EFFECT OF HYPEROXIA ON RATE OF RESTORATION
OF THE BLOOD COMPOSITION AFTER BLOOD LOSS

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Regeneration of the peripheral red blood is considerably inhibited in rabbits with anemia (caused by blood loss equivalent to 2% of body weight) exposed to hyperoxia (98% oxygen in the inspired air at a pressure of 2 atm) for 5 h.

KEY WORDS: hyperoxia; anemia; hematopoiesis.

Because of the widespread use of oxygen in medicine, aviation, astronautics, aquanautics, and so on the need has arisen for a detailed study of the physiological and toxic action of oxygen on the systems of the body, including the blood system. The writers showed recently that under the influence of hyperoxia erythropoietins disappear from the plasma of animals, and inhibitors of erythropoiesis may appear in their blood [6, 7]. This naturally raises the question of how the peripheral red blood regenerates after blood loss under conditions of an increased partial oxygen pressure in the inspired air.

EXPERIMENTAL METHOD

Experiments were carried out on 28 male rabbits weighing 2-3 kg. Blood was taken from all the animals in a volume equivalent to 2% of the body weight by puncture of the left ventricle. Immediately after bleeding 13 of the rabbits were kept for 5 h in a hyperbaric chamber containing 98% O₂ and 2% N₂ at a pressure of 2 kg force/cm² (CO₂ and water vapor were absorbed by soda lime and silica gel).

The remaining rabbits with anemia were kept under normal atmospheric conditions. The hemoglobin concentration, erythrocyte and reticulocyte counts, and hematocrit index were determined in all animals before bleeding, 12 h after bleeding, and thereafter daily for 9 days.

EXPERIMENTAL RESULTS AND DISCUSSION

After bleeding the hematocrit index was reduced on average by half. In the control rabbits it began to rise again 3 days after bleeding, but in the experimental rabbits this did not happen until 5 days after bleeding (P < 0.01; Fig. 1).

The erythrocyte count in the rabbits fell sharply after blood loss. In animals exposed to hyperoxia as well as blood loss it started to rise again only after 5 days (P < 0.01). In the control rabbits, however, this index began to rise as early as 3 days after blood loss (P < 0.01). The hemoglobin concentration 12 h after blood loss fell sharply, on the average by 49%. The hemoglobin concentration (like the erythrocyte count), in animals exposed to hyperoxia showed a small increase after 24 h, but for several days it continued at a low level; only after 5 days did this index begin to rise steadily (P < 0.01). In the control animals the hemoglobin concentration began to increase earlier, 3 days after blood loss (P < 0.01).

The reticulocyte count in the peripheral blood of the control animals began to rise 24 h and, in particular, 3 days after blood loss, but in the experimental animals this process was delayed by 24 h and was less marked.

The increase in the reticulocyte count in the peripheral blood indicates that the observed recovery of the hemoglobin, erythrocytes, and hematocrit indices after blood loss was the result of true formation of new red blood cells.
Fig. 1. Changes in hemoglobin concentration (1, 1a), hematocrit index (2, 2a), and reticulocyte count (3, 3a) in peripheral blood of rabbits after blood loss (2% of body weight). 1, 2, 3 - Animals kept under normal atmospheric conditions (control); 1a, 2a, 3a - animals kept under hyperoxic conditions (experiments). Ordinate, hemoglobin concentration (Hb), hematocrit index (Ht), and reticulocyte count (R); abscissa, time after bleeding (in days).

blood cells and not the result of hemodynamic changes in the body which could have arisen after exposure to a high partial pressure of oxygen.

In rabbits with anemia exposed to hyperoxia, regeneration of the red blood was thus considerably inhibited. In other words, an excess oxygen supply to the animals disturbs the stimulation of erythropoiesis that usually arises after acute blood loss to compensate the anemia.

In rats with anemia exposed to hyperoxia (PO₂ in the inspired air about 640 mm Hg for 4 days) the utilization of ⁵⁸Fe and the reticulocytosis also were lower than in control "anemic" animals [11].

The inhibitory effect of hyperbaric oxygenation on erythropoiesis can be explained by the disappearance of erythropoietin and also, possibly, by the secretion of inhibitors of erythropoiesis by the kidneys into the blood stream [7]. Under these circumstances differentiation of erythropoietin-sensitive cells into erythroblasts is evidently delayed also [5]. Restoration of the composition of the peripheral red blood may probably also be inhibited to some degree by damage to the enzyme systems of the erythrocytes by oxygen [3] and by an increase in the rate of their destruction [2, 10].

A respiratory mixture with an increased partial pressure of oxygen is now extensively used [1, 4, 8, 9]. However, as the results of this investigation show, oxygen therapy in patients with anemia caused by blood loss must be used with care, and the process of natural regeneration of the red blood must be monitored.

LITERATURE CITED