

RADIATION EXPOSURE: OVERCOMING VESTED INTERESTS THAT BLOCK GOOD SCIENCE

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ABSTRACT

Good scientific evidence continues to accumulate that contradicts and discredits the Linear No-Threshold Hypothesis (LNTH) dose-response relationship for low-level radiation exposure, and that supports the threshold concept. The basic difference between these models is described and some of the areas in which data has been accumulated are identified. Potential benefits from replacing LNTH with a threshold model are listed, representing savings of up to hundreds of billions of dollars per year. Reference is made to the huge radiation effects database that is evolving for the Mayak nuclear weapons complex in Russia. Several categories of vested interests in continuing the LNTH are identified, including both anti-nuclear and pro-nuclear camps. Steps that need to be taken to organize and interpret currently available and new data are described. Additional action needed to overcome the vested interests and to obtain accountability in government agencies is discussed. It is concluded that the LNTH should be replaced as soon as possible on the basis of presently known information. We cannot afford to first wait until all ongoing and proposed research is completed. The continued vitality of all nuclear activities may rest on making at least an interim change as soon as possible.

INTRODUCTION

Good scientific evidence continues to accumulate that contradicts and discredits the arbitrary Linear No-Threshold Hypothesis (LNTH) dose-response relationship for low-level radiation exposure. In spite of extensive existing evidence supporting the threshold concept and the great benefits that can be obtained by replacing the LNTH, there are vested interests that block making this advance. It is incumbent upon us to overcome the opposition to good science in order to continue achieving the benefits of nuclear science.

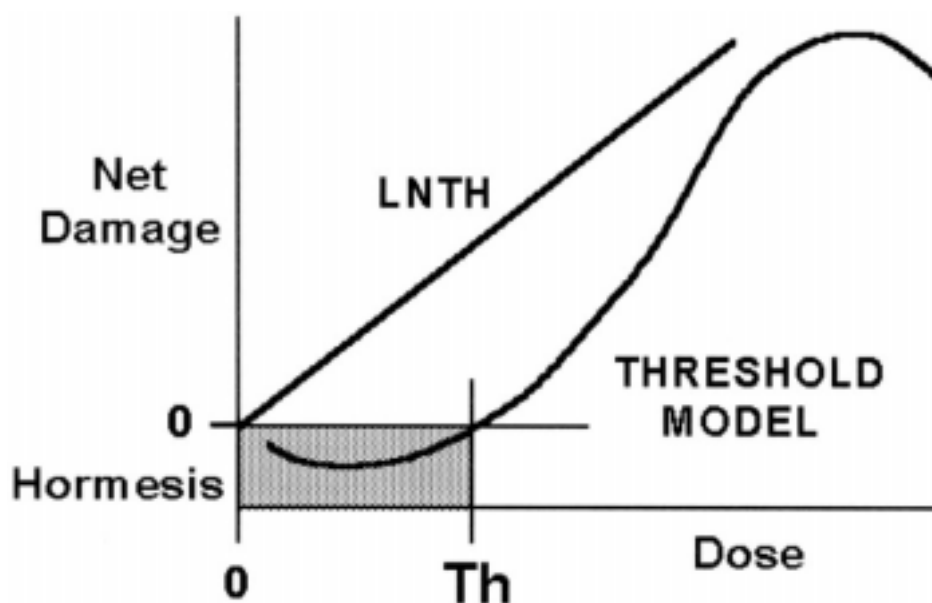
THRESHOLD MODEL VERSUS THE LNTH

The LNTH simply assumes that the incidence of health effects observed at a high-dose, or a high-dose-rate will decrease linearly with dose or dose-rate all the way down to zero, with no threshold level. This ignores repair and suppressor processes which negate effects below some threshold level. Figure 1 illustrates a comparison between the LNTH and the threshold model. The LNTH relationship notes a cluster of recognized health effects, or net damage observed at high doses and simply connects that cluster with zero by a straight line. Data at low doses that does not conform with the linear assumption has been conveniently and arbitrarily ignored. The threshold model recognizes that net damage decreases to zero at some threshold value ("Th" in Fig. 1), and that below the threshold, net benefits (negative "net damage"), known as "radiation hormesis" are observed. The shape of the curve above the threshold value has not yet been

clearly defined. The possible downward bend shown at high doses represents cell death instead of cancer development. However, the shape of the curve above a threshold value, while of interest, is less important than the recognition of the threshold level itself and the hormesis zone. The existence of a threshold value and the radiation hormesis zone is the basis of this paper.

SCIENTIFIC EVIDENCE SUPPORTS THRESHOLD MODEL

A compilation of data on low-level radiation health effects edited by Muckerheide (1) includes information and data from more than 700 cited references. The purpose of this paper is to begin an examination of vested interests that stand in the way of recognizing good science. Beyond stating a few of the areas presented in the literature as background, this paper accepts the existence of a threshold as illustrated in Fig. 1 and proceeds from there. Space does not permit attempting to repeat and argue the data itself or to list the vast number of references.



Briefly, what are some of the areas where data (1) contradicts the LNTH and supports the threshold concept? Nine nuclear worker studies show that exposed worker cancer mortality rates are lower than for non-exposed workers at the same plants. Studies have not found any excess cancer or leukemia among radiologists (after high-dose cases prior to 1925). Moderate doses to medically exposed patients are not found to cause adverse health effects. Data from studies of the radium dial painters and others with internal radium contradict LNTH. Persons participating in atomic weapons tests have not exhibited adverse health effects. Population groups living in high natural background radioactivity areas have displayed statistically lower cancer rates than similar population groups having lower exposure. Lung cancer incidence rates in high radon concentration areas are lower than in low radon areas, directly and dramatically contradicting LNTH. More than 2,000 studies show that low-level radiation produces beneficial health effects, known as radiation hormesis.

BENEFITS OF REPLACING THE LNTH

A preliminary identification and quantification of the benefits that may be derived by replacing the LNTH with a threshold model was presented in 1996 by Logan (2). The current radiation protection regulations evolved through continued application of the LNTH. Replacing the LNTH will permit increasing dose limits in regulations to realistic levels. A preliminary list of areas of direct benefits that can be realized by conversion to a threshold model follow:

1. Reduction in costs of emission control at nuclear facilities.
2. Reduction in costs of enforcement by regulatory agencies.
3. Reduce the unwarranted costs for remediation and land reclamation.
4. Reduce quantities and disposal costs of low-level nuclear wastes.
5. Reduce interim storage and disposal costs of spent fuel and high-level wastes.
6. Obtain radiation hormesis benefits.

In addition, there are intangible benefits:

1. Eliminate the "No level of radiation exposure is safe" myth.
2. Reduce unjustified public fear of radiation release incidents.
3. Reduce public fear of undergoing beneficial medical procedures involving radiation.
4. Promote the nuclear power option.

The economic quantification of the direct benefits totals up to hundreds of billions of dollars per year (2). The value of the intangible benefits is virtually unlimited! Elimination of the widely held but untrue belief that radiation is harmful, no matter how low the dose, can unleash the long-term benefits of nuclear power expansion, remove roadblocks to resolution of nuclear waste disposal, advance the use of nuclear medicine and realize benefits from radiation hormesis.

LOW-LEVEL RADIATION RESEARCH

New Funding

In addition to continuing research in numerous areas of radiation health effects, the U.S. Congress passed funding in 1998 for research into the cellular and other biological effects of low-level radiation. The Energy and Water appropriations public law provides \$12M for the coming year to implement a program plan developed by the Department of Energy (DOE).

International Health Programs

The mission of the International Health Programs (3) is to define the relationship between ionizing radiation dose and its effect on human health. The IHP includes programs in Europe, Japan, and the Marshall Islands. United States participation is through the DOE Office of International Health Programs. There are major projects of the IHP under the Joint Coordinating Committee for Radiation Effects Research in Russia (JCCRER). Long-term studies of populations and workers exposed to radioactive contaminants from the Mayak nuclear weapons production complex established in 1948 by the Soviet Union in the Southern Urals were started in 1997. Large

amounts of radioactive materials were released into the environment from accidents and poor management practices at the complex between 1948 and 1967, contaminating large areas and subjecting hundreds of thousands of people to significant radiation exposures. A huge database is evolving which covers a history of fifty years for several cohorts. This provides a potential for many constructive correlations. However, vigilance is needed to guard against further force-fits of data into the LNTH at the expense of good science.

OPPOSITION FROM VESTED INTERESTS

Opposition to replacing the LNTH with a threshold model is not restricted to the expected opposition by anti-nuclear activists and organizations. Much of the opposition comes from well-meaning persons within the nuclear field having vested interests in the LNTH.

Anti-Nuclear Camp

The anti-nuclear camp will fight to the end to preserve the myth that "No level of radiation exposure is safe." This is the cornerstone of their scare tactics to misrepresent everything nuclear. Not only is the threshold concept an anathema to these people, recognition of radiation hormesis is beyond their comprehension.

Radon Industry

Testing of homes for radon concentration and "remediation" of homes above the action level has spawned an extensive multi-billion dollar industry that can be expected to lobby against any change that reveals that there are relatively few homes where radon actually represents a risk.

Regulatory Agencies

Several of the United States and international regulatory agencies have become comfortable with the LNTH and resist any pressure to change. This goes back decades to the time when large acute doses were identified with health effects and it was arbitrarily decided to simply connect a cluster of points to zero with a straight line to define health effects at low-doses down to zero. This involved discarding some low-dose points but was viewed as being the safe thing to do. Some individuals in these agencies have a vested interest in perpetuating the no-threshold concept rather than admit the previous error. Some bureaucrats in regulatory agencies will oppose shrinking the size of their turf and budget that could result if regulations are relaxed.

Remediation Contractors

Regulations based upon the LNTH are unnecessarily restrictive for cleanup of contaminated sites. This causes the scope of work for construction and environmental sampling to be greater than really required to protect public health. These contractors will oppose changes in regulations that decrease the need for their services.

Risk Analysts and Others in the Nuclear Field

Some risk analysts who are comfortable with the LNTH and established computer models based on the LNTH will oppose having to "re-tool" with new models which have yet to be created and established. Many working in the nuclear field are not up-to-date and are still trapped by the oft-repeated but erroneous linear catechism. Researchers and institutions funded for projects based upon "linear relative risk models" will not want their funding diverted.

OVERCOMING THE OPPOSITION

Ongoing research in molecular and cellular biology, and the associated repair mechanisms and suppressor processors, is leading toward a full understanding of how radiation and other agents cause cancer. Dose-response curves will be defined and threshold levels will be more precisely identified. There is good potential in analyses of the Mayak database (3), providing the data is not misapplied. In the meantime, while the research continues, economic losses from overly restrictive regulations also continues, and the anti-nuclear camp continues to make progress in eroding public acceptance of the benefits of nuclear science. Currently available data from good science adequately supports adopting the threshold concept. It is possible to proceed with at least interim revised standards and regulations in parallel with research, to get on the right track. Later, refinements can be made as a greater level of understanding is attained.

Steps We Need to Take

Several steps we need to take that were recommended in 1997 (4) to move the initiative along in parallel with new research are as follows:

1. Assemble threshold-related data: Assemble the extensive, but scattered, documented data available in the literature into a cataloged database.
2. Assemble Opposing View Data: Assemble data and arguments purporting to support the LNTH , along with counter-arguments with the purpose of resolving any concerns some may have.
3. Translate total dose into dose rates: Extend the database where possible to translate accumulated dose into dose rates to correspond to the approach generally used in regulations.
4. Identify thresholds: Interpret the dose rate vs. damage and beneficial effects to converge on a consensus for apparent threshold values and their uncertainties.
5. Determine new regulatory limits: Revise regulatory limits for dose rates and corresponding concentrations to appropriate levels below the threshold values.

Additional Action Needed

The steps listed above relate primarily to organizing and interpreting currently available data plus new data as it becomes available. There is additional pressure needed to bring about accountability within regulatory agencies and professional organizations. There appear to be individuals entrenched in each of the agencies who have a vested interest in continuing the LNTH and who dismiss out-of-hand, attempts to introduce the threshold concept. There is the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP). The NCRP draws support from the Executive Branch of the U.S. Government. There is the Committee on the Biological Effects of Ionizing Radiations

(BEIR) which is under the National Academy of Science (NAS). The NAS is a private entity that contracts under the Environmental Protection Agency (EPA) and the Nuclear Regulatory Commission (NRC). These agencies, plus the Department of Energy (DOE) comprise an intricate relationship in which it is difficult to eliminate erroneous concepts supported by vested interests.

Federal legislation with related Congressional hearings may be necessary to expose and resolve the issue. Examples of such action are to call upon the DOE and the NAS to provide justification for terminating the study of the radium dial painters and other radium-burden populations, and to justify not publishing the completed 1978-1987 Nuclear Shipyard Worker Study. Testimony by well-informed persons on behalf of the threshold concept could open up the past suppression of data and termination of projects that were not coming up with "the right answers."

CONCLUSIONS

Accumulated evidence discredits the Linear No-Threshold Hypothesis and argues that it should be replaced by a model recognizing thresholds for net low-level radiation damage. Reform in regulations is possible by adopting a threshold model, which has the potential for saving hundreds of billions of dollars now wasted because of the arbitrary application of the LNTH. Present regulations set limits typically 0.1 to 0.3 times the average radiation background, and ALARA (As Low As Reasonably Achievable) guidelines lower the limit to only one percent of background. On the other hand, the threshold for net radiation damage is more than 20 times as great as background. The gap between current regulations and science-based regulations is unconscionable and needs to be corrected if the benefits of nuclear science are to remain available to our children and beyond. The continued vitality of all nuclear activities may rest on making the change as soon as possible, before nuclear opponents reach their ultimate misdirected objective. While research continues to develop full understanding of processes, we need to assemble what is already known and define science-based regulatory revisions that can be adopted. Prehistoric man did not fully understand combustion and metallurgy prior to achieving the benefits of bronze tools. Continued use of the LNTH should be challenged at every opportunity and agencies should be made accountable for their actions.

REFERENCES

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