Hits and ROS affect natural protection systems (> 150 genes)

Oxygen leakage from aerobic metabolism

Naturally-occurring ROS



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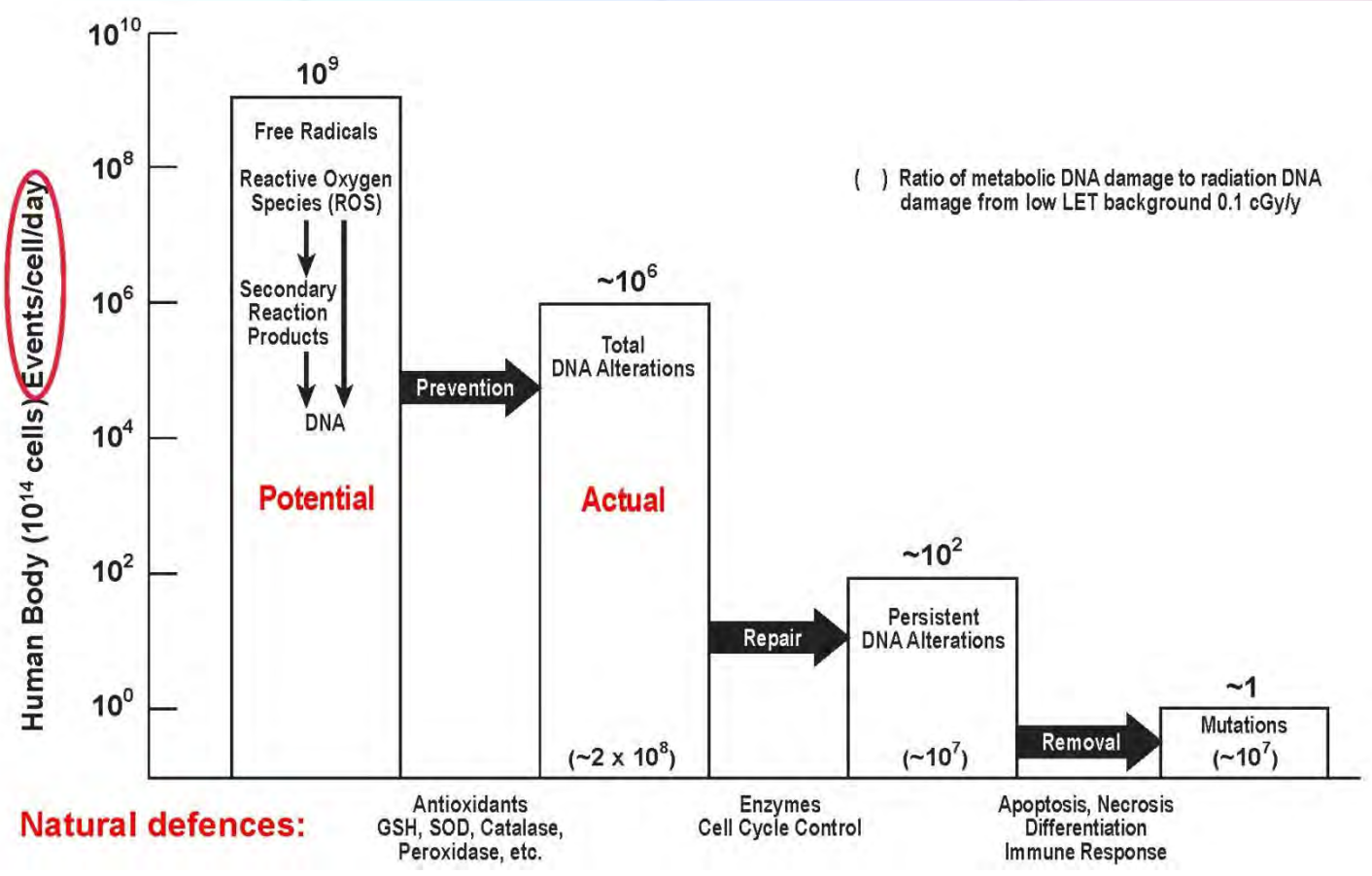
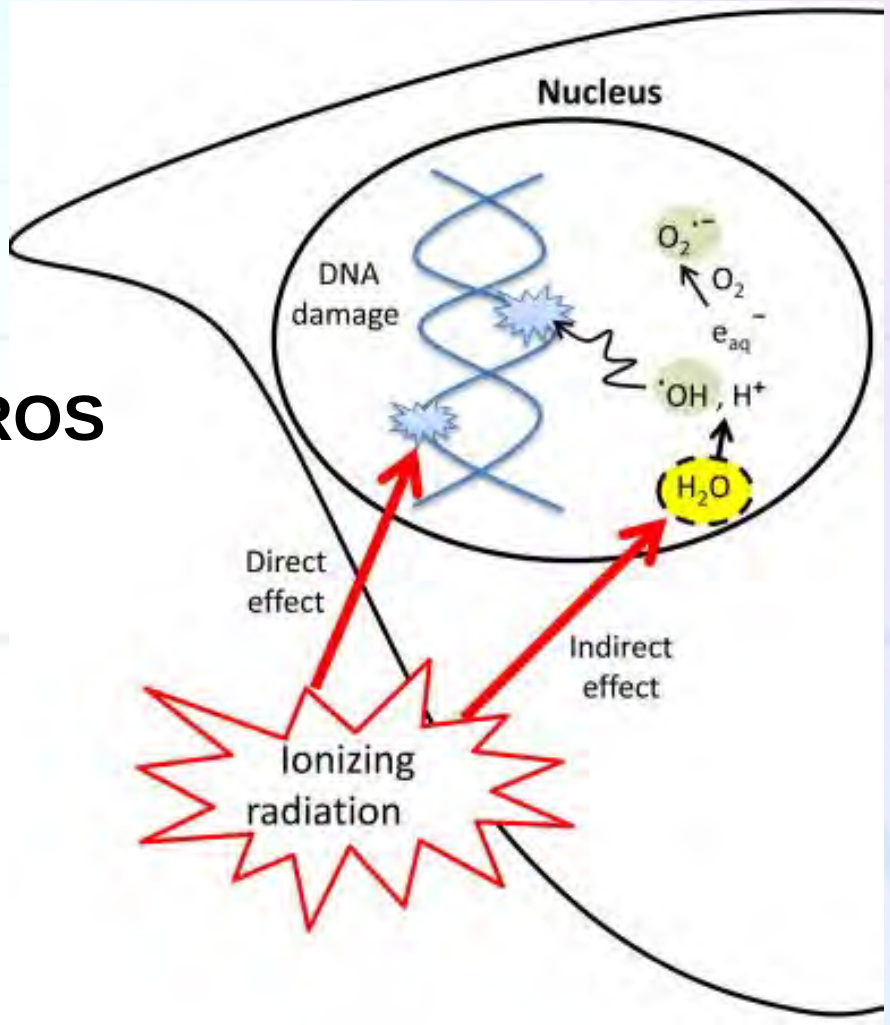
Role of natural protection systems against DNA damage rate from breathing oxygen



Organisms get energy by reacting oxygen and glucose; however, oxygen leaks and damages their biomolecules

Ionizing radiation effects on DNA and H_2O

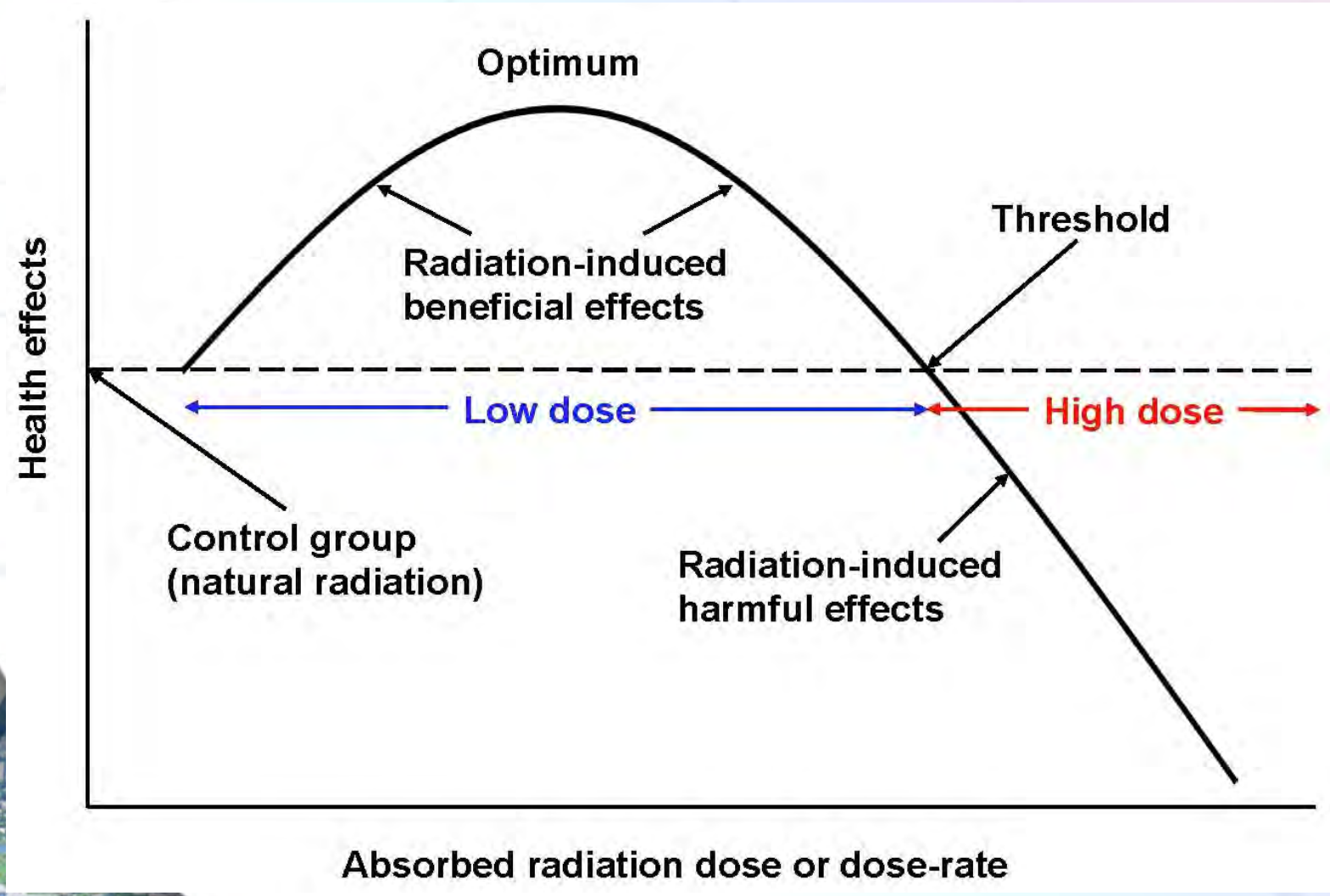
Radiation-induced ROS



Definition of a “low dose” of ionizing radiation

- **Radiation “hits” and ROS send *signals* to other locations in the body (“bystander effects”); they initiate many damage-control activities, both positive and negative**
- **The actual processes that occur are very complicated**
- **A high dose inhibits or damages these biosystems and produces observable harm (immediate or latent)**
- **A low dose stimulates damage-control biosystems, which act on damage, both natural and radiation-induced, to produce observable health benefits**
- **Repeat low doses extend the duration of stimulation, and natural protection systems adapt to become more active**

Hormetic dose-response model

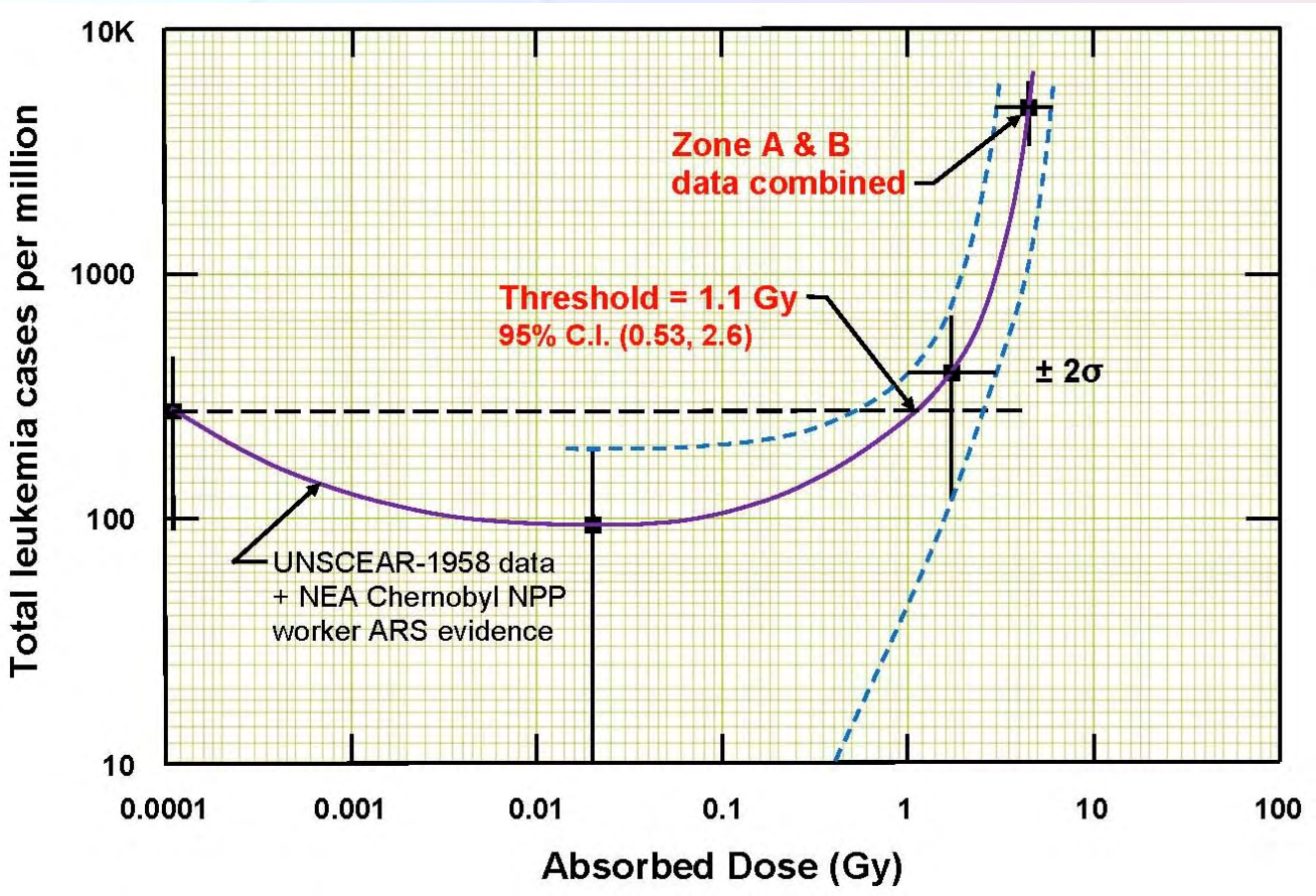


What about radiation-induced cancer and other life-limiting diseases?

1. **A high dose inhibits the cancer-fighting immune system**
2. **Since blood-forming cells in bone marrow are very sensitive to radiation, we can expect radiation-induced leukemia (via mutations) to occur soon after an exposure**
   - **Evidence of threshold for radiation-induced leukemia at ~ 1.1 Gy**
   - **Threshold is high, ~ 10 times the LDIR treatment dose**
   - **Evidence of dose-rate threshold at ~ 600 mGy/year for life span**
   - **Continuous radiation level above this threshold shortens life span**
   - **Low-dose radiation treatments are very safe**

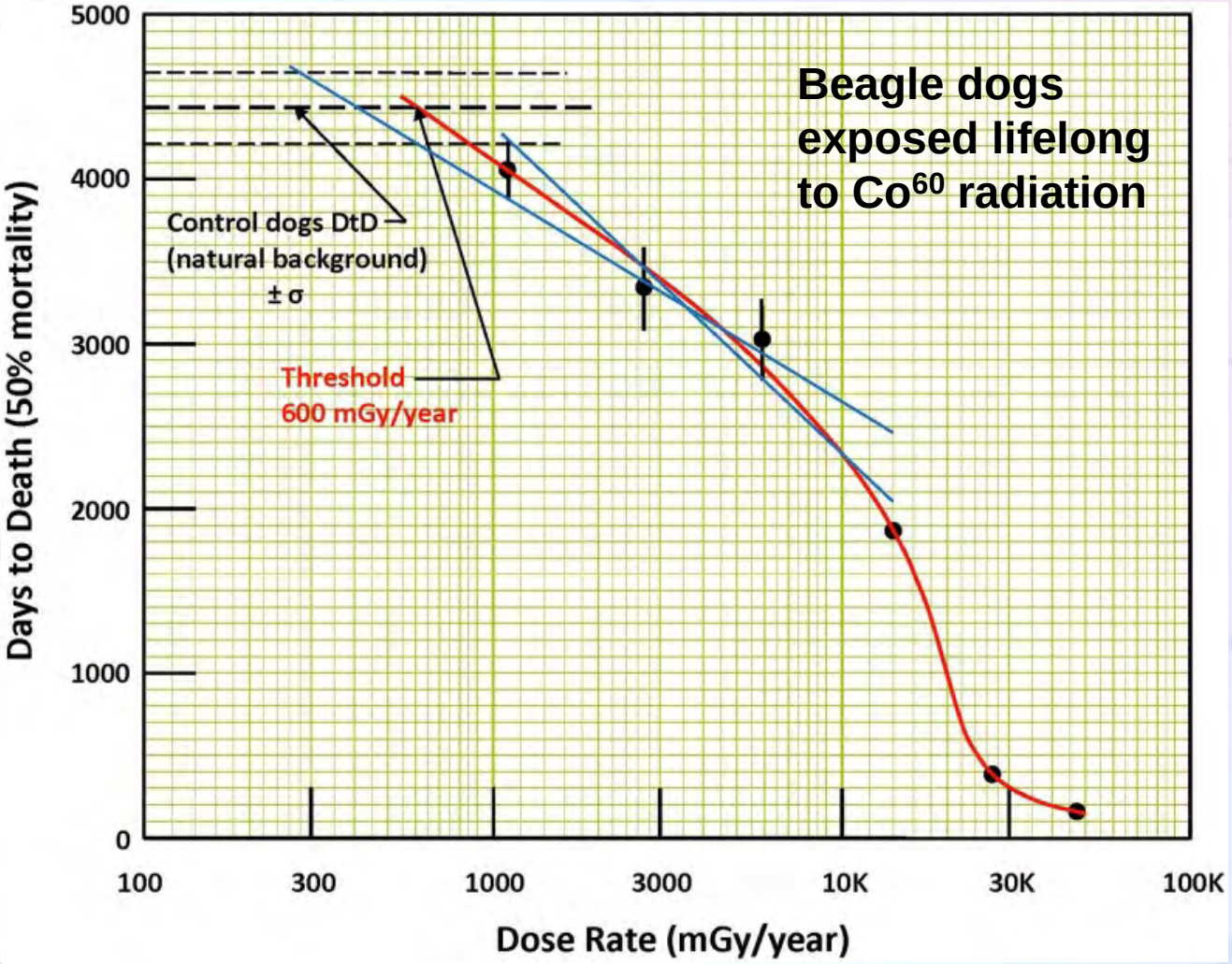
Leukemia cases vs. radiation dose

Hiroshima data (Zone A, B & C radiation doses from Chernobyl worker doses)



Data of 95,819 atomic bomb survivors
Jan. 1950 to Dec. 1957 (8 years)
In Zones A & B, 48 cases in 10,051 (0.5%)

Longevity vs. radiation dose-rate



Original Article

Radiotherapy for Pertussis: An Historical Assessment

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5424867/

Edward J. Calabrese, PhD[1], Gaurav Dhawan, MBBS, MPH, RBP[2], and Rachna Kapoor, MD, MPH[3]

Dose-Response:
An International Journal
April-June 2017:1-9

DOI: 10.1177/1559325817704760
journals.sagepub.com/home/dos
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Abstract

X-ray therapy was used to treat pertussis/whooping cough during a 13-year period from 1923 to 1936 in North America and Europe. Twenty studies from clinicians in the United States reported that approximately 1500 cases of pertussis were treated by X-ray therapy usually with less than 0.5 erythema dose. Young children (<3 years) comprised about 70% to 80% of the cases, with the age of cases ranging from as young as 1 month to 50 years. In general, symptoms of severe coughing, vomiting episodes, and spasms were significantly relieved in about 85% of cases following up to 3 treatments, while about 15% of the cases showed nearly full relief after only 1 treatment. The X-ray therapy was also associated with a marked reduction in mortality of young (<3 years) children by over 90%. Despite such reported clinical success from a wide range of experienced researchers, the use of X-rays for the treatment of pertussis in young children was controversial, principally due to concerns of exposure to the thymus and thyroid even with the availability of lead shielding. By the mid-1930s, the treatment of pertussis cases via vaccine therapy came to dominate the therapeutic arena, and the brief era of a radiotherapy option for the treatment of pertussis ended.

Dose-Response, 11:469–479, 2013
Formerly Nonlinearity in Biology, Toxicology, and Medicine

ISSN: 1559-3258
DOI: 10.2203/dose-response.13-004.Calabrese
International Dose-Response Society

THE HISTORICAL USE OF RADIOTHERAPY IN THE TREATMENT OF SINUS INFECTIONS

Edward J. Calabrese, Ph.D., and Gaurav Dhawan, MPH □ Department of Public Health, Environmental Health Sciences, University of Massachusetts, Amherst, MA

□ The aim of this paper is to assess the historical role of radiotherapy in the treatment of sinus infections. This assessment involved a literature-based review of how radiotherapy was used to treat sinus infections in the first half of the 20th century. Low doses of x-rays were used with considerable success to treat nearly 3,000 patients of sinus infection in a span of 12 years with these cases being reported in leading medical journals as case studies. The mechanism of x-ray induced reduction of inflammation and increased tissue repair is uncertain but appears to be related to the development of a multifactorial and integrative anti-inflammatory phenotype.

How Radiotherapy Was Historically Used To Treat Pneumonia: Could It Be Useful Today?

Edward J. Calabrese, PhD*, and Gaurav Dhawan, MPH

Department of Public Health, Environmental Health Sciences, University of Massachusetts, Amherst, Massachusetts

X-ray therapy was used to treat pneumonia during the first half of the 20th century. Fifteen studies report that approximately 700 cases of bacterial (lobar and bronchopneumonia), sulfanilamide non-responsive, interstitial, and atypical pneumonia were effectively treated by low doses of X-rays, leading to disease resolution, based on clinical symptoms, objective disease biomarkers, and mortality incidence. The capacity of the X-ray treatment to reduce mortality was similar to serum therapy and sulfonamide treatment during the same time period. Studies with four experimental animal models (i.e., mice, guinea pig, cat, and dog) with bacterial and viral pneumonia supported the clinical findings. The mechanism by which the X-ray treatment acts upon pneumonia involves the induction of an anti-inflammatory phenotype that leads to a rapid reversal of clinical symptoms, facilitating disease resolution. The capacity of low doses of X-rays to suppress inflammatory responses is a significant new concept with widespread biomedical and therapeutic applications.

Historical use of x-rays: Treatment of inner ear infections and prevention of deafness

Human and Experimental Toxicology
2014, Vol. 33(5) 542–553

DOI: 10.1177/0960327113493303
het.sagepub.com
SAGE

EJ Calabrese and G Dhawan

Abstract

Purpose: This article provides an historical assessment of the role of radiotherapy in the treatment of inner ear infections. **Materials and methods:** The research utilized a literature-based evaluation of the use of x-rays during the first half of the 20th century on the treatment of otitis media (OM), mastoiditis, and cervical adenitis and their impact on the occurrence of deafness. **Results:** X-Rays were consistently found to be effective as a treatment modality at relatively low doses, in the range of 10–20% of the skin erythema dose, rapidly reducing inflammation, and accelerating the healing process. The mechanistic basis of the clinical successes, while addressed by contemporary researchers, is evaluated in the present article in light of current molecular biology advances, which indicate that clinically effective low doses of ionizing radiation act via the creation of an anti-inflammatory phenotype in highly inflamed tissue. **Conclusions:** X-Ray treatment of OM, mastoiditis, and cervical adenitis was widely accepted in the first half of the 20th century by clinicians as an effective treatment when administered within an appropriate dosage range.

Dose-Response, 10:626-643, 2012
Formerly Nonlinearity in Biology, Toxicology, and Medicine

ISSN: 1559-3258
DOI: 10.2203/dose-response.12-016.Calabrese

International Dose-Response Society
www.Dose-Response.org

THE ROLE OF X-RAYS IN THE TREATMENT OF GAS GANGRENE: A HISTORICAL ASSESSMENT

Edward J. Calabrese, Gaurav Dhawan □ Department of Public Health, Environmental Health Sciences, University of Massachusetts

□ While the use of x-rays to treat patients with gas gangrene ended in the early 1940's with the advent of antibiotics, x-ray had been widely accepted as a useful and highly effective treatment for this condition. The present paper re-assesses the historical foundations of this belief, the quality of the data, use of confirmatory animal models, and underlying mechanisms that might account for the therapeutic role of x-rays in the treatment of gas gangrene.

Wound Repair and Regeneration

PERSPECTIVE ARTICLE

Historical foundations of wound healing and its potential for acceleration: dose-response considerations

Edward J. Calabrese, PhD

Department of Public Health, Environmental Health Sciences, University of Massachusetts, Amherst, Massachusetts

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Tel: 413-545-3164;
Fax: 413-545-4692;
Email: edwardc@schoolph.umass.edu

Manuscript received: January 26, 2012
Accepted in final form: July 19, 2012

DOI:10.1111/j.1524-475X.2012.00842.x

ABSTRACT

This paper provides a detailed historical assessment of the origin and developmental progress of the concept of wound healing and its attempted acceleration from its start in the beginning of the 20th century to approximately 1960. Emphasis is placed on the development of cell culture in the assessment of wound healing and in attempts to validate experimental findings via clinical research. Of particular interest were the observations that wound healing could be accelerated in the 30–50% range with the dose response displaying biphasic characteristics consistent with the hormesis dose-response model. Such findings set the stage for the hormetic dose-response revolution that is occurring within the biological and biomedical sciences, including wound healing, whereby considerable research now supports the capacity for endogenous and exogenous agents to accelerate the process of wound healing and its functional performance.

X-Ray treatment of carbuncles and furuncles (boils): A historical assessment

Human and Experimental Toxicology
32(8) 817–827

DOI: 10.1177/0960327112467046
het.sagepub.com
SAGE

Edward J Calabrese[1]

Abstract

The goal of this article was to assess the historical role of radiotherapy in the treatment of selected inflammatory diseases. The specific research involved a literature-based assessment of the use of x-rays during the first half of the 20th century for the treatment of furuncles and carbuncles, the potentially serious staphylococcus infections. X-Rays were reported to be effective as a treatment at relatively low dose, about 10–20% of the skin erythema dose, which often quickly and profoundly reduce pain and accelerate the resolution/healing of the furuncles and carbuncles. These findings were based on considerable clinical experience that was generally reported in the form of case studies. The mechanism of x-ray–induced reduction of inflammation and acceleration of healing was suggested to result from a combination of immune alterations that enhanced phagocytosis as well as via an anti-localization effect on the pathogenic organism that facilitates their destruction.

RADIATION RESEARCH **184**, 180–192 (2015)
0033-7587/15 $15.00

DOI: 10.1667/RR14080.1

The Use of X Rays in the Treatment of Bronchial Asthma: A Historical Assessment

Edward J. Calabrese,[a,1] Gaurav Dhawan[a] and Rachna Kapoor[b]

[a] *Departments of Environmental Health Sciences and* [b] *Public Health, University of Massachusetts, Amherst, Massachusetts, 01003*

Calabrese, E. J., Dhawan, G. and Kapoor, R. The Use of X Rays in the Treatment of Bronchial Asthma: A Historical Assessment. *Radiat. Res.* 184, 180–192 (2015).

This article provides a historical assessment of the role of X-ray therapy in the treatment of bronchial asthma. This analysis revealed that X-ray therapy in the treatment of bronchial asthma spanned the first six decades of the 20th century, and involved nearly 6,000 patients in published clinical case studies. Patients selected typically had at least moderate to severe asthma and were refractory to other commonly employed treatments. The results of more than 60 studies indicated that about 70% of patients had rapid and marked reductions in clinical symptoms with about half of these patients showing complete symptom relief. The

important with the use of anticholinergic alkaloids, adrenergic agents such as adrenaline and ephedrine from a Chinese herb. These procedures and agents became mainstay treatments during the first half of the past century (*1*, *3*).

Despite these advances, many severely affected asthma patients remained unresponsive to treatment, and other medicines and technologies were subsequently developed in an effort to help those individuals as well. Reported here is a historical assessment of how ionizing radiation was used to treat asthmatic patients during the first half of the 20th century, including the origin of such treatments, their effectiveness, treatment techniques, optimal dose-response relationship, explanatory mechanisms and limitations.

X-ray treatments cured gas gangrene infections

Roentgen Treatment *of* Infections

By JAMES F. KELLY, M.D.

Professor and Director of the Department of Radiology, Creighton University School of Medicine; Attending Radiologist, Creighton Memorial St. Joseph's Hospital, etc.

and D. ARNOLD DOWELL, M.D.

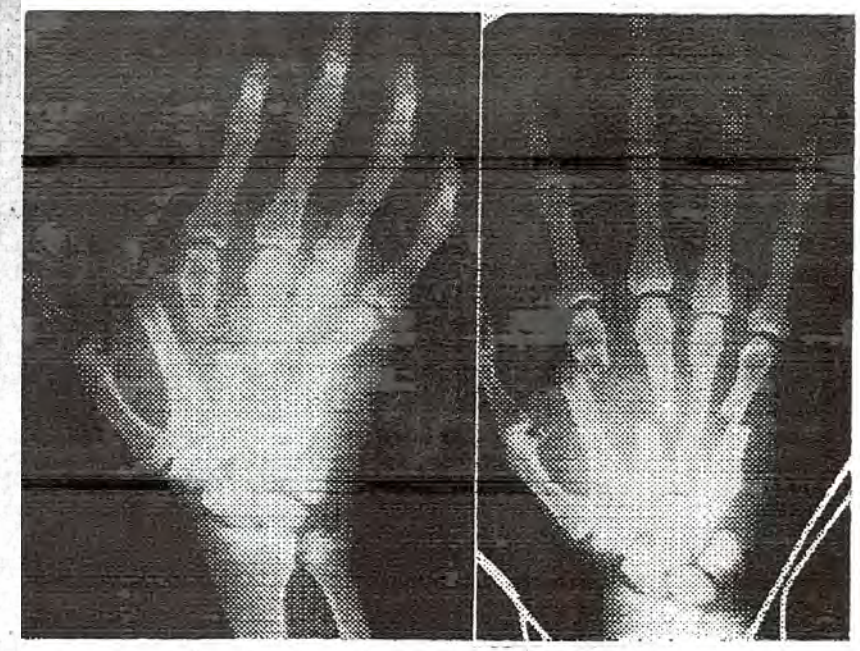
Assistant Professor of Radiology, Creighton University School of Medicine.

THIS is *a book that deserves consideration*, not only by radiologists, but also by surgeons and all others concerned with reducing the mortality from gas gangrene and peritonitis. Practitioners, teachers and students of radiology will welcome it as the first complete American textbook on the x-ray treatment of infections, covering the third great field (malignancies and dermatology being the others) where roentgen therapy is effective. It contains all the scientific, clinical and bibliographic material appropriate to a standard textbook—procedures in thorough detail, supporting evidence of their efficacity, and critical review of the literature.

Internists and general physicians will find it an authoritative guide, based on nearly two decades of clinical experience and investigation, to the application of this modality to twenty-seven types of infections. Its subject is that form of treatment which requires only the usual low-voltage x-ray apparatus and only small doses of rays—hence that field of radiologic therapy in which the fully informed physician can work safely and effectively.

To the military and industrial surgeon charged with responsibility for the welfare of the fighting forces and of the factory-workers who supply them, this monograph will be especially timely. The authors were the originators of the mobile therapy unit for prompt prophylaxis and bedside treatment of cases of gas gangrene resulting from all sorts of fractures, crushing injuries, penetrating wounds, etc.; and the reader will be immediately impressed with the possibilities which this form of management offers for minimizing the sequelae of such accidents and for restoring patients to normal activity with a minimum of hospitalization.

Pediatricians, gynecologists, ophthalmologists and oto-laryngologists are others who will find helpful information within *(Continued on inside flap)*



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.

WHICH RECEIVED PROPHYLACTIC
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

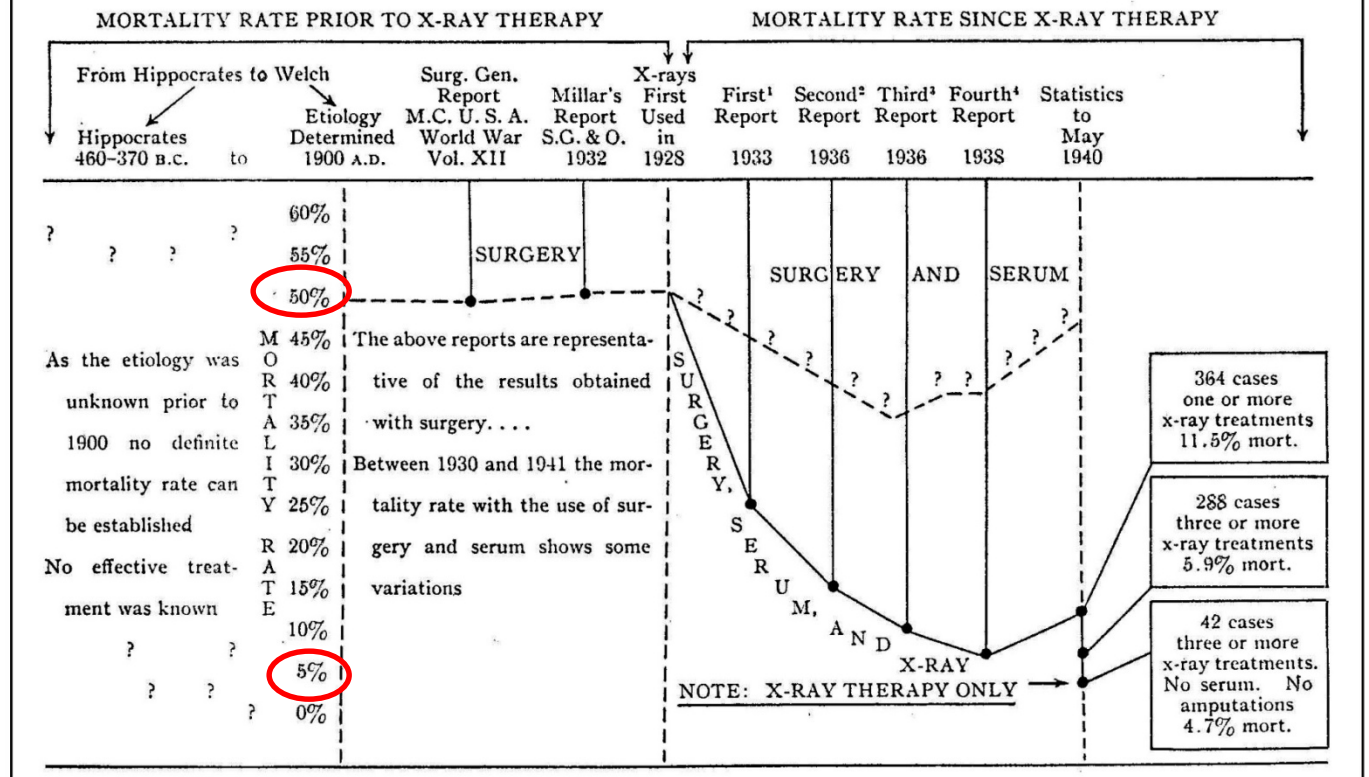


Figure 1

LOW-DOSE IRRADIATION THERAPY TO CURE GAS GANGRENE INFECTIONS

The original caption[8] stated: End of gas gangrene as a serious infection (if X-ray therapy is used). From Hippocrates' time (460-370 B.C.) to 1900 A.D., the aetiology of gas bacillus infection was unknown and as a result the mortality rate during that period cannot be accurately determined. Between 1900 and 1928, the mortality rate was 50 percent. Since 1928, the mortality has been reduced to 5 percent by the use of X-ray therapy without serum or radical surgical measures. X-ray therapy will prevent or cure the disease.

Potential therapy for flesh-eating disease

Review

Dose-Response:
An International Journal
July-September 2019:1-6

DOI: 10.1177/1559325819871757
journals.sagepub.com/home/dos
SAGE

Necrotizing Fasciitis: Low-Dose Radiotherapy as a Potential Adjunct Treatment

Gaurav Dhawan[1], Rachna Kapoor[2], Asha Dhamija[3], Ravinder Singh[4], Bharat Monga[5], and Edward J. Calabrese[6]

Abstract

Necrotizing fasciitis (NF) is a rapidly spreading bacterial infection causing extensive tissue necrosis and destruction. Despite appropriate therapy, the disease results in significant morbidity/mortality and substantial treatment costs. Several studies published in the early 1900s demonstrated the effective use of low-dose X-ray radiotherapy (RT) for the treatment of many diverse inflammatory conditions and diseases (eg, gas gangrene, sinus infections, arthritis, tendonitis, and serious inflammatory lung conditions). The mechanism by which therapeutic RT doses produce positive patient outcomes is related at least in part to its capacity to induce tissue-based anti-inflammatory responses. This action is due to the polarization of macrophages to an anti-inflammatory or M2 phenotype via optimized low-dose RT. Low-dose RT has the potential to significantly reduce debilitating surgeries and aggressive treatments required for NF, providing a 3-prong benefit in terms of patient mortality, length of hospitalization stays, and cost of health care (both short term and long term). Low cost and easy availability of low-dose RT makes it a potentially useful option for patients of every age-group. In addition, low-dose RT may be a particularly useful option in countries treating many patients who are unable to afford surgeries, antibiotics, and hyperbaric oxygen.

Nasal radium irradiation; no link to any disease

The standard 50 mg monel metal radium applicator is passed into the nasopharynx after cocaine anesthesia and left in place for twelve minutes on each side. The treatment is given three times with intervals of two weeks between applications. Beneficial results may be expected within six to twelve weeks. It is probably unwise to submit the child to more than two series of such treatments[11,12] (Figure 7).

US CDC estimates up to 2,500,000 children received NRI from 1940-1970 as a standard medical practice to shrink adenoids. **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.

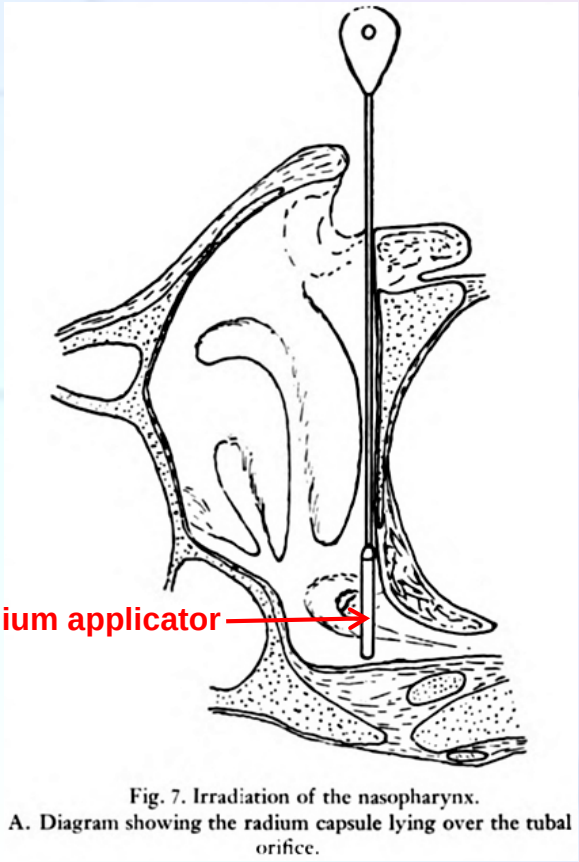


Fig. 7. Irradiation of the nasopharynx.
A. Diagram showing the radium capsule lying over the tubal orifice.

http://www.cancer.gov/cancertopics/factsheet/Risk/nasopharyngeal-radium

National Cancer Institute
at the National Institutes of Health

No link to any disease

Reviewed: January 10, 2003

Nasopharyngeal Radium Irradiation (NRI) and Cancer: Fact Sheet

Key Points

- Nasopharyngeal radium irradiation, (NRI) was widely used from 1940 through 1970 to treat ear dysfunctions in children and military personnel. Use of NRI was stopped when concern arose about possible adverse effects, including cancer.
- The purpose of NRI was to shrink swollen tissue in the nasopharyngeal cavity—the opening behind the nose and mouth. The treatment involved inserting a radioactive compound through the nostril into the nasopharyngeal opening for short periods of time. Some radiation exposure to the salivary, thyroid, and pituitary glands, and to brain tissue also occurred during this process.
- NRI was used in several European countries, Canada, and the United States. In the United States, it is estimated that between 0.5 million and 2.5 million children and at least 8,000 military personnel were treated with NRI.
- Children are considered to be the most vulnerable to radiation-related cancers.
- At this time, worldwide studies have not confirmed a definite link between NRI exposure and any disease.

Optimal dose for radiotherapy, 2019

Article

Human and Experimental Toxicology
1–11

DOI: 10.1177/0960327119846925
journals.sagepub.com/home/het
SAGE

Radiotherapy treatment of human inflammatory diseases and conditions: Optimal dose

EJ Calabrese[1], G Dhawan[2], R Kapoor[3] and WJ Kozumbo[4]

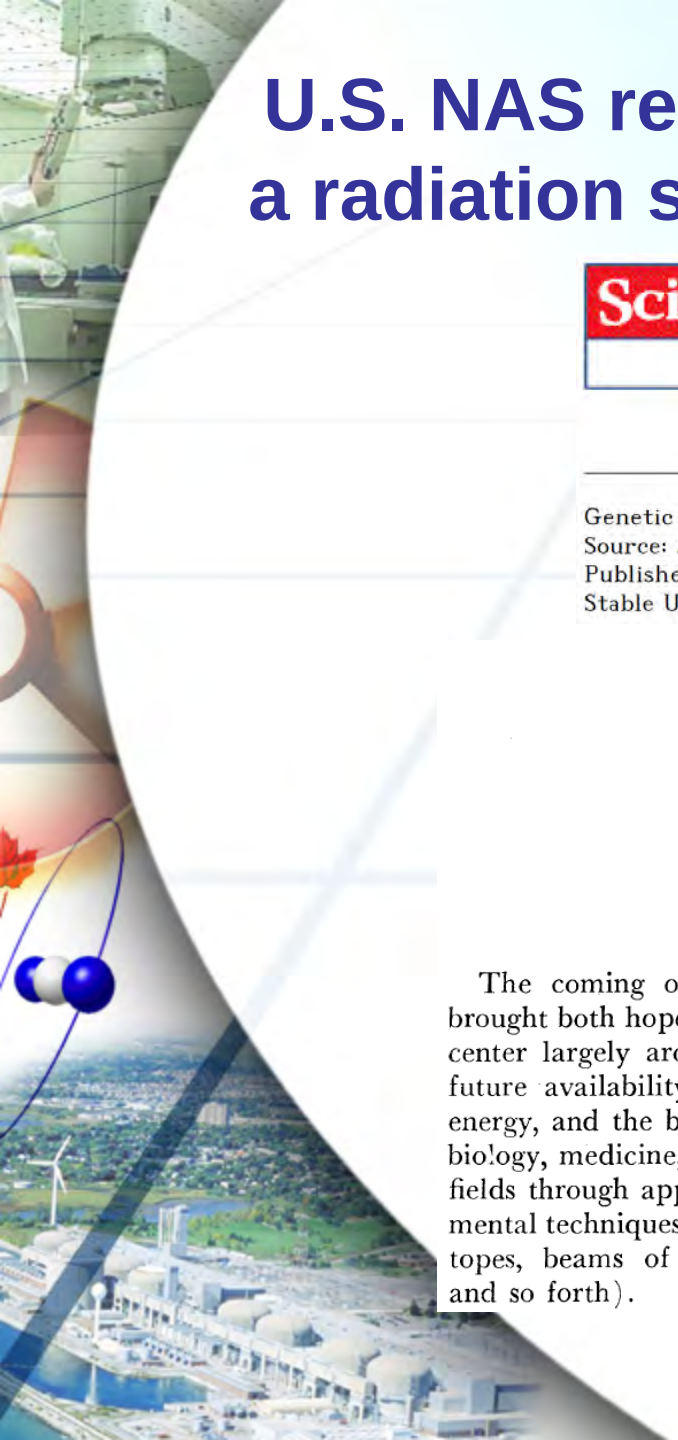
Abstract

During the early part of the past century, hundreds of clinical studies involving more than 37,000 patients were conducted that showed radiotherapy (RT) to be a successful and safe alternative to drug therapy for the treatment of many diverse inflammatory conditions and diseases (e.g. tendonitis, bursitis, arthritis, and serious inflammatory lung conditions). Data from these studies were collected and analyzed with the intent of estimating an optimal dosing range for RT that would induce an efficacious treatment response. RT was reported to be frequently effective after only a single treatment, with a rapid (within 24 h) and often long-lasting (from months to years) relief from symptoms. Over a two-decade span from the 1920s to the 1940s, the therapeutic responses to a single RT treatment consistently improved as the dosing for multiple ailments decreased over time to between 30 roentgen (r) and 100 r. These findings are significant and in agreement with a number of contemporary reports from Germany where RT has been commonly and successfully employed in treating ailments with an inflammatory origin. A proposed mechanism by which RT mitigates inflammation and facilitates healing is via the polarization of macrophages to an anti-inflammatory or M2 phenotype.

Diseases successfully treated by X-rays

	Number of subjects	Successful treatment (%)	Studies (*N*)	References
Arthritis	>5000	~85	Cumulative experience	Kahlmeter[14] and Kuhns and Morrison[15]
Bronchial asthma	~4000	75–80	57	Calabrese et al.[12]
Carbuncles	187	60–90	5	Calabrese[6]
Cervical adenitis	893	75–90	11	Calabrese and Dhawan[10]
Deafness	15,000	>95%; performed prior to age 15	Cumulative experience	Crowe and Baylor[22]
Furuncles	420	75–95	5	Calabrese[6]
Gas gangrene	365	Mortality rate decreased from 40% to 10%	13	Calabrese and Dhawan[7]
Otitis media/ mastoides	564	~90	16	Calabrese and Dhawan[10]
Pertussis	~2400	~80	22	Calabrese et al.[13]
Pneumonia	863	80–85	18	Calabrese and Dhawan[8]
Sinus infection	4492	75–90	16	Calabrese and Dhawan[9]
Tendonitis/bursitis	3333	70–90	31	Calabrese and Dhawan[10]
	37,517			

U.S. NAS recommends LNT model in 1956 — a radiation scare to stop atomic bomb testing



Science
AAAS

Genetic Effects of Atomic Radiation
Source: *Science*, New Series, Vol. 123, No. 3209 (Jun. 29, 1956), pp. 1157-1164
Published by: American Association for the Advancement of Science
Stable URL: http://www.jstor.org/stable/1749925

Genetic Effects of Atomic Radiation

The coming of the atomic age has brought both hopes and fears. The hopes center largely around two aspects: the future availability of vast resources of energy, and the benefits to be gained in biology, medicine, agriculture, and other fields through application of the experimental techniques of atomic physics (isotopes, beams of high-energy particles, and so forth).

active material is formed and released into the atmosphere, to be carried by the winds and eventually to settle down at distances which may be very great. Since it does finally settle down it has been aptly named "fallout."

There has been much concern, and a good deal of rather loose public debate, about this fallout and its possible dangers.

Are we harming ourselves; and are

Calabrese on NAS Genetics Panel scandal

Commentary

Toxicology Research and Application

http://journals.sagepub.com/doi/pdf/10.1177/2397847317694998

LNTgate: The ideological history of cancer risk assessment

Toxicology Research and Application
1–3

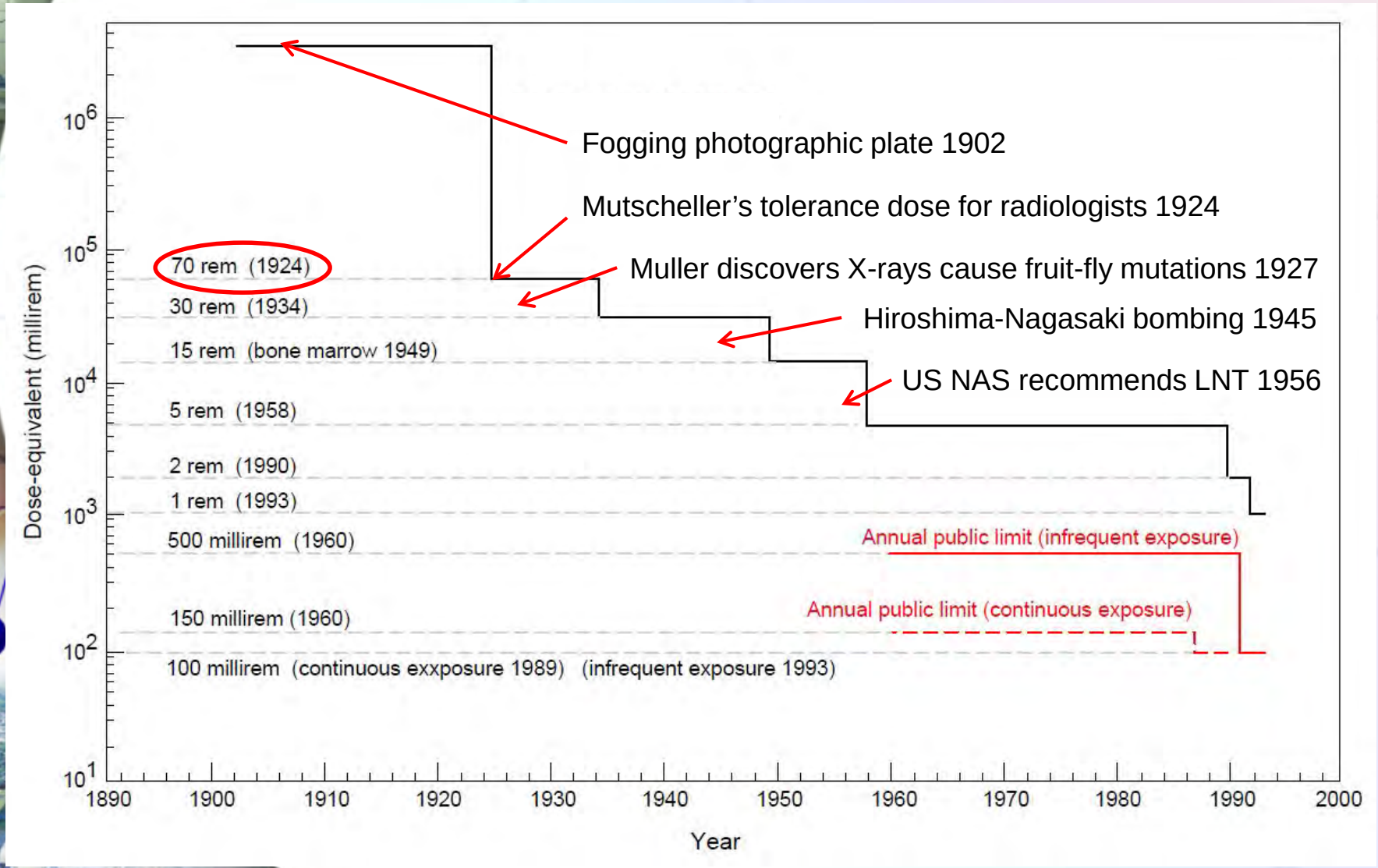
DOI: 10.1177/2397847317694998
journals.sagepub.com/home/tor
SAGE

Edward J Calabrese

Abstract

This commentary summarizes a spate of recent papers that provide historical evidence that the 1956 recommendation of the US National Academy of Sciences Biological Effects of Atomic Radiation I Genetics Panel to switch from a threshold to a linear dose–response model for risk assessment was an ideologically motivated decision based on deliberate falsification and fabrication of the research record. The recommendation by the Genetics Panel had far-reaching influence, affecting cancer risk assessment, risk communication strategies, community public health, and numerous medical practices in the United States and worldwide. This commentary argues that the toxicology, risk assessment, and regulatory communities examine this issue, addressing how these new historical evaluations affect the history and educational practices of these fields as well as carcinogen regulation.

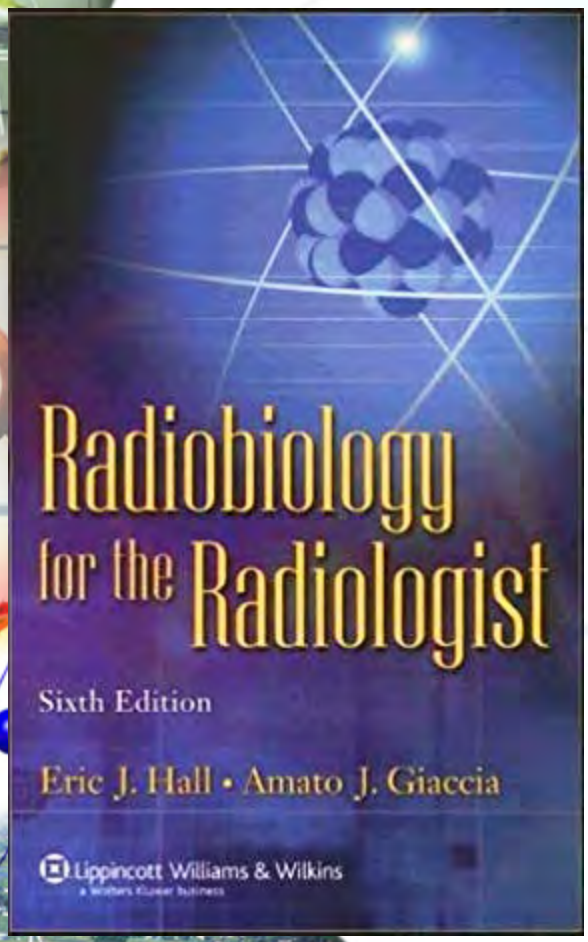
Cancer scare drives down annual dose limit



LDR therapies became controversial after 1956

- After the June 1956 U.S. NAS recommendation to assess risk of radiation-induced mutations using the LNT model, radiation treatments to stimulate became very controversial
- Concerns were raised about risks of mutations and cancer
- MDs replaced low-dose treatments with newly available antibiotics and pharmaceuticals
- All of the MDs have been carefully taught that any radiation risks cancer. Must weigh potential benefit of diagnostic CT scan against the risk of cancer, as calculated by LNT model
- No funding to perform clinical studies on low-dose therapy
- Case report written when a low dose benefit was observed

Physicians are carefully taught that



radiation-induced mutations and cancer can be predicted by the LNT dose-response model

This book fails to mention:

- **that aerobic metabolism leaks oxygen (ROS) from the mitochondria**
- **the very high natural rate of DNA damage due to internal ROS leakage**
- **the very powerful natural protection systems against DNA damage**
- **that a low dose of radiation stimulates these protection systems, including immunity, to produce observable beneficial health effects**
- **the dose threshold for onset of cancer and the dose-rate threshold for life span decline**

Sakamoto clinical studies and recent case reports

日放腫会誌 *J. Jpn. Soc. Ther. Radiol. Oncol. 9: 161-175. 1997*

謹呈

■ REVIEW ARTICLE

FUNDAMENTAL AND CLINICAL STUDIES ON CANCER CONTROL WITH TOTAL OR UPPER HALF BODY IRRADIATION

Kiyohiko SAKAMOTO*[1], Miyako MYOJIN[2], Yoshio HOSOI[3], Yoshihiro OGAWA[1], Kenji NEMOTO[1], Yoshihiro TAKAI[1], Yoshihisa KAKUTO[1], Shogo YAMADA[1], Nobuyuki WATABE[4]

Abstract: The tumor control effects of total body irradiation (TBI) for tumor bearing mice and human tumor were investigated fundamentally and clinically. TBI is usually used in tissue transplantation experiment in order to prevent rejective response for transplanted tissues by immunological reaction. This kind of suppressive effect of immunological response by TBI is considered as to be caused even if very small dose of TBI. However, there are only a few data concerning the effect of low dose of TBI, and TBI of low dose level is concluded to bring about the same effect as in high dose level by back extrapolation from the data of high dose level.

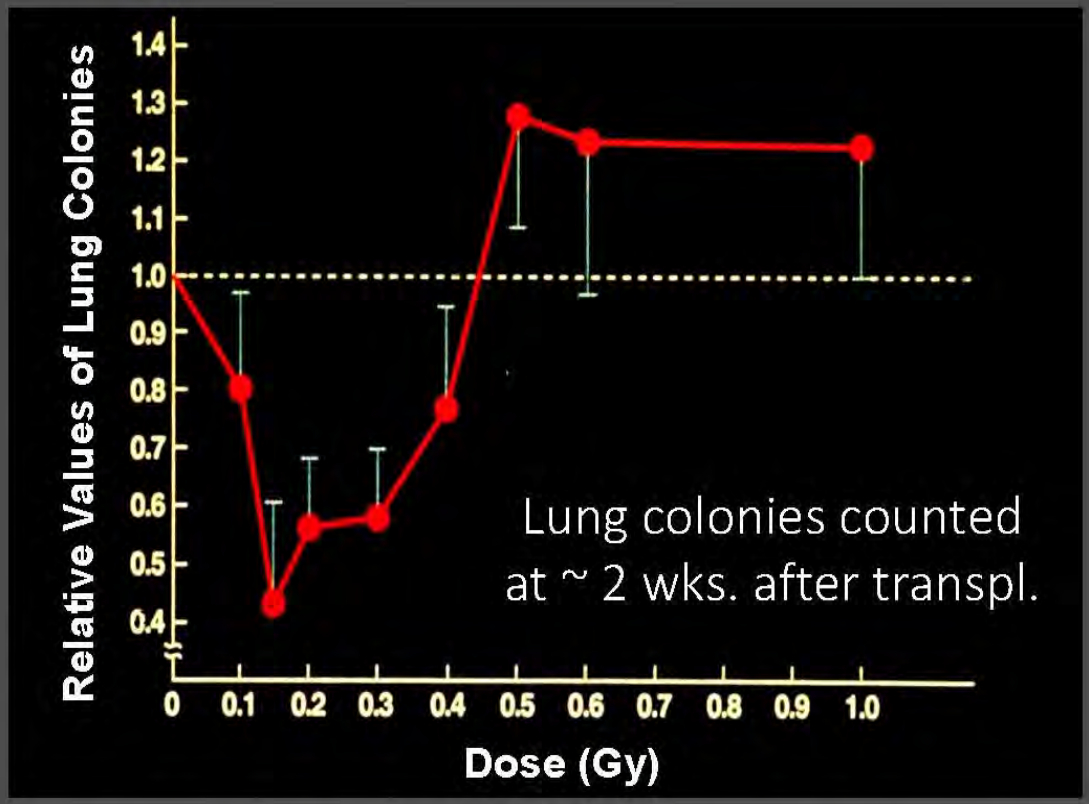
In present paper, firstly the effects of TBI for tumor control in murine squamous carcinoma are reported, and secondly the results of clinical trial in malignant lymphoma are demonstrated.

In fundamental studies, TBI of low doses (10-15 cGy) suggests potentiating effect in cell killing in combination of TBI of 10 cGy and local irradiation given at 12 hours after TBI, though TBI of 10 cGy is not able to detect any cell killing effect. TBI of 10 cGy or 15 cGy also stands for suppressive effect of distant metastasis (lung metastasis).

In clinical studies, malignant lymphoma (non-Hodgikin's lymphoma) is selected as the first disease of clinical trial, and the results is seemed to be prospective method to overcome cancers with radiotherapy, though the trial is not phase III clinical trial.

Low Doses ↓ Lung Metastases , Mice

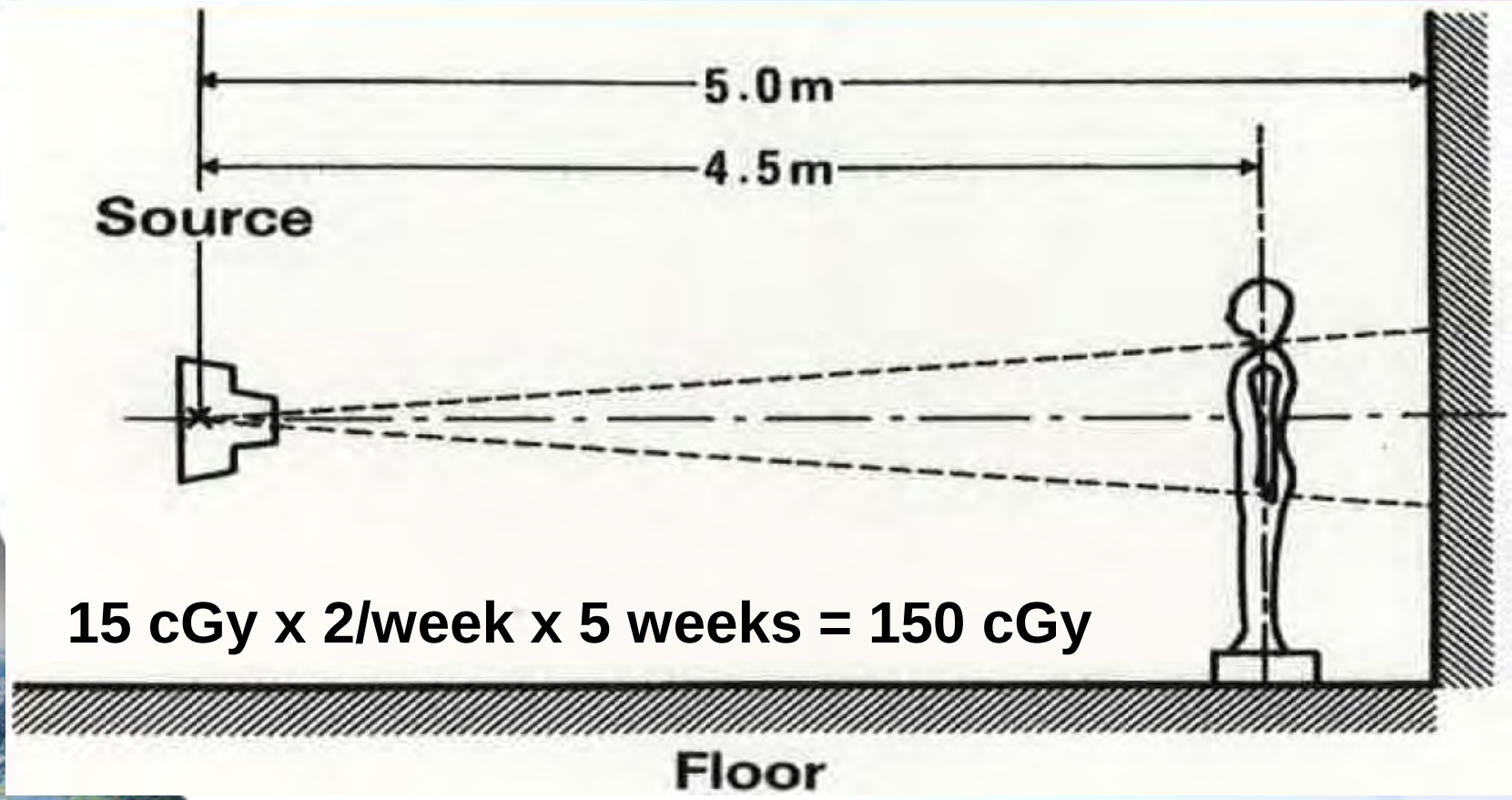
Whole body γ-irradiation given 12 days after tumor cell transplantation into groin



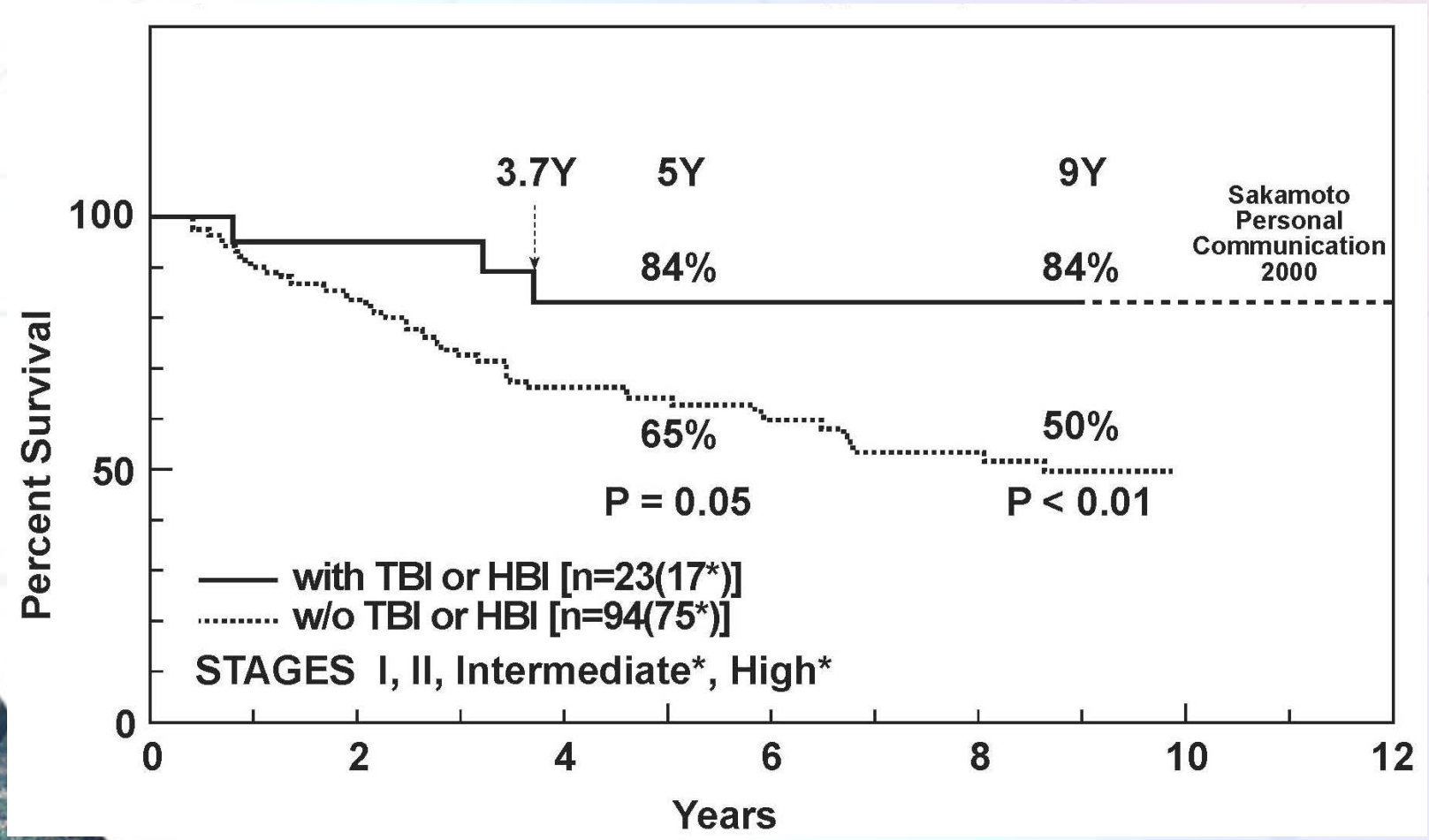
Adapted from Sakamoto K et al., Jpn. Soc. Ther. Radiol. Oncol., 1997

Source – patient scheme for half-body therapy

"Observed the total removal of tumors in all regions of the body of a patient with advanced ovarian cancer."



HBI or TBI for non-Hodgkin's lymphoma



Case Rep Clin Pract Rev 2004; 5: 425-431

WWW.CRCPR-ONLINE.COM
Case Report

Received: 2004.06.03
Accepted: 2004.06.27
Published: 2004.10.05

Waldenstrom's Macroglobulinemia treated with fractionated low-dose total body irradiation

James S. Welsh

Department of Human Oncology, University of Wisconsin-Madison, USA

Summary

Background: Low-dose total body irradiation (TBI) is known to be an effective treatment for low-grade non-Hodgkin's lymphoma and chronic lymphocytic leukemia but has fallen out of favor because of perceived side effects and the development of newer chemotherapy agents. The mechanism of action is poorly understood but may involve immunomodulation as well as direct cytotoxicity.

LD X-ray therapy, Hurthle cell carcinoma, 2009

HBI therapy; prophylaxis against cancer, 2011

Dose-Response, 5:26–38, 2007
Formerly Nonlinearity in Biology, Toxicology, and Medicine

ISSN: 1559-3258
DOI: 10.2203/dose-response.06-112.Pollycove

International Hormesis Society
www.HormesisSociety.org

RADIOBIOLOGICAL BASIS OF LOW-DOSE IRRADIATION IN PREVENTION AND THERAPY OF CANCER

Myron Pollycove □ North Bethesda, MD

□ Antimutagenic DNA damage-control is the central component of the homeostatic control essential for survival. Over eons of time, this complex DNA damage-control system evolved to control the vast number of DNA alterations produced by reactive oxygen species (ROS), generated principally by leakage of free radicals from mitochondrial metabolism of oxygen. Aging, mortality and cancer mortality are generally accepted to be associated with stem cell accumulation of permanent alterations of DNA, i.e., the accumulation of mutations. In a young adult, living in a low LET background of 0.1 cGy/y, the antimutagenic system of prevention, repair and removal of DNA alterations reduces about one million DNA alterations/cell/d to about one mutation/cell/d. DNA alterations from background radiation produce about one additional mutation per 10 million cells/d. As mutations accumulate and gradually degrade the antimutagenic system, aging progresses at an increasing rate, mortality increases correspondingly, and cancer increases at about the fourth power of age. During the past three decades, genomic, cellular, animal and

Original Article

Dose-Response:
An International Journal
January-March 2017:1-7

DOI: 10.1177/1559325817697531
journals.sagepub.com/home/dos
SAGE

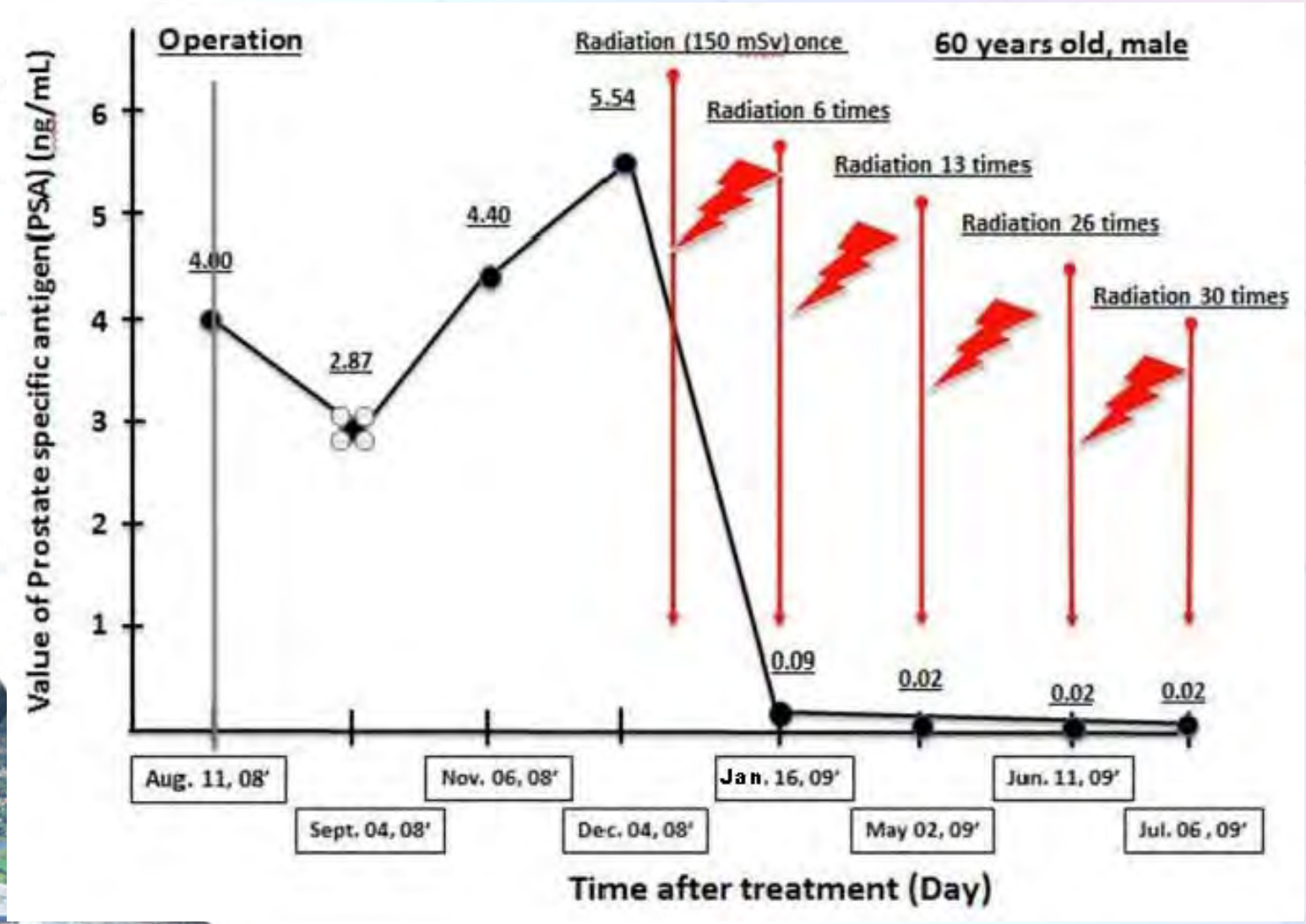
Treatment of Cancer and Inflammation With Low-Dose Ionizing Radiation: Three Case Reports

Shuji Kojima[1], Mitsutoshi Tsukimoto[1], Noriko Shimura[2], Hironobu Koga[3], Akishisa Murata[3], and Tsuyoshi Takara[4]

Abstract

There is considerable evidence from experimental studies in animals, as well as from clinical reports, that low-dose radiation hormesis is effective for the treatment of cancer and ulcerative colitis. In this study, we present 3 case reports that support the clinical efficacy of low-dose radiation hormesis in patients with these diseases. First, a patient with prostate cancer who had undergone surgical resection showed a subsequent increase in prostate-specific antigen (PSA). His PSA value started decreasing immediately after the start of repeated low-dose X-ray irradiation treatment and remained low thereafter. Second, a patient with prostate cancer with bone metastasis was treated with repeated low-dose X-ray irradiation. His PSA level decreased to nearly normal within 3 months after starting the treatment and remained at the low level after the end of hormesis treatment. His bone metastasis almost completely disappeared. Third, a patient with ulcerative colitis showed a slow initial response to repeated low-dose irradiation treatment using various modalities, including drinking radon-containing water, but within 8 months, his swelling and bleeding had completely disappeared. After 1 year, the number of bowel movements had become normal. Interest in the use of radiation hormesis in clinical practice is increasing, and we hope that these case reports will encourage further clinical investigations.

Low doses for recurrent prostate cancer



No prostate cancer metastases after LD therapy

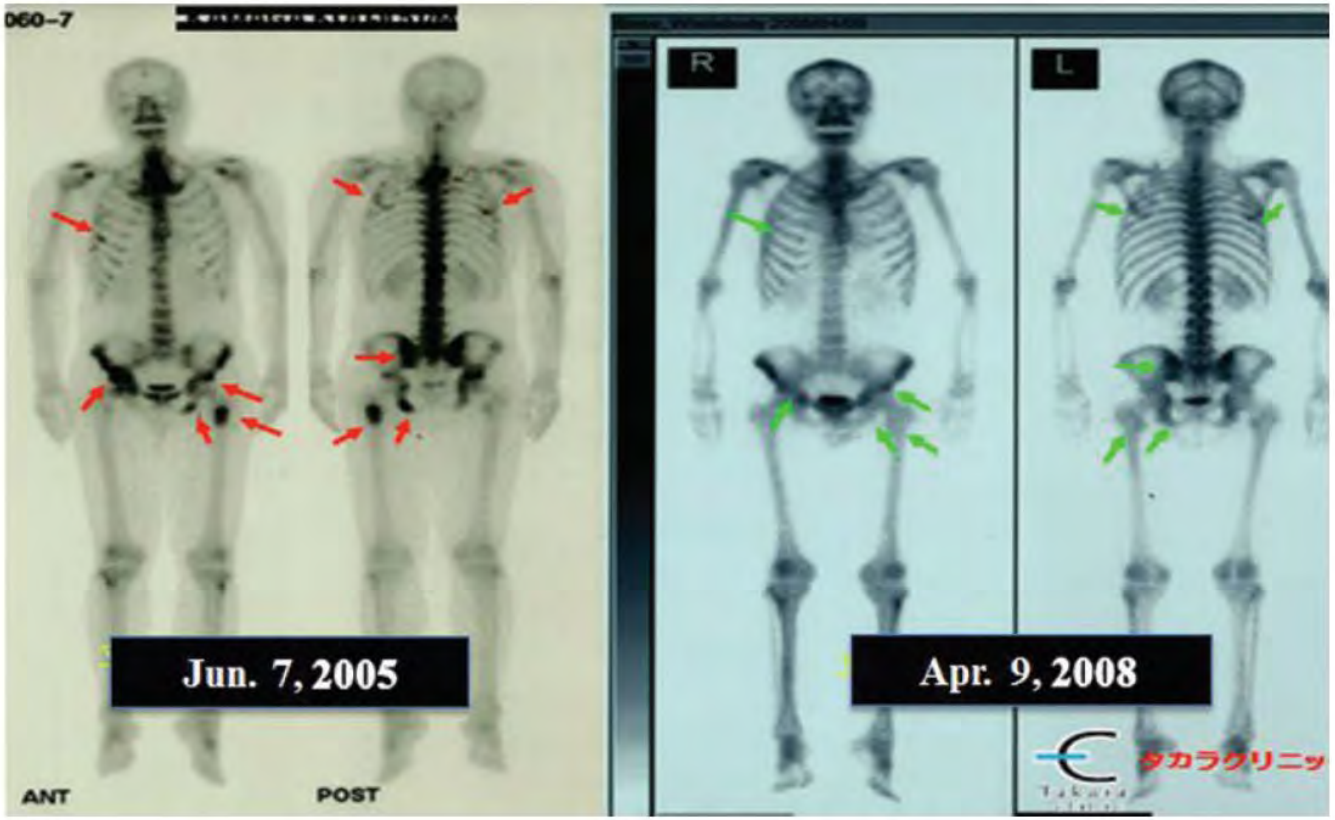
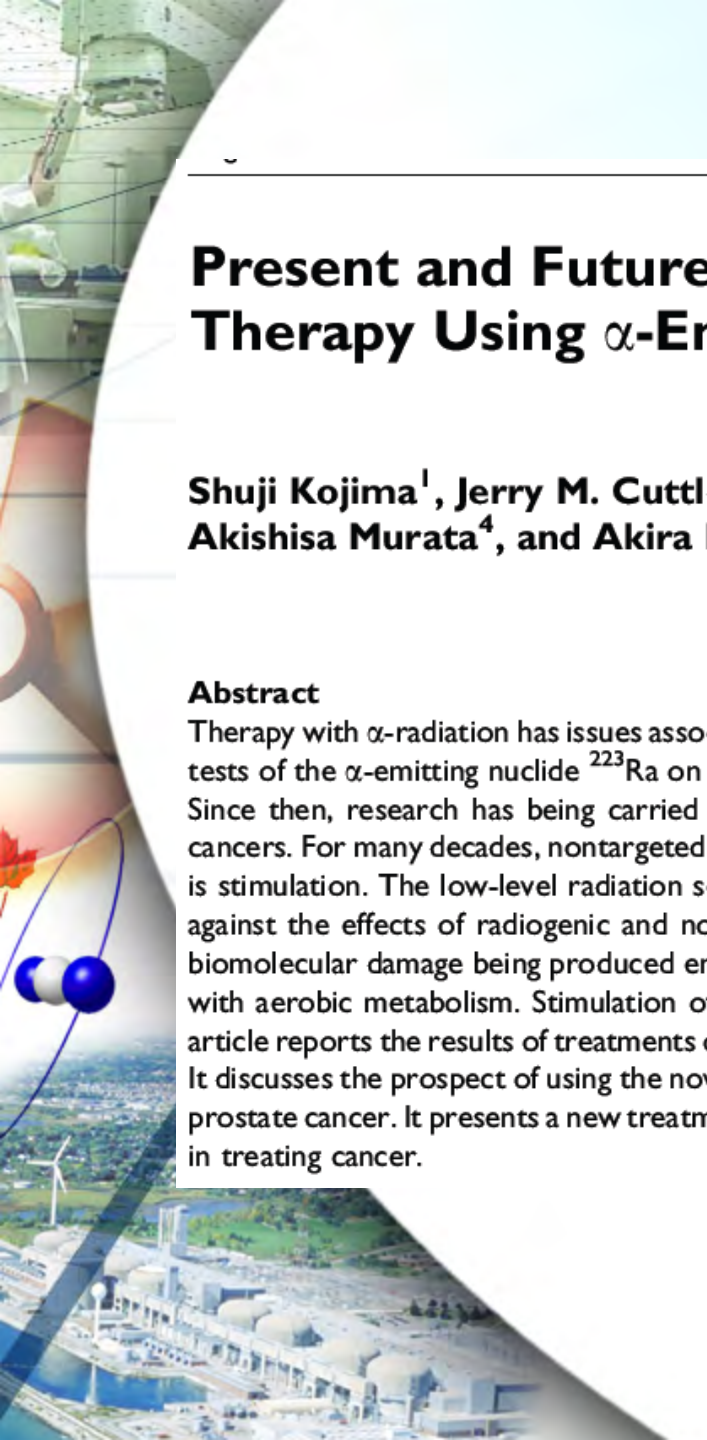


Figure 4. Bone scintigraphy with 99mTc-hydroxymethylene diphosphonate (^{99m}Tc-HMDP) of the patient with prostate cancer with bone metastasis before and after radiation hormesis treatment.



Dose-Response:
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January-March 2018:1-8

DOI: 10.1177/1559325817747387
journals.sagepub.com/home/dos
SAGE

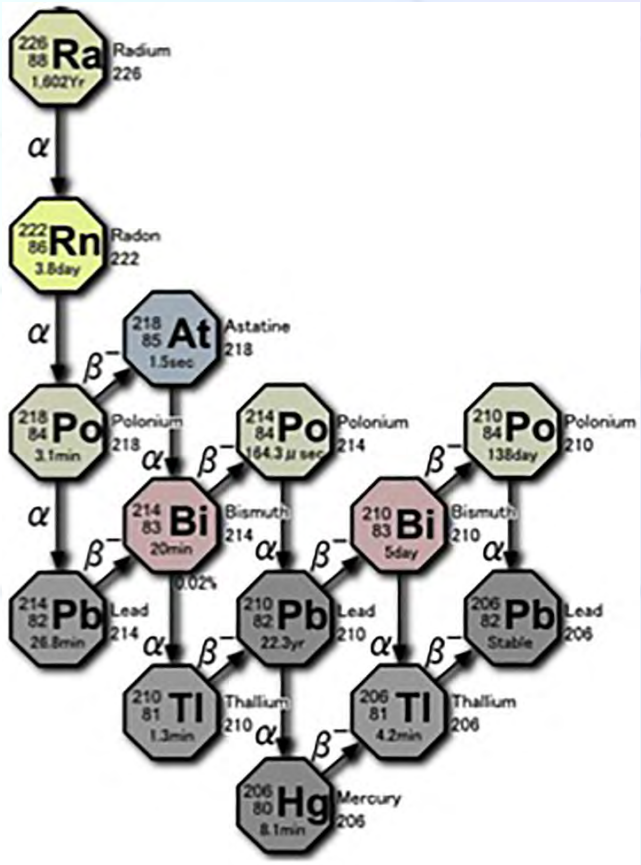
Present and Future Prospects of Radiation Therapy Using α-Emitting Nuclides

Shuji Kojima[1], Jerry M. Cuttler[2], Noriko Shimura[3], Hironobu Koga[4], Akishisa Murata[4], and Akira Kawashima[5]

Abstract

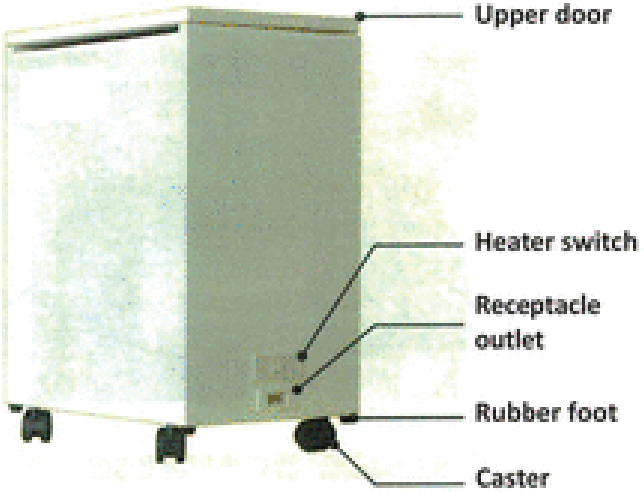
Therapy with α-radiation has issues associated with internal exposure; its clinical use has been avoided. However, phase III clinical tests of the α-emitting nuclide ^{223}Ra on patients with cancer have been conducted, and results were reported in 2011 to 2012. Since then, research has being carried out on targeted internal therapy by introducing α-emitting nuclides directly into the cancers. For many decades, nontargeted radon therapy has been carried out and is controversial because its mechanism of action is stimulation. The low-level radiation sends powerful signals to upregulate many biological protection systems, which protect against the effects of radiogenic and nonradiogenic toxins. These vital systems prevent, repair, and remove DNA and other biomolecular damage being produced endogenously at a very high rate by the very abundant reactive oxygen species associated with aerobic metabolism. Stimulation of protection systems results in beneficial effects, including a lower risk of cancer. This article reports the results of treatments on 4 patients with cancer and reviews the clinical use of α-radiation from ^{223}Ra and radon. It discusses the prospect of using the novel ^{225}Ac-prostate-specific membrane antigen ligand-617 ligand as a therapeutic agent for prostate cancer. It presents a new treatment system that we developed, α-Radiorespiro-*Rn*, which seems to be extremely effective in treating cancer.

Radon emits 4 alpha plus beta and gamma rays

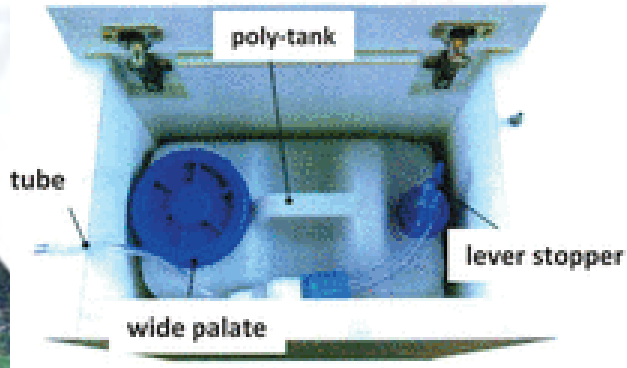


α-Radiorespiro-*Rn*® radon generator

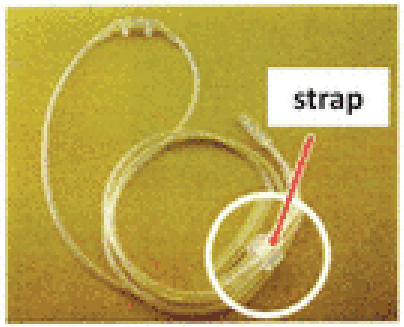
(a) Body appearance



(B) Inside the main body

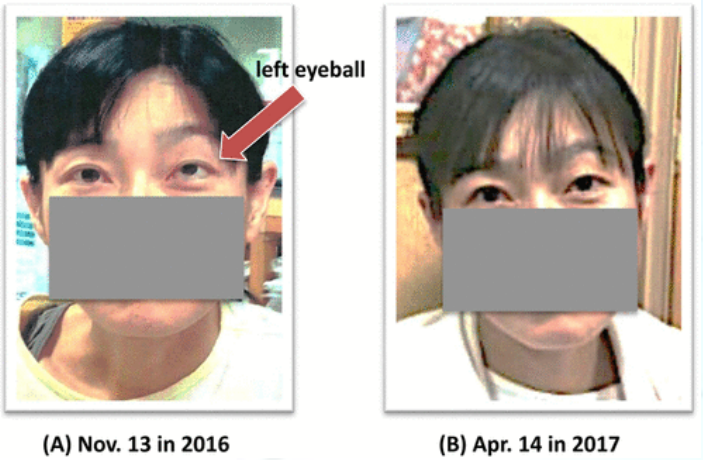


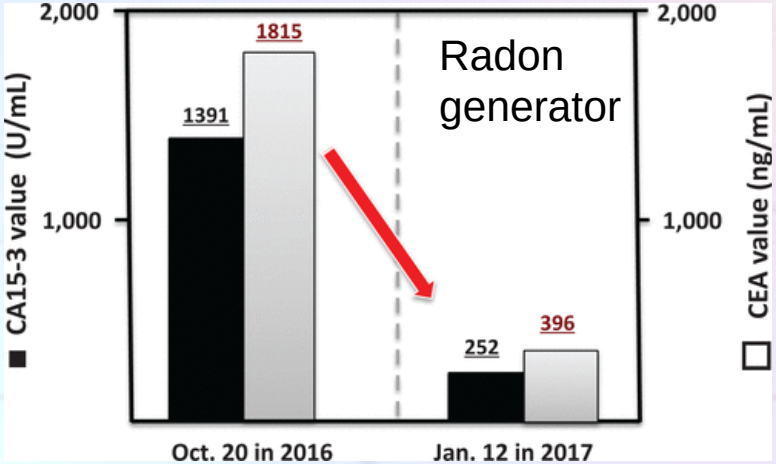
(C) Appearance of suction tube installation



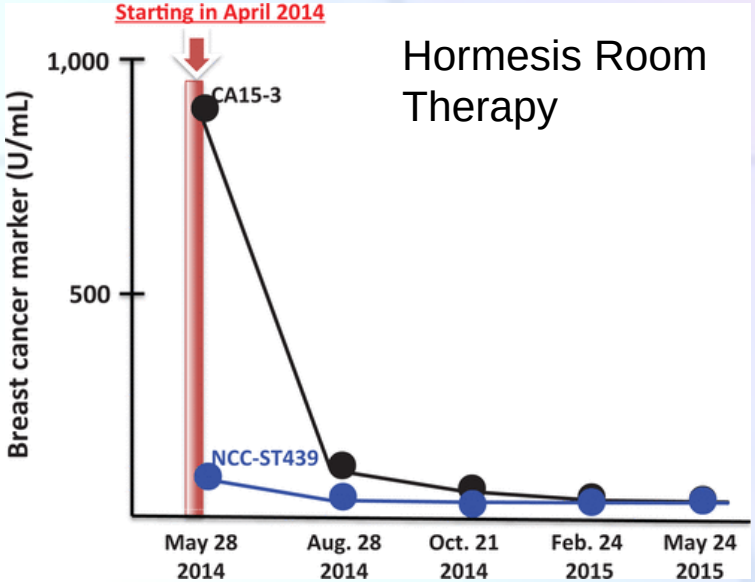
(D) Actual usage of a patient

Metastasized breast cancer patients





Patient #2



Dose-Response:
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April-June 2019:1-9

DOI: 10.1177/1559325819853163
journals.sagepub.com/home/dos
SAGE

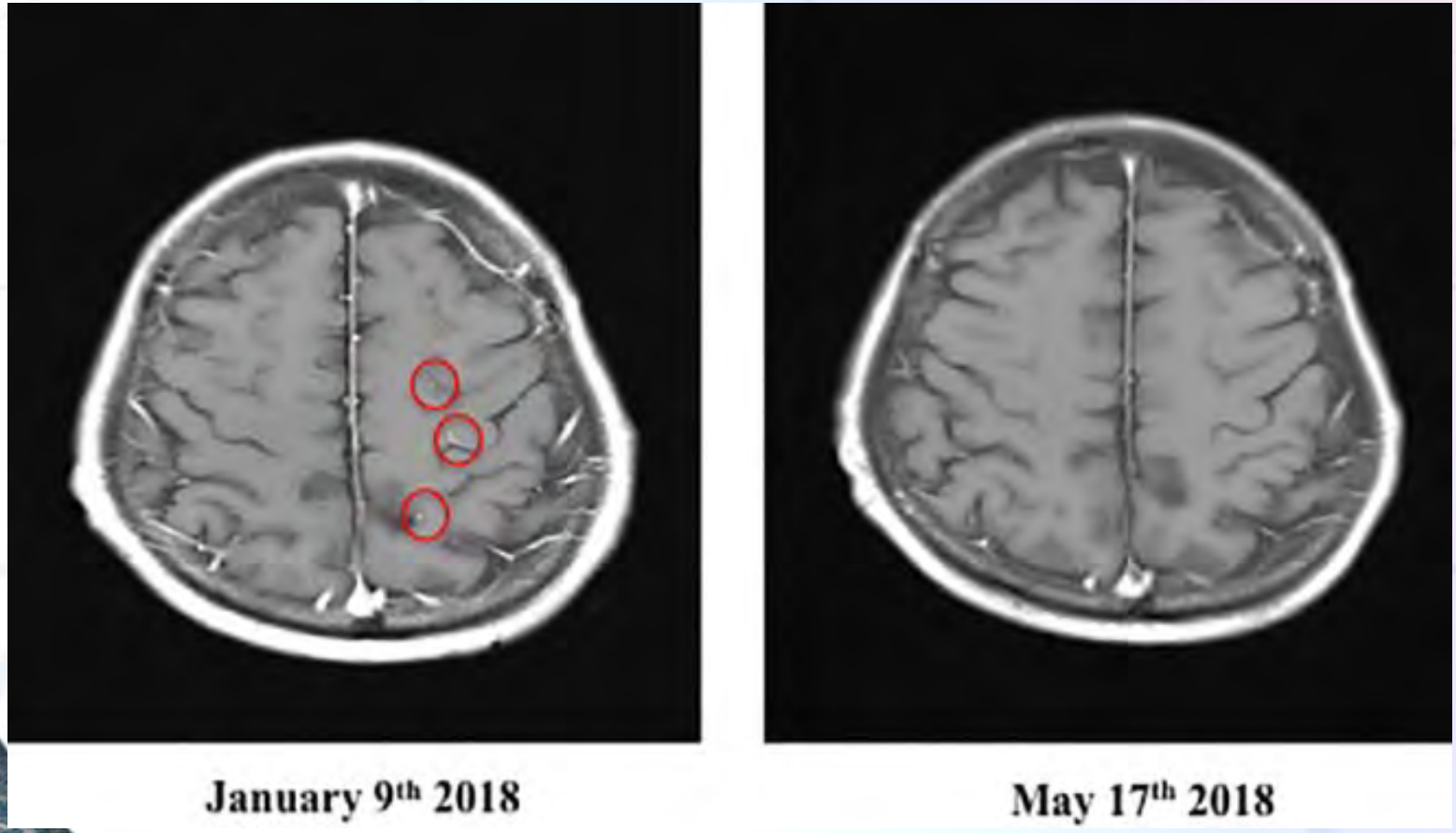
Radon Therapy Is Very Promising as a Primary or an Adjuvant Treatment for Different Types of Cancers: 4 Case Reports

Shuji Kojima[1], Jerry M. Cuttler[2], Kiyomi Inoguchi[3], Kenshou Yorozu[4], Takashisa Horii[5], Noriko Shimura[6], Hironobu Koga[7], and Akihisa Murata[7]

Abstract

We report on the application of radon inhalation therapy to patients with 4 types of cancer: colon, uterine, lung, and liver cell. The radon treatments were given to improve the efficacy of chemotherapy and were potent in all 4 cases. Marker values decreased and disease symptoms were alleviated. We include a lengthy discussion on the mechanism that may be responsible for the observed results. While employing the radon generator to treat the patient with hepatocellular carcinoma, we discovered that a concentration of 6 MBq/m^3 was very effective, while 1 MBq/m^3 was marginal. This implies different, and rather high, radon concentration thresholds for the treatment of different types of cancer. The evidence from these 4 cases suggests that radon inhalation may be beneficial against various cancer types as an important adjuvant therapy to conventional chemotherapy and for local high-dose radiotherapy, which would address the problem of distant metastasis. A previous case report on 2 patients with advanced breast cancer, who refused chemotherapy or radiotherapy, indicates that radon may be effective as a primary therapy for cancer. Clinical trials should be carried out to determine the best radon concentrations for treatment of other types of cancer, at different stages of progression.

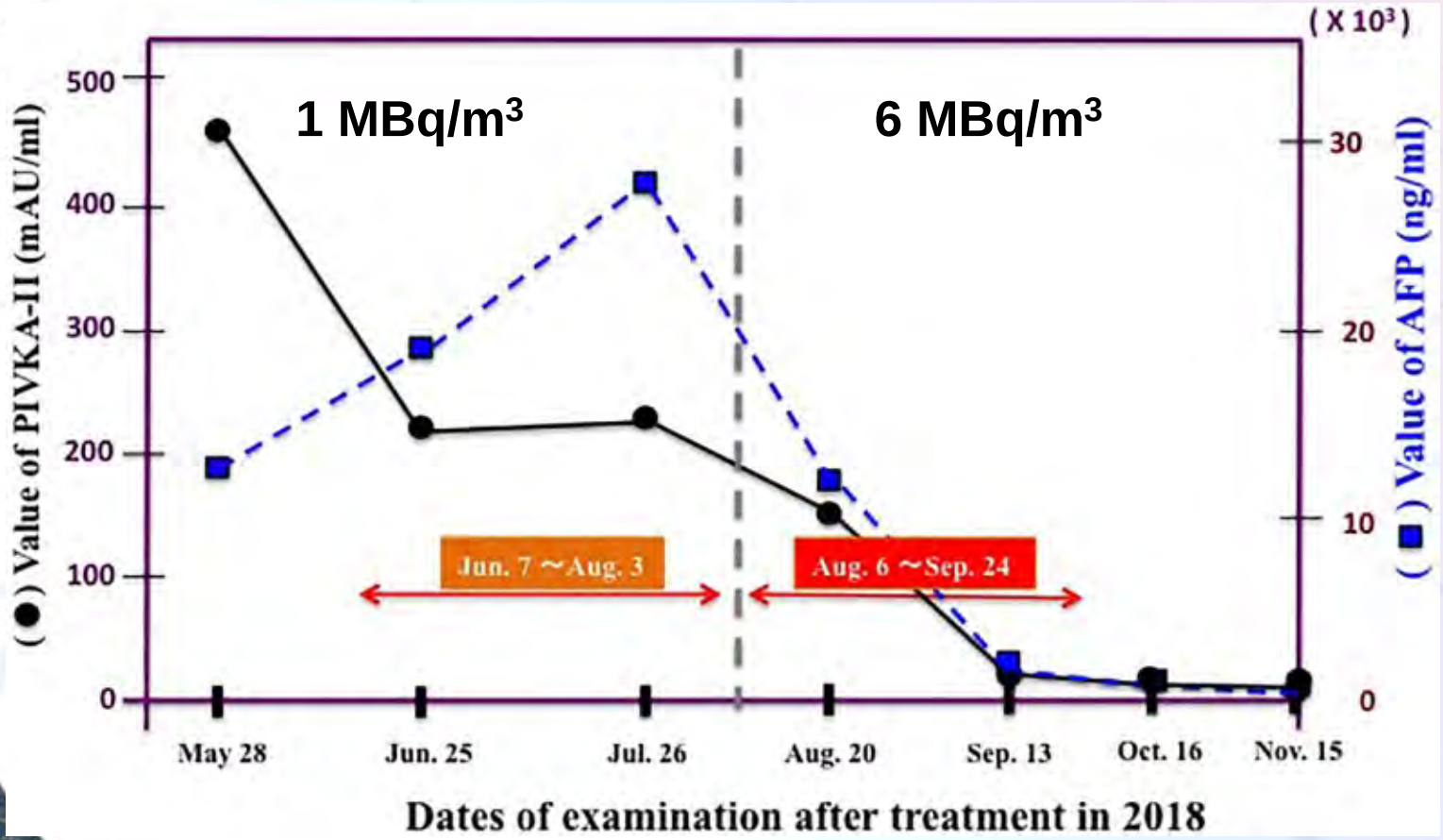
Brain MRI images, metastatic lung cancer patient

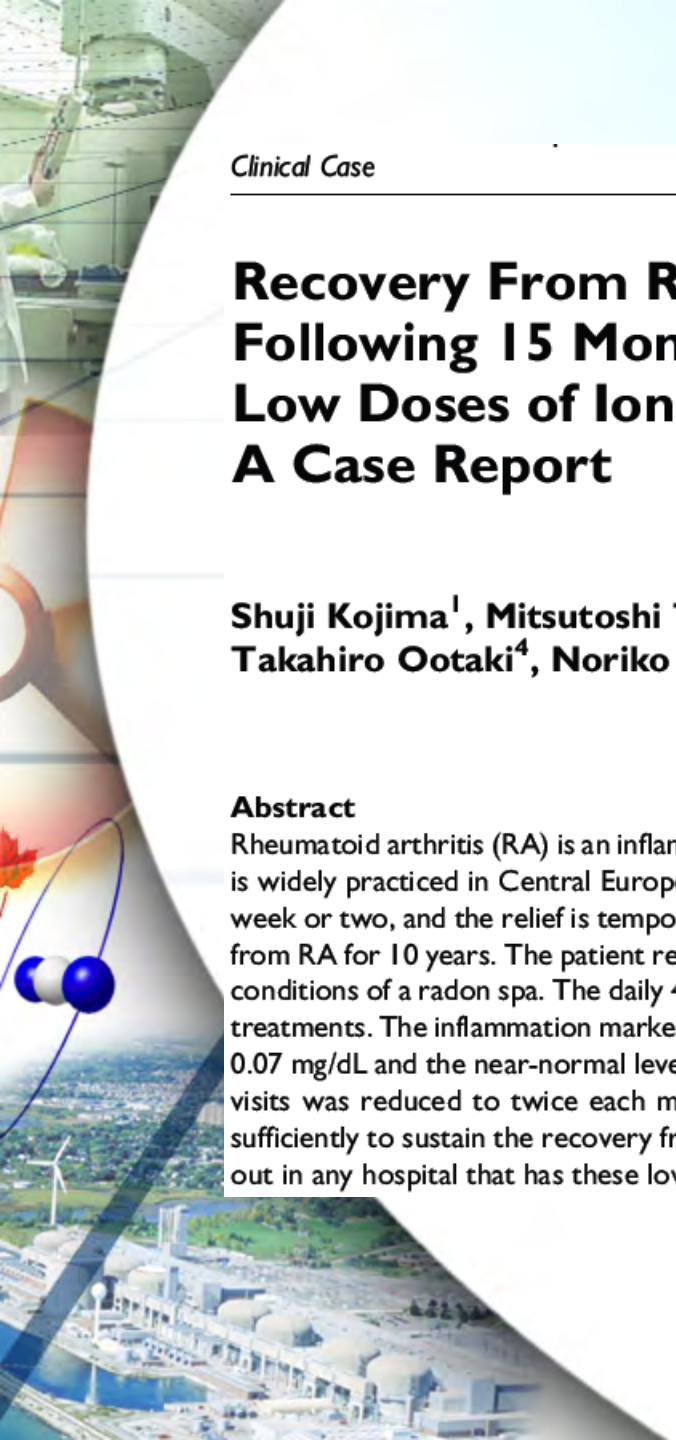


January 9th 2018

May 17th 2018

Tumor markers for liver-cell cancer patient





Clinical Case

Recovery From Rheumatoid Arthritis Following 15 Months of Therapy With Low Doses of Ionizing Radiation: A Case Report

Dose-Response:
An International Journal
July-September 2018:1-7

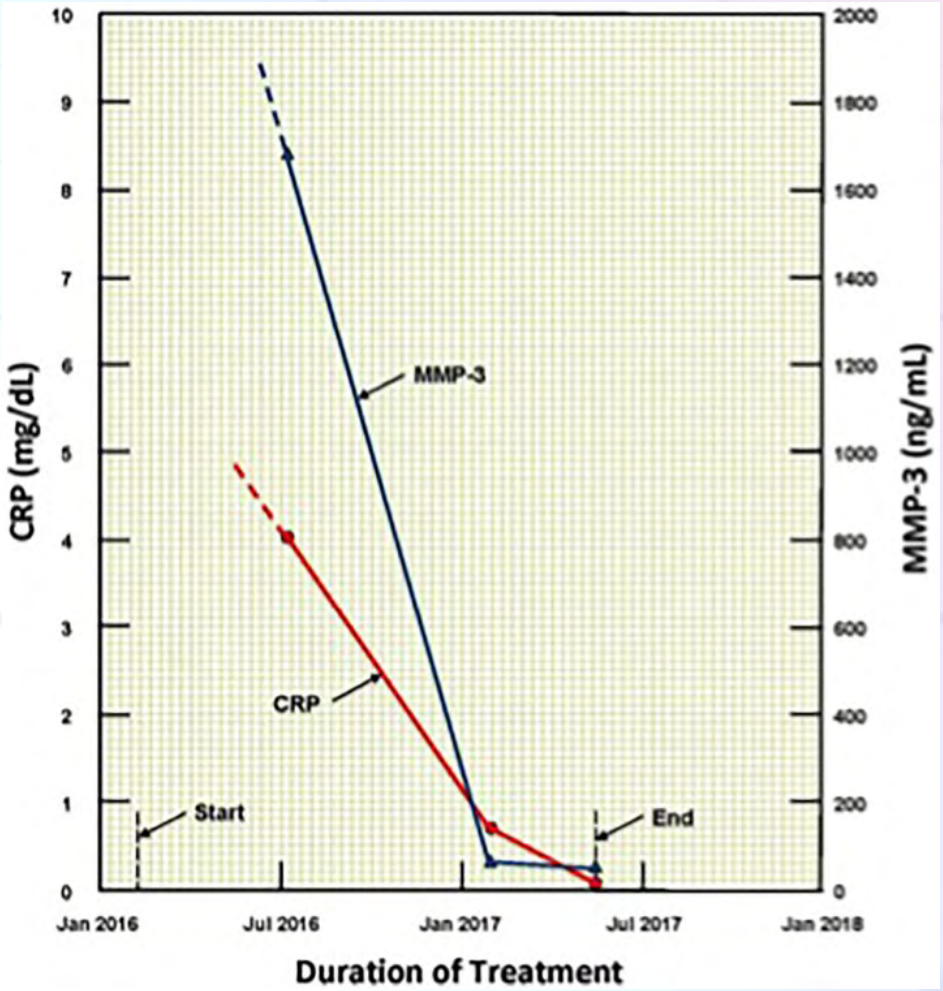
DOI: 10.1177/1559325818784719
journals.sagepub.com/home/dos
SAGE

Shuji Kojima[1], Mitsutoshi Thukimoto[1], Jerry M. Cuttler[2], Kiyomi Inoguchi[3], Takahiro Ootaki[4], Noriko Shimura[5], Hironobu Koga[6], and Akihisa Murata[6]

Abstract

Rheumatoid arthritis (RA) is an inflammatory autoimmune disease that occurs commonly in old people. Hot spring radon therapy is widely practiced in Central Europe and Japan for relief from the painful symptoms. The usual duration of a spa treatment is a week or two, and the relief is temporary. This article reports on the near-complete recovery of a patient who had been suffering from RA for 10 years. The patient received 15 months of low-dose radon and γ-radiation therapy in a room that reproduced the conditions of a radon spa. The daily 40-minute exposure in the therapy room was supplemented by ten 6-minute radio-nebulizer treatments. The inflammation markers C-reactive protein and matrix metalloproteinase 3 declined strongly to the normal level of 0.07 mg/dL and the near-normal level of 48.9 ng/mL, respectively. After the patient's return to good health, the frequency of the visits was reduced to twice each month. The patient's protection systems appear to have adapted to stimulated conditions, sufficiently to sustain the recovery from RA. Such a long-term course of treatments and follow-up maintenance could be carried out in any hospital that has these low-dose radiation therapy rooms. The therapy could be scheduled to suit patient availability.

Rheumatoid arthritis markers – radon therapy



Radon Therapy for Autoimmune Diseases Pemphigus and Diabetes: 2 Case Reports

Dose-Response:
An International Journal
April-June 2019:1-8

DOI: 10.1177/1559325819850984
journals.sagepub.com/home/dos
SAGE

Shuji Kojima[1], Jerry M. Cuttler[2], Noriko Shimura[3], Hironobu Koga[4], Akihisa Murata[4], and Akira Kawashima[5]

Abstract

We report on the application of radon therapy to relieve the suffering of 2 patients with autoimmune diseases, one with pemphigus with an old myocardial infarction and diabetes mellitus and the other with type I diabetes. We include a lengthy discussion of the biological mechanisms that we believe produced the observed benefits. During the 6 to 9 months of the treatments, the marker values decreased to the upper limit of their normal ranges and the symptoms of the diseases were alleviated. Disorders of Th1/Th2 balance are implicated in the onset of many diseases, including autoimmune diseases. Our decision to give radon (^{222}Rn) therapy to these patients was based on the results of 2 similar case reports and our earlier mouse experiments, which indicated that low doses of radiation induce regulatory T cells. Regulatory T cells regulate the T helper 1 cell and the T helper 2 cell balance. There are more than 80 different autoimmune diseases that are treated with anti-inflammatory agents or immune-suppressing drugs because the exact causes of these diseases and the cures are unknown. These and other case reports indicate that proper radon therapy is an effective treatment. We urge physicians to consider radon as a standard therapy for refractory autoimmune diseases.

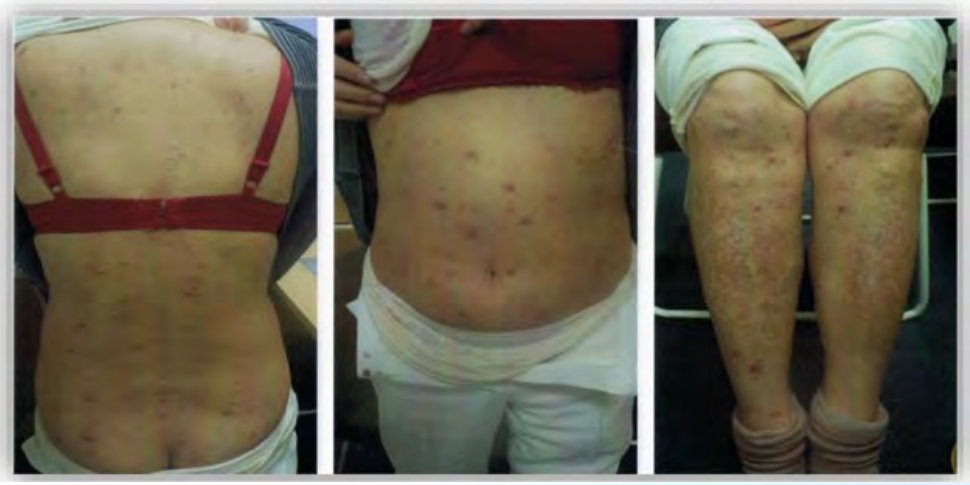
Pemphigus, an autoimmune disease

Before

A

After radon therapy

B



Radon therapy for pancreatic cancer

Shuji Kojima on Aug 8, 2019:

Radon alpha therapy has been effective in improving the condition of pancreatic cancer patients.

We have not started preparing the manuscript because we have not completed collecting all of the related data.

Please wait for a while.

Treatment of AD and PD with CT X-rays in Michigan 2015

A call for help

- In April 2015, my colleague Dr. Eugene Moore in Midland, Michigan, USA telephoned me
- “I put my wife in hospice; she has AD”
- “Can we do anything to save her life?”
- In 2013, reviewed paper “Low Dose Radiation Adaptive Protection to Control Neurodegenerative Diseases.”

Dose-Response, 12:277–287, 2014
Formerly Nonlinearity in Biology, Toxicology, and Medicine

ISSN: 1559-3258
DOI: 10.2203/dose-response.13-030.Doss

International Dose-Response Society

LOW DOSE RADIATION ADAPTIVE PROTECTION TO CONTROL NEURODEGENERATIVE DISEASES

Mohan Doss □ Fox Chase Cancer Center

□ Concerns have been expressed recently regarding the observed increased DNA damage from activities such as thinking and exercise. Such concerns have arisen from an incomplete accounting of the full effects of the increased oxidative damage. When the effects of the induced adaptive protective responses such as increased antioxidants and DNA repair enzymes are taken into consideration, there would be less endogenous DNA damage during the subsequent period of enhanced defenses, resulting in improved health from the thinking and exercise activities. Low dose radiation (LDR), which causes oxidative stress and increased DNA damage, upregulates adaptive protection systems that may decrease diseases in an analogous manner. Though there are ongoing debates regarding LDR's carcinogenicity, with two recent advisory committee reports coming to opposite conclusions, data published since the time of the reports have overwhelmingly ruled out its carcinogenicity, paving the way for consideration of its potential use for disease reduction. LDR adaptive protection is a promising approach to control neurodegenerative diseases, for which there are no methods of prevention or cure. Preparation of a compelling ethics case would pave the way for LDR clinical studies and progress in dealing with neurodegenerative diseases.

Condition of Alzheimer patient

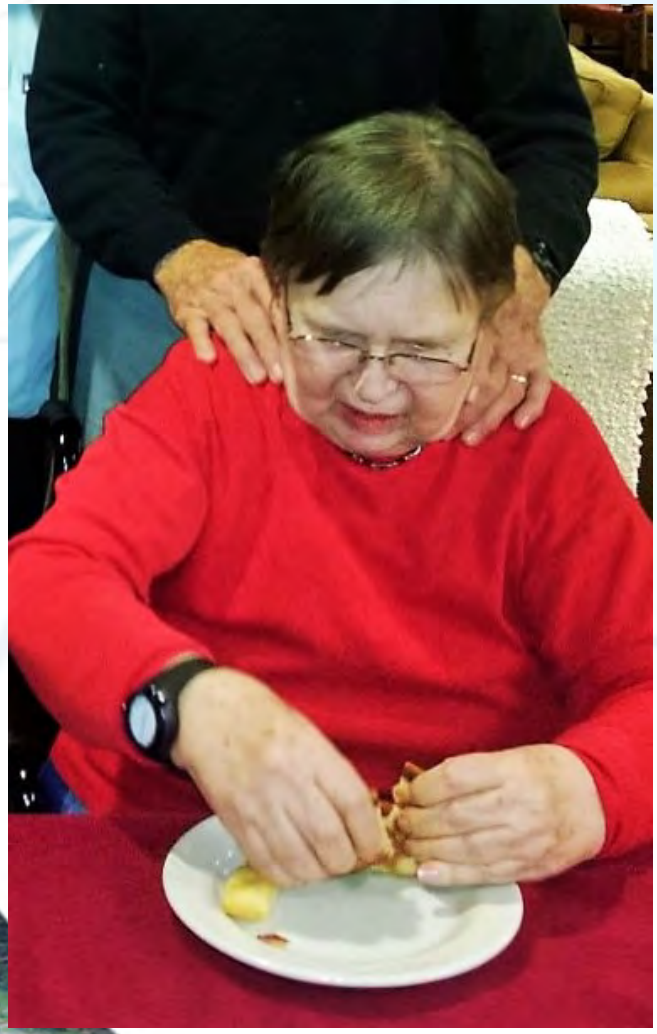
- May 21 2015 “completely nonresponsive”
- Age 81, diagnosed with AD 10 years ago
- Progressed to final stages
- Frequently refused medication
- Almost totally non-communicative
- Almost immobile; no attempt to rise from her wheelchair in months

Therapeutic CT scan

- I suggested whole-body X-ray treatment
- Her MD (internist) prescribed CT scan of her brain
- Radiologist quoted $4000 cost, with image analysis
- Husband self-paid $75, no analysis
- Patient moved during July 23 scan; so scan was repeated scan, dose $CTDI_{vol}$ = 2 x 40 = 80 mGy
- Next morning, caregiver observed improved:

  Cognition, Memory, Speech, Movement and Appetite
- Observed also by husband and by visiting friends
- She recognized husband, but not her son

Barbara, look at the camera!



Appetite

Responsive

Ongoing treatments

- I expected stimulation to fade with time, so I suggested repeat treatments of 2 scans/week
- Physician urged caution, so 1 scan/2 weeks
- Improvement observed after 2 more scans
- Setback after 4th scan; but patient soon recovered
- Nov 20, patient sent from hospice to mental care home, with stimulating day programs
- CT scans given in 2016 at different intervals

Dates and doses

Date	Interval (days)	Dose (mGy)
07/23/2015		82**
08/06/2015	14	39
08/20/2015	14	47
10/01/2015	42	39
02/24/2016	146	40
06/22/2016	119	40
10/27/2016	127	40
12/13/2016	47	40
01/24/2017	41	80**

** two CT scans

Progress Note

PATIENT NAME: Barbara A. Moore
DATE OF BIRTH: October 28, 1934

PATIENT NUMBER: 5646
DATE SEEN: April 15, 2016

I met with Mr. and Mrs. Moore and their son, David. Unlike our last visit, Mrs. Moore was able to give simple verbal responses to direct, simple questions. Not all of her responses were related to the direct questions, but she seemed to be reacting appropriately to the prosody and nonverbal cues of those around her. This represents some improvement from October 12, 2015 when I last saw her.

Mr. Moore has been living at Bicksford Home in Midland since March 1, 2011. Mr. Moore reported that his wife is no longer receiving services through hospice at this time because of her lack of decline. He indicated that she was able to get out of the car by herself with some standby assist. However, she has not resumed walking independently. Mr. Moore reported that his wife occasionally feeds herself, but she still requires cueing.

Mr. Moore feels the low-dose x-ray treatment for tremor and the immune system is helping with his wife's cognitive difficulties. He is presenting a paper on the initial results at the 15th Annual International Conference on Dose-Response at the University of Massachusetts next week.

DIAGNOSTIC IMPRESSION: Senile dementia-probable Alzheimer's disease.

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AD progressed in 2017; death in 2018

- During 2017, AD progressed; patient deteriorated
- March 6th 2017 patient returned to hospice
- Gradually lost ability to swallow food
- Weight declined from 185 to 160 lbs
- 83rd birthday celebrated October 28th 2017
- Died on May 18th 2018

Patient with Parkinson's

- **Husband 83-y old with Parkinson's Disease asked for a CT after seeing the improvement in wife's AD symptoms**
- **During night of Oct 6, 2015, constant tremors stopped; he slept well and awoke refreshed**
- **Lowered Carbidopa/Levodopa from 6 to 2-3 pills/day**

CT scans for Parkinson's

Date	Interval (days)	Dose (mGy)
10/06/2015		40
06/16/2016	253	40
07/13/2016	28	40
09/29/2016	51	40
11/21/2016	80	40
12/21/2016	30	40

4 to 6 weeks was suitable interval

Effects of on PD symptoms

- During 2017, patient received 8 CT scans
- Medication stopped (no pills) almost no tremors
- Tremors decreased after each CT scan
- Vision improved: can read at 18" without glasses; Fuchs dystrophy (corneal edema) lessened
- Hearing improved 5 dB at 4000 Hz; 18 dB at 6000 Hz
- Neuropsychological evaluations indicated notable improvements as well as relatively mild declines

Papers on AD and PD patients

Original Article

Treatment of Alzheimer Disease With CT Scans: A Case Report

2016

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http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4826954/ http://dos.sagepub.com/content/14/2/1559325816640073.full

Abstract

Alzheimer disease (AD) primarily affects older adults. This neurodegenerative disorder is the most common cause of dementia and is a leading source of their morbidity and mortality. Patient care costs in the United States are about 200 billion dollars and will more than double by 2040. This case report describes the remarkable improvement in a patient with advanced AD in hospice who received 5 computed tomography scans of the brain, about 40 mGy each, over a period of 3 months. The mechanism appears to be radiation-induced upregulation of the patient's adaptive protection systems against AD, which partially restored cognition, memory, speech, movement, and appetite.

Keywords

Alzheimer disease, CT scan, adaptive protection systems, ionizing radiation

Letter to the Editor

Update on a Patient With Alzheimer Disease Treated With CT Scans

2017

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https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5347268/

Letter to the Editor

Second Update on a Patient With Alzheimer Disease Treated by CT Scans

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Phase-1 clinical trial in Toronto, July 2017

- **Physicians do not accept the Michigan evidence**
- **I urged neurologists at Baycrest and Sunnybrook hospitals to do study on 3 severe AD patients**
- **Approved by 2 Research Ethics Boards July 2018**
- **No external funding**
- **Registered at www.ClinicalTrials.gov**

Treatments started in 2019

- CT-scan treatments on Feb-Mar, Jul-Aug and Sep-Oct
- Difficult to measure improved behavior of first 2 patients
- But significant improvement observed on 3rd Sep 11-12 !!!
- Plan to treat 2 more patients with severe AD
- There is no biological “marker” for AD in blood; however, F2-isoprostanes in cerebrospinal fluid is a good marker
- Sampling and analysis of CSF is invasive and expensive

AD patient #3 is eating and posing, Sep 12

Objectives of large clinical trials

- A treatment device instead of expensive CT scanner
- Protocols for patients at different stages of AD, to prevent, stop or reverse neurodegeneration
- Determine optimal radiation dose for treatment
- Determine optimal interval between treatments
- Measure F2-Isoprostanes marker in cerebrospinal fluid

Conclusions

1. All aerobic organisms leak ROS at a very high rate naturally and they have very powerful adaptive protection systems against the potential and actual damage to their DNA and other biomolecules
2. A low dose of ionizing radiation produces hits and ROS; each burst stimulates these systems (includes the immune system)
3. These protection systems act against damage that is radiation induced and any damage that is not caused by radiation
4. Low doses of radiation have been used for > 120 years to treat infections, cancer, inflammations, autoimmune diseases, etc.
5. US NAS misled the world in 1956 by recommending LNT model to assess risk of radiation-induced mutations (and cancer)

6. Physicians stopped using low-dose therapy; they disregard all information about the remarkable efficacy of these treatments
7. Medical textbooks follow LNT—omit information on radiation stimulation of adaptive protection systems against diseases
8. Follow-up studies on many thousands of children treated by nasal radium irradiation show no definite link to any disease
9. Radium intake threshold is 100 μCi for onset of malignancy; cumulative dose threshold is 10 Gy for onset of bone sarcoma
10. Evidence of high dose-threshold and dose-rate-threshold for onset of harmful effects ignored by radiation protection people
11. Radon therapy may be very effective against different cancers
12. Clinical trials of low-dose radiation therapies will encounter difficulty obtaining medical endorsement and external funding