PATHOLOGICAL PHYSIOLOGY AND GENERAL PATHOLOGY

ERYTHROPOIESIS IN RADIATION DISEASE COMBINED WITH BURN*

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Both burns and acute radiation sickness cause changes in the peripheral blood. However, the number of erythrocytes in the blood during these influences depends upon erythropoiesis, hemolysis, vascular reactions and, finally, upon bleeding. The reticulocytes, in their turn, do not always exactly reflect the functional condition of the bone marrow [1, 3]. The rate of erythropoiesis in the bone marrow and the rate of erythrocyte entry into the blood can best be determined by the degree of radioactive iron inclusion in the erythrocytes. A series of authors [5, 4, 6, 2] have studied erythropoiesis during radiation sickness with the aid of radioactive iron.

In view of the lack of material in the literature on erythropoiesis during combined affections, we decided to study this question using the labeled atoms method.

EXPERIMENTAL METHODS

One hundred and twenty rats (in 4 groups) were used in the experiments. The animals of the first group were given a one-time general radiation dose of 500 r at a rate of 21 r per minute to the surface in conditions of stable intensity at 180 kv, 10 ma, filter — 0.5 mm Cu + 1 mm Al and with a focusing distance from the skin of 60 cm.

In another group of animals, burns were produced by submerging the lower extremities and the distal part of the body (to the iliac crest) for one second in water 95-100° in temperature. The animals of the third group were subjected to the practically simultaneous action of both factors.

The fourth group contained the control animals.

Ferric chloride, labeled Fe^{59}, with an activity equal to 5 microcuries, in a dose of 1 mg in 0.5 ml of a physiological solution was injected subcutaneously into the rats at different intervals after the injury. Twenty-four hours later, the rats were decapitated. The erythrocytes were separated from the plasma and carefully rinsed; the erythrocyte suspension, in amounts of 0.05 ml, was applied to two targets, and the radioactivity of the erythrocytes was then determined with a B apparatus with an end-window counter. Identical conditions of radioactive iron determination made it possible to find any erythropoietic change in the injured animals as compared with the control animals.

EXPERIMENTAL RESULTS

With one radiation treatment, erythropoiesis was sharply inhibited on the very first day (see Table) and was practically nonexistent between the 2nd and 5th days after the radiation, since, as experiments we conducted earlier have shown[2], the inclusion of iron in the peripheral blood erythrocytes can cause slight erythrocyte radioactivity.

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Radioactive Iron Inclusion in Erythrocytes of Injured Rats Expressed in Percent of Eruthrocyte Radioactivity in Healthy Animals

Type of injury	Days after injury							
	0–1	1–2	3–4	5–6	7–8	9–10	11–12	15–16
General irradiation in dose of 500 r	32	10	15	28	56	87	104	129
Boiling water burn	125	160	121	84	70	52	73	86
General irradiation+ burn	28	18	10	12	16	23	27	35

Later, erythrocyte production increased, and, after two weeks, it had returned to normal.

With the burn, on the other hand, erythropoiesis was considerably intensified during the first few days following the burn; the iron inclusion in the erythrocytes began to decrease after the 5th day, reaching 52% of normal by the 10th day. Erythrocyte formation had still not reached the original level on the 16th day. With the burn, therefore, the primary changes of the blood were caused by true intensification of erythropoiesis as well as by redistribution of the blood and plasma loss. The subsequent inhibition of the bone marrow function is evidently connected with the inflammatory complications. We have established that the erythropoietic activity of the bone marrow is inhibited in animals with inflammatory processes, artificially induced by an injection of a culture of various microorganisms.

With the combined injury, erythropoiesis and the exodus of erythrocytes from the bone marrow ceased almost completely during the first 10 days after the injury.

Fifteen days after the radiation, erythrocyte radioactivity was still three times less that of the control.

In each series of killed animals, iron inclusion in the erythrocytes did not vary much in the individual rats during the first few days, but subsequently, there were considerable differences. For example, erythrocyte radioactivity in three animals which had been subjected to the combined injury and killed 24 hours later was 22-32%, the average being 28%, while after 15 days, in three other rats, erythrocyte radioactivity fluctuated from 14 to 71%, with an average of 35%; the other 7 rats which had been kept for this interval died.

One must mention that the unit activity of the erythrocytes reflected erythropoiesis well the first few days after the radiation; the very slight increase of radioactivity with progressing anemia did not yet indicate the restoration of hemopoiesis, since the activity of a definite amount of erythrocytes did not depend on the amount of erythrocytes in the peripheral blood.

With the same number of radioactive erythrocytes released by the bone-marrow, erythrocyte unit acitivity would be more rather than less that of the erythrocytes in the peripheral blood.

Nevertheless, with one radiation, erythrocyte radioactivity had increased by 29% after 15 days and the number of erythrocytes had decreased by 20%, which indicates that restoration of erythropoiesis was complete at this time.

Besides these experiments, the serum iron was determined in 24 rats on the 2nd and 6th days after each type of injury. The easily-released iron increased most with the combined factors; with the burn, the increase was most expressed on the 2nd day after the injury, but, with the radiation sickness, on the 6th day.

Therefore, with a combination of burn and radiation sickness, there is maximum erythropoiesis inhibition and hemolysis intensification, which leads to the rapid development of expressed anemia.

SUMMARY

Experiments with radioactive iron have demonstrated that in rats subjected to x-ray irradiation (500 r) erythropoiesis is for the first ten days inhibited, and restored at the end of the first week. In rats with burns of

the distal parts, caused by boiling water, erythropoiesis is enhanced during the first days and then with the development of inflammatory complications, is inhibited, not being restored even at the end of two weeks. In animals subjected to both irradiation and burns, release of erythrocytes ceases almost completely and in surviving ones restoration of erythropoiesis proceeds very slowly.

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