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Acute Myelogenous Leukemia Following Fallout Radiation Exposure

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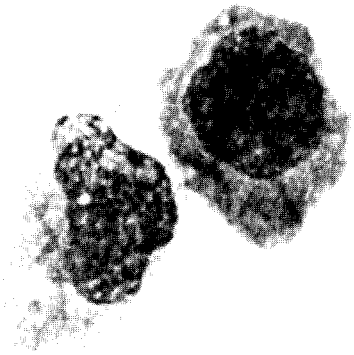
ACUTE myelogenous leukemia developed in a 19-year-old Marshallese man who had been exposed to radioactive fallout at 1 year of age. He was one of 64 people on Rongelap Island accidentally exposed in 1954 following the testing of an atomic device on Bikini atoll 100 miles away. The acute effects of exposure on this population were hematological depression from total body exposure to gamma radiation of 175 rads and beta-ray burns and epilation from deposit of fallout on the skin. There were no deaths, and recovery occurred within a year. Internal absorption of radionuclides from inhalation and consumption of contaminated food and water produced no acute effects, but absorption of radioactive iodine resulted in later development of thyroid lesions in one third of the population; three of these lesions were malignant. The highest incidence was in children exposed at less than 10 years of age, some of whom had growth retardation.[1]

Report of a Case

The man in this case report experienced nausea, vomiting, and itching of the skin during the first two days following exposure. By two weeks, transient beta-ray burns developed on the skin over the neck, arms, and legs, with spotty epilation of the scalp. By six weeks, his leukocyte count had dropped to 3,900/cu mm with depression of both neutrophil and lymphocyte count, while his platelet count had reached a low of 140,000/cu mm at 30 days. There was gradual return of these blood elements to near normal levels. He had remained healthy with only the usual childhood diseases until age 13, when benign adenomas of the thyroid gland were detected and surgically removed. He remained euthyroid with normal growth and development on a regimen of supplementary levothyroxine sodium treatment.

In September 1972, an annual examination showed his leukocyte count to be 2,000/cu mm. There were no other noteworthy findings, and he appeared to be a healthy, husky 19-year-old. Bone marrow examinations at Brookhaven National Laboratory revealed acute myelogenous leukemia (promyelocytic type with numerous Auer bodies) (Fig 1). Extensive antileukemic therapy was then begun at the National Cancer Institute, but since compatible platelet transfusions were not available to combat severe thrombocytopenia that developed, death from extensive pulmonary bleeding intervened before a remission could be achieved.

Fig 1.—Promyelocytes with Auer rods (×2,000).



Comment

Retrospective examination of the hematologic data obtained at frequent intervals since exposure is noteworthy. Comparison of this patient's peripheral blood leukocyte counts (case 54) with the mean levels of eight other boys exposed at less than 5 years of age and eight unexposed Marshallese boys in the same age range is plotted in Fig 2. The leukemia case showed greater depression of neutrophil count both during the immediate postexposure period and during subsequent years. Plots of individual cases in the comparison groups showed none with similarly low levels. The platelets showed lesser comparative depression, and the lymphocytes and erythrocytic elements showed very little difference in the leukemia case when compared with the other groups. Other hematologic data were generally normal (neutrophilic alkaline phosphatase level, basophil counts, serum protein con-

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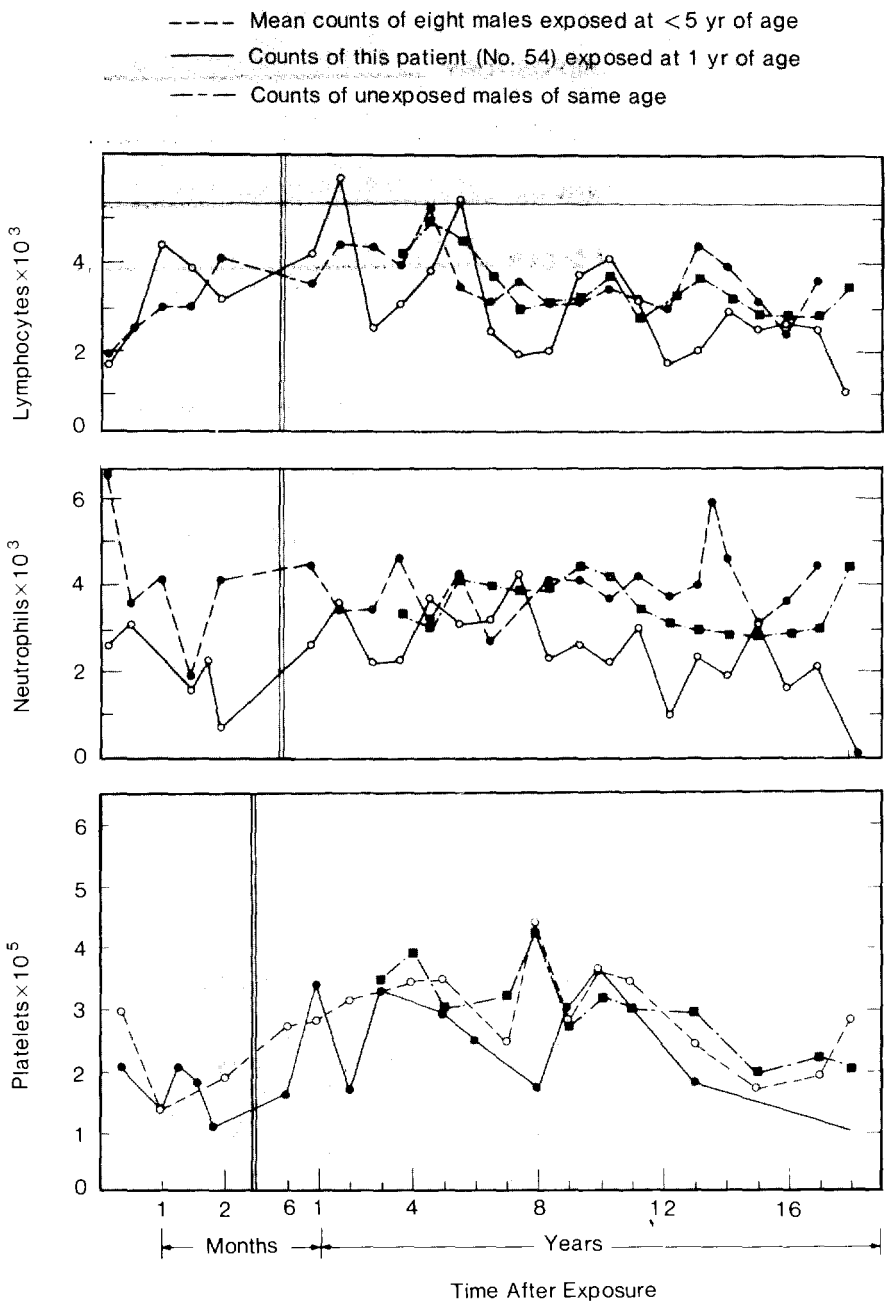

Fig 2.—Comparison of blood cell counts of this patient, other exposed males, and unexposed males.

centrations, Australia antigen). Chromosomes studies of peripheral blood performed 12 years after exposure and of the bone marrow at the time of his present illness did not show aneuploidy or structural changes of the chromosomes. However, increased chromosome breakage (11% of the cells) that may have been related to radiation exposure or possibly to his disease was noted terminally. Unfortunately, bone marrow examinations were not done prior to his present illness.

Although the occurrence of one case of leukemia in this population is not statistically strong evidence of radiation as its cause, it must be seriously considered. With an incidence of two cases of leukemia per year per million people per rad, on the basis of Japanese statistics compiled at Hiroshima and Nagasaki,[2] the expected incidence among the Marshallese would have been about 0.33 cases. On the basis of Marshallese and US statistics on spontaneous incidence, about 0.02 to 0.067 cases might have been expected. The ratio of incidence of radiation-induced to otherwise caused cases indicates that the Marshallese case was about 5 to 15 times more likely to have been radiation-induced than spontaneous. Although the latent period in this case was relatively long, the incidence in Japan (28 years after exposure) is still higher among the exposed group than among the general population. Moreover, the incidence in Japan was higher among those exposed as children, particularly males, in whom the myelocytic form of the disease was more common.

The greater effect of radiation exposure on the myelocytes of this patient is interesting in view of the later development of the myelocytic form of leukemia. Morphologic changes in the myelocytes were not apparent as late as one year before the development of the illness. The thrombocytic and erythrocytic elements did not show evidence of abnormality until near death. Neutrophilic depression was the only evidence of a possible preleukemic syndrome that has been described in some cases of this disease.[3] One might speculate in this case that the frequency of infections that occur in the Marshallese environment may have played a role in the development of a possible radiation-induced mutant clone.

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References

1. Conard RA, Dobyns BM, Sutow WW: Thyroid neoplasia as late effect of exposure to radioactive iodine in fallout. *JAMA* 214:316-324, 1972.

2. *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation: Report of the Advisory Committee on the Biological Effects of Ionizing Radiations.* National Academy of Science, National Research Council, November 1972.

3. Linman JW, Saarni MI: The preleukemic syndrome. *Semin Hematol* 11:73-92, 1974.

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