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ABSTRACT

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The Effects of Radiation on Hemopoiesis

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By

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It is the object of this report to consider the effects of radiation on hemopoietic tissue from the present viewpoint of the authors. Much of the background for these opinions is in the work done by various members of the Manhattan Project and whenever data from these investigators have been used it is so acknowledged in the text.

In a consideration of radiation effects on hemopoiesis the following facts are considered fundamental. (1). There is little evidence that the morphological constituents of the peripheral blood are appreciably affected except by very large amounts of radiation (2). The peripheral blood picture resulting at any given period after radiation is greatly influenced by the length of life or rate of utilization of the different morphological elements in the peripheral blood. (3) The effect of radiation on the peripheral blood is influenced by the radiosensitivity of the various parent cells of the peripheral elements. (4) The ability of the various tissues to regenerate is of great importance.

With these basic considerations in mind, the effects of radiation discussed under the following divisions.

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1. Single dose to the body as a whole.
2. Changes in morphology of the hemopoietic tissues in rats given single doses of roentgen radiation
3. Repeated small doses to the body as a whole.
4. Single or repeated doses to one area of the body
5. Internal radiation

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6. The effect of neutrons
7. The effect of total body radiation on coagulation of blood and hemorrhagic manifestations
8. Effect of radiation on man.

Single Dose of Roentgen Radiation to the Body as a Whole

The effects on the various morphological elements (based largely on animal experiments) of the peripheral blood are discussed. Little effect was noted on the levels of peripheral blood erythrocytes, platelets, or neutrophils until dosages of 200r were given. The lymphocytes however showed appreciable reduction with dosage of 25r and maximal reduction at twenty-four hours at a dosage level of 200r. In general, the data indicates that the precursors of the lymphocyte are much more sensitive than those of the other blood elements. The time at which the various peripheral elements begin to decline shows close correlation with the life span of these elements as computed by other methods. Thus the order of disappearance is lymphocytes, neutrophils, platelets, and erythrocytes--regeneration of the last element often masking radiation effects on its precursors to some extent. The data suggest that the radiosensitivity of platelet, neutrophil, and erythroid precursors is of roughly equal order, the erythrocyte precursors being perhaps slightly more radiosensitive as evidenced by the effects on reticulocytes.

Detailed data for the various elements at different dosage levels are presented.

Changes in Morphology of the Hemopoietic Tissues in Rats Given Single Doses of Roentgen Radiation

The pathologic changes observed in the spleens, lymphoid tissue, and bone marrow of rats given a single dose of 350r is discussed.

Repeated Small Dosages of Radiation to the Body as a Whole.

Marked species differences in radiosensitivity are apparent. Data is presented showing the effects of daily dosage of 0.11r, 1.1r, 4.4r, 8.8r administered to mice,

guinea pigs, and rabbits. The latter animal is very radioresistant. In exposures of this type the total dosage is the most important single factor, and within limits the effect of roentgen radiation given in this way is cumulative.

Radiation to a Local Area

The effect on the hematopoietic tissues of radiation applied locally to non-hematopoietic tissue has been a source of considerable argument and speculation for a number of years. Cross circulation studies and local radiation experiments failed to demonstrate any specific radiation effect on hematopoietic tissues outside the field of radiation. These observations point strongly to the absence of any direct effect of radiation on hematopoietic tissue not itself exposed. It is suggested that the whole question of leukopenia following local roentgen ray therapy in humans is in need of critical re-evaluation.

Internal Radiation

Attention is called to the probable usefulness of radioactive isotopes, certainly in research and possibly in therapy.

The Effect of Neutrons

The effects of neutron irradiation of mice in repeated small daily doses is discussed. In general the results are similar to roentgen radiation except 8r is the rough equivalent of 1N when percentage of survival, medium lethal time, and the hematologic effects are used as indicies of comparison.

The Effect of Total Body Radiation or Coagulation of Blood and Hemorrhagic Manifestation

In the dog evidence has been presented that the liberation of heparin in large amounts is an important factor in hemorrhagic manifestations due to radiation in that animal. Further work in this connection will be viewed with great interest.

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Effect of Radiation on Man

The application of the animal experiments to the case of man is discussed. The importance of a probable cumulative effect is emphasized. The possibility of the earlier development of leukemia and allied disorders in predisposed persons is an important consideration. From a practical standpoint any change from normal in the blood of a human with possible exposure to radiation should be considered as due to radiation until proved otherwise. Leukopenia is the most common manifestation of chronic exposure to radiation in the experience of the authors but alterations of any type may occur. In conclusion, it is pointed out that the cummulative effect of radiation is established, the incidence of leukemia is increased, and finally changes may develop after apparent recovery from exposures. What additional effects of chronic radiation will be found we are unable to say.