TO: Robert Newlin, Chief, News Branch,
- Division of Public Information
Washington (Germantown)
(Note: Suggest a check with B&M Division.)
FM: Wayne Range
Asst. to the Manager
Oak Ridge Operations

1974

REVISED DRAFT/Range
June 23, 1971

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A United States biological researcher today pointed out to an international audience the need for additional research on radiation effects because of apparent inconsistencies and incomplete data.

Dr. John B. Storer, of Oak Ridge National Laboratory, first explained at the Fourth United Nations International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, that data regarding long-term effects of radiation accumulate slowly because observations must be made over long periods of time. However, he noted, based on currently available data there are apparent inconsistencies and inadequacies related to comparisons between human groups, comparisons of human and animal results and in the extrapolation of high radiation dose data to low dose or low dose rate exposures.

Dr. Storer reported that studies of life shortening involving radiologists, Japanese atomic bomb survivors, and a group of patients irradiated for spinal diseases have yielded data that is apparently conflicting. However, animal experiments predict that life shortening should be uniformly observed in humans at fairly high dose rates.

Retrospective studies performed on the relation between prenatal exposure and childhood tumors have shown an apparent positive correlation,

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he noted, but similar studies on the Japanese bomb patients yielded incompatible information. Also, prospective studies of current prenatal exposures have been negative. Dr. Storer called for consideration and further study as to the reasons for these apparent inconsistencies in human data.

Certain principles have emerged from animal studies which are consistent with available human data. The examples he cited were that not all types of tumors can be induced by radiation, gamma rays are much less effective in producing injury at low dose rates, various types of tumors have different dose response curves, neutrons are generally more effective than gamma rays on an absorbed dose basis, and immature animals may be more sensitive than adults.

The effect of low doses is extremely difficult to investigate because sample sizes must be so large, he explained. Thus, effects at very low doses are simply not feasible to study. In view of the minimal data on low dose effects, estimates are usually made by interpolating between zero effect (control population) and an observed high dose rate effect. This assumes a linear relationship between dose and effect. However, he reported, the Japanese studies lead to the conclusion that, for high dose rate gamma exposures, the response curve is curvilinear with increasing slope at high doses. This non-linear response suggests the presence of "multi-hit" effects.

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Dr. Storer noted that there are two apparent inconsistencies in the methods used by radiation standards setting bodies. The first of these relates to dose rate effects. Radiation standards are based upon dose rates -- so many millions per year. However, in deriving upper limit estimates of risk for delayed effects, these standards groups fail to allow credit for low dose rate. The second inconsistency relates to the assignment of high Relative Biological Effectiveness (RBE) factors for types of radiation which deposit all their energy in short distances, high Linear Energy Transfer (LET) radiation. If risks do increase linearly with doses of low LET radiation, like gamma or X-rays, and there is no dose rate effect, then the radiation effect must be from "single hit" events. If this is true, then high LET should have RBE factors less than unity since most of their ionization would be wasted on a single cell. This inconsistency results from the assumptions of linear dose response at high rates without a low dose rate correction for low LET radiations. Some modification of these assumptions appears warranted, Dr. Storer stated.

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The effect of low doses is extremely difficult to investigate because sample sizes must be so large, he explained. Thus, effects at very low doses are simply not feasible to study. In view of the minimal data on low dose effects, estimates are usually made by interpolating between zero effect (control population) and an observed high dose rate effect. This assumes a linear relationship between dose and effect. However, he reported, the Japanese studies lead to the conclusion that, for high dose rate gamma exposures, the response curve is curvilinear with increasing slope at high doses. This non-linear response suggests the presence of "multi-hit" effects.

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to an international audience

A United States biological researcher today pointed up the need for additional research on radiation effects because of apparent inconsistencies and incomplete data. ~~to an international conference in Geneva, Switzerland.~~

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Retrospective studies performed on the relation between prenatal exposure and childhood tumors have shown an apparent positive correlation, he noted, but similar studies on the Japanese bomb patients yielded incompatible information. Also, prospective studies of current prenatal exposures have been negative. Dr. Storer called for consideration and further study as to the reasons for these apparent inconsistencies in human data.

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Dr. Philip P. Cohen, Professor and Chairman, Department of Physiological Chemistry, University of Wisconsin School of Medicine, Madison;

Dr. Clement A. Finch, Professor of Medicine, Division of Hematology, Department of Medicine, University of Washington Medical School, Seattle;

Dr. Arie J. Haagen-Smit, Professor of Biology, California Institute of Technology, Pasadena;

Dr. John S. Laughlin, Chief, Division of Biophysics, Sloan-Kettering Institute for Cancer Research, New York;

Dr. William J. Schull, Professor, Department of Human Genetics, University of Michigan, Ann Arbor.

Dr. John B. Storer of the Biology Division of ORNL is Scientific Secretary of the Committee and Miss Rosemary Elmo of AEC's Headquarters is Executive Secretary.

# # #

NEW FILM ON RADIOACTIVE WASTE DISPOSAL AVAILABLE FOR LOAN TO THE PUBLIC

OAK RIDGE, Tenn. -- A new color motion picture describing the Atomic Energy Commission's proposed project for disposing of radioactive waste in underground salt deposits is now available for loan to the public.

The 16-mm film entitled "SAFETY IN SALT: The Transportation, Handling and Disposal of Radioactive Waste" is 28 minutes in length and was produced for the AEC by the AEC's Sandia Laboratories, Albuquerque, New Mexico.

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Data regarding the long-term effects of radiation accumulate slowly because observations over long periods of time are required. This paper notes inadequacies and apparent inconsistencies in presently available data. Particular attention is paid to the degree of consistency between groups of human data, comparisons of human and animal results, and the accuracy of extrapolating high dose data to low dose or low dose rate radiation exposures.

Studies of life shortening in the Japanese atomic bomb survivours, a group of patients irradiated for spinal diseases, and radiologists have yielded data that is apparently conflicting. However, animal experiments predict that life shortening should be uniformly observed in humans at fairly high dose rates.

Retrospective studies have been performed on the relation between prenatal exposure and childhood tumors. These have shown an apparent positive correlation. However, similar studies on the Japanese bomb patients yielded incompatible information. Also, prospective studies of current prenatal exposures have been negative.

The reason for these apparent inconsistencies in human data should be considered and studied further.

Certain principles have emerged from animal studies which are consistent with available human data. ~~Examples are~~ The examples he cited were that not all types of tumors can be induced by radiation, gamma rays are much less effective in producing injury at low dose rates, various types of tumors have different dose response curves, neutrons are generally more effective than gamma rays

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on an absorbed dose basis, and immature animals may be more sensitive than adults. ~~However, as noted above, animal data predicts uniform life shortening in humans which has not been observed.~~

The effect of low doses is extremely difficult to investigate because sample sizes must be so large, he explained. Thus, effects at very low doses are simply not feasible to study. In view of the minimal data on low dose effects, estimates are usually made by interpolating between zero effect (control population) and an observed high dose rate effect. This assumes a linear relationship between dose and effect. However, he reported, the Japanese studies lead to the conclusion that, for high dose rate gamma exposures, the response curve is curvilinear with increasing slope at high doses. This non-linear response suggests the presence of "multi-hit" effects.

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PRESS SUMMARY
Storer - Geneva Paper

INCONSISTENCIES IN RADIATION RESULTS STUDIED

Because of the required prolonged period of study, new data on the long-term effects of exposure of man and experimental animals to ionizing radiation are accumulated slowly. Because the problem is under continuing review by various scientific committees, this paper is concerned primarily with the following questions: 1) Are the data from the various human populations consistent with one another? 2) Is there general agreement between the human and experimental studies? 3) Are the methods used in interpolation to risk at low doses and dose rates both internally consistent and consistent with well-established principles of radiation biology?

Studies of the Japanese survivors of the bombings, patients who were irradiated for ankylosing spondylitis in Great Britain and Northern Ireland, and radiologists and their technicians give evidence that is somewhat conflicting. The reasons for this lack of consistency should be considered.

On the basis of animal experiments one would expect life shortening in irradiated human populations, as in all the studies where high radiation doses have been employed, the animals have shown a loss of longevity. It is not clear then why the data for effects of radiation on longevity in man are conflicting.

The effect of low total doses has not been extensively investigated because the sample sizes needed are so large that the experiments are not feasible. There are some cases where it appears that certain cancers may be increased by doses of a few hundred rads, but the yield to date is insufficient to make a risk estimate.

The anticipated effects of radiation in the low dose range are based on an interpolation between the observed effects at high doses and the control or zero dose incidence. Retrospective studies have also been performed on the relation between prenatal exposure to low x-ray doses and childhood tumors, and have usually suggested a positive association. Prospective studies, however, have

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been negative. Furthermore, retrospective studies performed on the prenatal children mentioned above were entirely incompatible with similar studies performed on the Japanese bomb victims. It seems fair to say that the issue is in doubt at present, and further work is needed.

The Japanese studies lead to the conclusion that for gamma rays delivered at high dose rates the dose-response curve must be curvilinear with increasing slope at increasing doses, since the low doses yield a smaller proportion of multihit injury.

Certain general principles have emerged from animal experimentation that are consistent with the data for human populations. Among them are: Not all tumor types are radiation-inducible; there is usually a marked decrease in effectiveness of gamma rays when the doses are protracted; the various radiation-inducible tumors have quite different dose-response curves; neutrons tend to be more effective on a dose-for-dose basis than gamma rays; and immature [illegible] than adults.

It must be noted that in the methods used by committees that recommend exposure standards there are two principal inconsistencies: The first concerns dose rate effects. Radiation protection guides are given in terms of dose rate, i.e., so many millirem per year. Yet, in deriving upper limit estimates of risk for late effects, no credit for dose rate is admitted. A second inconsistency arises from assuming high values of relative biological effect (RBE) to high linear energy transfer (LET) radiations. If risks increase linearly with dose of low LET radiation, and there is no dose rate effect, then it follows that the relevant injury is produced principally by single-hit events. If this is true, then the RBE for high LET radiations should be less than unity, since most of their ionizations would be wasted. The inconsistency is the assumption of linearity at high dose rates and no dose rate effect for low LET radiation.

In the case of both of these inconsistencies, some modifications of the conflicting premises would seem to be indicated.

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