HEALTH EFFECTS OF LOW-LEVEL IONIZING RADIATION

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STATEMENT
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ON

HEALTH EFFECTS OF LOW-LEVEL IONIZING RADIATION

BEFORE THE
SUBCOMMITTEE ON HEALTH AND SCIENTIFIC RESEARCH
SENATE COMMITTEE ON HUMAN RESOURCES

Senator Edward Kennedy, Chairman
April 4, 1979
Mr. Chairman and Members of the Committee:

I am honored to appear before you today to discuss possible hazards to health of persons exposed to low-level ionizing radiation. My remarks will be restricted primarily to those long-term health effects following exposure to x-rays and to gamma rays from radioactive sources, since these are the ionizing radiations most often encountered in medicine and in industry.

Briefly, low-level ionizing radiations can affect the cells and tissues of the body in three important ways. First, if the damage occurs in one or a few cells, such as those of the blood-forming tissues, the irradiated cell can occasionally transform into a cancer cell, and after a period of time there is an increased risk of cancer developing in the exposed individual. This health effect is called carcinogenesis. Second, if the fetus is exposed during pregnancy, injury can occur to the developing cells and tissues, leading to developmental abnormalities in the newborn. This health effect is called teratogenesis. Third, if the injury is in the reproductive cell of the testis or ovary, the hereditary structure of the cell can be altered, and the injury can be expressed in the descendants of the exposed individual. The health effect is called mutagenesis or a genetic effect.

There are a number of other biological effects of ionizing radiations, but these three important health effects - carcinogenic, teratogenic and genetic - stand out because: (a) a considerable
amount of scientific information is known from epidemiological studies of exposed human populations and from laboratory animal experiments; and (b) we believe that any exposure to radiation at low levels of dose carries some risk of such deleterious effects. Furthermore, as the dose of radiation increases above very low levels, the risk of these deleterious effects increases in the exposed human populations.

It is these latter observations that have been central to public concern about the possible health effects of low-level ionizing radiation, and the task of determining standards for protection of the health of exposed populations. Reports of expert advisory committees are in close agreement on the broad and substantive issues of such health effects. Based on careful statistical analyses of epidemiological surveys of exposed human populations, in conjunction with extensive research in laboratory animals on (a) dose-response relationships of carcinogenic, teratogenic and genetic effects, and on (b) mechanisms of cell and tissue injury, a number of important conclusions on the health effects of ionizing radiation has emerged.

• In regard to radiation-induced cancer, the solid cancers arising in the various organs and tissues, such as the female breast and the thyroid gland, rather than leukemia, are the principal late effects in individuals exposed to radiation. The different
organs and tissues vary greatly in their relative susceptibility to radiation-induced cancer. The most frequently occurring radiation-induced cancers in man include primarily in decreasing order of susceptibility, the female breast, the thyroid gland, especially in young children and females, the blood-forming organs (causing leukemia), the lung, certain organs of the gastrointestinal tract, and the bones. There are influences, however, of age at the time of irradiation, of sex, and of the radiation factors and types affecting the cancer risk.

- The effects on growth and development of the embryo and fetus are related to the stage at which exposure occurs. It would appear that a threshold level of radiation dose may exist below which gross effects will not be observed. However, these levels would vary greatly depending on the particular abnormality.

- The paucity of human data from exposed populations has made it necessary to estimate genetic risks based mainly on laboratory mouse experiments. Our knowledge of fundamental mechanisms of radiation injury at the genetic level permits greater assurance for extrapolation from laboratory experiments to man. With new
information of the incidence of serious genetically-related disease in man, such as diabetes, the risk of radiation-induced mutations affecting future generations takes on a new and special meaning.

However, there is still very much we do not know about the potential hazards of low-level ionizing radiation:

- We do not know what the health effects are at dose rates as low as a few hundred millirem per year. It is probable that if health effects do occur, they will be masked by environmental or other factors that produce similar effects.

- The epidemiological data on exposed human populations is highly uncertain as regards the forms of the dose-response relationships for radiation-induced cancer, and this is especially the case for low dose levels. Therefore, it has been necessary to estimate human cancer risk at low doses primarily from observations at relatively high doses. To do this, the linear no-threshold hypothesis has been frequently used, as in the 1972 BEIR report and the 1977 UNSCEAR report, recognizing the lack of our scientific understanding of fundamental mechanisms of radiation-induced cancer in man. In considering the many forms of the dose-response relationships applied to epidemiological data, the linear model has emerged as
the simplest and the most conservative, but not necessarily the universally correct form. However, it is not known whether the cancer incidence observed at high dose levels applies also at low levels.

- As yet, we have no reliable method of estimating the repair of injured cells and tissues of the body exposed to very low doses and dose rates. And, further, we cannot identify those persons who may be particularly susceptible to radiation injury.

- From the epidemiological surveys of irradiated populations exposed in the past, we have only limited information on the precise radiation doses absorbed by the tissues and organs, and we do not know the complete cancer incidence in each population, since new cases of cancer continue to appear with the passing of time. Thus, any estimation of risks to health based on such limited dose-response information must be incomplete.

- Finally, we do not know the role of competing environmental and other host factors - biological, chemical or physical factors - existing at the time of exposure, or following exposure, which may affect and influence the carcinogenic, teratogenic, or genetic effects of low-level ionizing radiation.
In summary, Mr. Chairman, it is now assumed that any exposure to radiation at low levels of dose carries some risk of deleterious effects. How low this level may be, or the probability or magnitude of the risk, still are not known. Our best scientific knowledge and advice are essential for the protection of the public health, for the effective application of new technologies in medicine and industry and for guidance in the production of nuclear energy. Unless man wishes to dispense with those activities which inevitably involve exposure to low levels of ionizing radiations, he must recognize that some degree of risk to health, however small, exists. A pragmatic appraisal of how man wishes to continue to derive the benefits of health and happiness from such activities involving ionizing radiation in times of everchanging conditions and public attitudes in our resource-limited society is the task which lies before all of us - all men and women of our society, of science and of medicine, and of law and government - now and in the future.
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