

IS ALL NUCLEAR RADIATION HARMFUL?*

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A B S T R A C T

An analysis is made of available experimental results on the longevity effects of chronic low-level radiation upon animals. It is shown that a statistical average life-lengthening effect occurs at chronic life-time radiation exposure levels below about 2-5 rad/week; for higher exposures, a life-shortening effect is observed although the data do show variations among animals. Similarly, available data on chronic internal exposures resulting from injection of radioisotopes show that for such materials of interest as plutonium and uranium statistical life-lengthening effects also occur for comparatively low injections where higher injections produce life shortening. The principal sources of human data are statistical studies on the longevity of radiologists, and these also indicate an apparent greater life expectancy for this group as compared to physicians in general. It is noted that available data do not permit unequivocal determination of the over-all genetic effects of low levels of radiation, primarily because the data do not clearly indicate environmental selection principles. Some of the philosophical bases involved in evaluating the over-all somatic and genetic effects of low levels of radiation are briefly discussed.

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World Health Organization in 1957 (35). These documents have provided the primary reference information.

Although experimental data have been obtained with a wide variety of living materials, both plant and animal, only a few statistical studies of induced mutations in man have been attempted, these including analyses of the offspring of the survivors of the first atomic bombs. From these human data, Lejeune (36) concludes that statistical significance may be attached only to those which indicate a possible increase in heart disease among the progeny of radiologists and to those which indicate a slight change in the sex ratio of the progeny of irradiated parents. Stevenson (37) points out the difficulties inherent in various proposed methods for evaluating mutational effects in man. Otherwise, the studies most frequently reported for man refer to the results of spontaneous mutations. It is noted in particular that no data have given unambiguous correlations of any genetic or somatic effects to differences in background levels at different geographic locations.⁶

Information of a different type on the possible genetic effects of radiation to man has been given by Kaplan (40) who has followed the experience of 644 women whom he has treated with 200 kv X-rays for sterility and infertility; 688 conceptions in 351 of these women were attributed to these treatments. In reviewing his experience, he has come to the conclusions that "----- no increase in genetic damage was found in 644 married women given approximately 65 r to the ovaries and followed for one to 33 years," and "the incidence of genetic damage

to the children and grandchildren of this group is less than that in the normal population." Kaplan recognizes the statistical deficiencies in his report and indicates that additional information is available from the experience of other physicians providing similar treatments but does not give a specific reference to these data.

In general, experimental information obtained with other living material has shown that radiation can increase the normal mutation rate and has also verified some of the conclusions developed from studies of spontaneous mutations. As in the case of spontaneous mutations, the vast majority of recognizable mutations result in lethal and deleterious effects.

Of these experiments, those of Russell and his co-workers with large numbers of mice are probably the most nearly applicable to man since they provide essentially the only available information concerning the effect of radiation on mammalian genetics, particularly under controlled conditions. Among the effects noted was a shortening of the life span of the offspring of some of his male animals which had been irradiated with neutrons (41); Kohn, however, did not observe a similar effect for the progeny of male mice given total body irradiation of 550 r by 250 kv X-rays (42). He also did not note a change in the sex ratio of these offspring as had been reported for man.

Russell and his co-workers (43) have recently given mice exposures at levels down to 10 rad/week, and have shown that the rate of exposure does have a definite effect upon the rate of production of recognized mutations with comparatively fewer mutations being produced by a given

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