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Paper 2

## BLOOD CHANGES IN HUMAN BEINGS FOLLOWING TOTAL-BODY IRRADIATION\*

By J. J. Nickson

### 1. INTRODUCTION

A major problem facing the Manhattan Project was the protection of workers against injury resulting from either acute or chronic exposure to external radiation. It was anticipated that the total dose sustained by personnel and the rate of administration could vary widely. Further, there was the problem of assessing the injurious effects, either transitory or permanent, which might arise from such exposures. The problem of detecting evidence of injury following total-body irradiation led to the study with which this paper deals.

Both the experimental<sup>1-4</sup> and clinical<sup>5-7</sup> evidence pointed to the blood-forming organs as among the most radiosensitive tissues in the body. When this study was undertaken, the work previously done in this field indicated that changes in the blood-forming organs and in the hematological constituents of the peripheral blood were a good index of exposure of the whole body to radiation, whether chronic as seen in occupational exposure<sup>6,8</sup> or acute as in radiation therapy.<sup>9,10</sup> The responses of this system can be readily, although indirectly, inferred from serial determinations of the absolute numbers and ratios of the various cellular elements of the blood. The major changes observed in the peripheral blood and reported in the literature are summarized in the following paragraphs.

After acute exposure to large amounts of radiation, a precipitous fall had been noted in the absolute number of lymphocytes, together with a transient marked increase followed by a marked decrease in the number of neutrophils. The time necessary for the return to nor-

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The marked, though transient, depression in the neutrophil, lymphocyte, and platelet counts noted in case 11 about 100 days after the onset of therapy is interesting in the light of the findings of B. V. A. Low-Beer and R. S. Stone,<sup>12</sup> who feel their cases indicate that this drop may be a delayed result of the x-ray exposures.

5.3 Group 3. No evidence of change in the cellular elements of the blood was noted in any of these cases. It will be remembered that the individuals were all normal males in so far as could be demonstrated. These cases were of particular interest to us inasmuch as they indicated that acute exposure to far more than the maximum permissible level of 0.1 r per working day could not be expected to produce diagnostic changes in the elements of the peripheral blood which were studied.

From the practical point of view these studies should have been extended to include the examination of individuals subjected to x-ray exposure of from 0.1 to 1 r per day for long periods of time. For obvious reasons these studies were not undertaken with human beings. Since, however, the data discussed in this paper check in a general way with experimental data on animals subjected to comparable rates and amounts of exposure,<sup>14</sup> it is perhaps reasonable to assume that the data on animals subjected to low levels of exposure for protracted periods of time are applicable, at least approximately, to the effects that might be seen in human beings. These data are presented in Division IV, Volumes 22 B and 22 C, of this series and are summarized in a paper in this volume.

## 6. SUMMARY

Results of examinations of elements of the peripheral blood in 14 individuals following exposure to total-body irradiation were presented. The individuals were divided into three groups: Group 1 consisted of eight individuals who were irradiated with x-rays at one sitting; group 2 consisted of three individuals who were irradiated with x-rays in divided doses; and group 3 consisted of three normal individuals who were irradiated with x-rays in three doses of 7 r each.

In group 1 the most persistent abnormality noted was a diminution in the number of lymphocytes shortly after the completion of the treatment.

In group 2 depression in the lymphocytic count was also the most marked single change.

In group 3 no alterations were noted in the elements of the peripheral blood which were studied.

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