RIBONUCLEIC ACID IN THE LYMPHOCYTES DURING ADRENAL LYMPHOCYTOSIS

(DATA RELATING TO THE MECHANISMS OF THE GENERAL ADAPTATION SYNDROME)

A. P. Gindin, N. M. Ogienko, and A. V. Ushakova

From the N. F. Gamaleya Institute of Epidemiology and Microbiology
(Dir., Prof. P. A. Vershilova) of the AMN SSSR, Moscow
(Presented by Active Member of the AMN SSSR G. V. Vygodchikov)
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The action of any harmful agent on the organism very quickly causes a "stress reaction", in which the hormonal functioning of the adrenals is intensified. This is one of the adaptive mechanisms of the organism [7]. Along with this, it is known that when the concentration of adrenalin in the blood is increased a lymphocytosis ensues [5, 6, 8]. Chinese investigators recently confirmed this in experiments on volunteers [9]. Apparently, this lymphocytosis can also be considered a component of the adaptation syndrome.

However, the lymphocytes circulating in the blood are not uniform in the amount of ribonucleic acid (RNA) contained in their protoplasm [2]. Inasmuch as RNA is physiologically a rather active substance, a greater or lesser concentration of it could determine the level of physiological activity of the lymphocyte. Thus, it is of major interest to elucidate the influence of an increased concentration of adrenalin in the blood on the quantitative proportions of lymphocytes with various RNA contents, and most important, on the number of lymphocytes with saturation levels of RNA.

It was shown earlier that 11 ±0.6% of the lymphocytes circulating in the blood of horses are saturated with RNA [2]. The purpose of this investigation was to elucidate the influence of an elevation in the concentration of adrenalin in blood on the number of these lymphocytes.

EXPERIMENTAL METHOD

In the experiment, 25 adult, healthy horses were used, each weighing approximately 400 kg. We injected 3 ml of a 0.1% adrenalin solution into the jugular vein of each horse. Blood for the investigation was drawn from the jugular vein immediately before administration of the adrenalin, and 4 minutes, 2 hours, 24 and 48 hours after the adrenalin injection. In order to study the effect of the venapuncture itself on the concentration of these lymphocytes in the blood, 4 horses were used as controls. Blood was taken from them at the same intervals. The blood was investigated by the usual hematological methods. To demonstrate RNA we used the method of Brashe (on smears). Division of the lymphocytes into groups, according to their concentration of RNA, was carried out according to the method described earlier [2]. After this, the number of cells per mm^3 of blood was calculated, and the obtained numerical data were analyzed statistically.

EXPERIMENTAL RESULTS

The general reaction to the injection of adrenalin in all the experimental animals, without exception, after only 2 minutes, involved manifest restlessness, tremors and increased sweating, i.e., the clinical signs of the "alarm reaction" (Selye). In the control animals, the blood drawing procedure caused slight unrest only at the moment the needle pierced the skin.

The results of counting the cell concentration per mm^3 of blood and the percent hemoglobin are presented in the table.

The fluctuations in the indicated indices, in percent relationship to the original levels, for both the experimental and control animals, are shown in the figure.

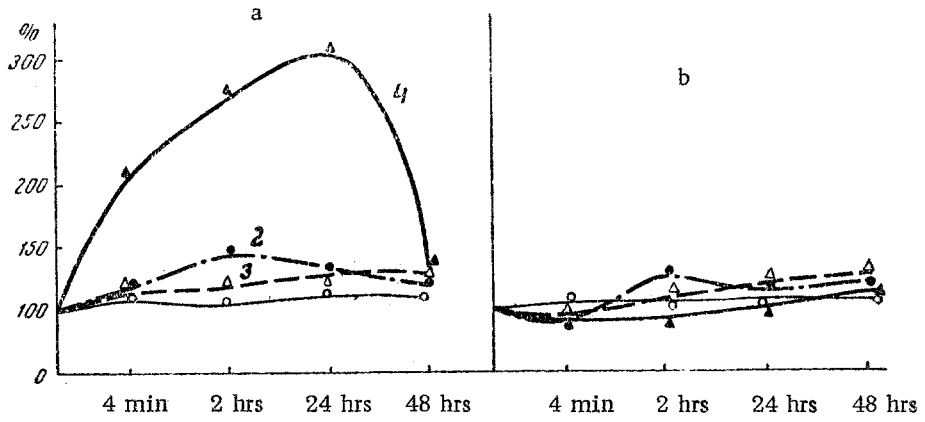
Investigating the blood of the experimental animals showed that the total number of leukocytes increased by almost $1\frac{1}{2}$ times after 2 hours, and the total number of lymphocytes by 13%. The number of lymphocytes saturated

with RNA increased by 2 times after 4 minutes, by 2½ times after 2 hours, by 3 times after 24 hours, and after 48 hours it fell to almost the normal level.

The Effect of Adrenalin on the Number of Leukocytes, Lymphocytes, and the Lymphocytes Saturated with RNA, per mm^3 of Blood, and on the Hemoglobin Concentration

Index	Before injection of adrenalin	After injection of adrenalin			
		by 4 minutes	by 2 hours	by 24 hours	by 48 hours
	in hundreds (M ± m)				
Total number of leukocytes	100 ± 3.5	112 ± 4.6	147 ± 4.2	132 ± 3.6	118 ± 4.1
Total number of lymphocytes	47 ± 4.9	53 ± 3.0	60 ± 5.3	61 ± 6.6	58 ± 1.5
Number of lymphocytes saturated with RNA	8.2 ± 1.5	17 ± 2.1	22 ± 1.9	25 ± 2.8	10.5 ± 0.7
Hemoglobin (in %)	84 ± 3.3	92 ± 2.5	84 ± 3.0	89 ± 2.1	89 ± 3.5

Analysis of the data presented shows that the increase in the total number of lymphocytes occurred as a result of a rise in the number of cells saturated with RNA. The total number of lymphocytes after 2 hours increased by 1300; the number of lymphocytes saturated with RNA increased by this figure—1380. In the control group, the number of the latter fluctuated within the normal limits (see figure). According to the data in the literature [10], adrenalin induced leuko- and lymphocytosis may occur through contraction of the smooth musculature of the spleen [5], and the contractile apparatus of the lymph nodes [1].



The effect of adrenalin on the composition of the formed elements of the blood, and on the number of lymphocytes saturated with RNA, in the experimental (a) and control (b) horses. 1—hemoglobin; 2—leukocytes; Δ ------ lymphocytes; ▲——— lymphocytes saturated with RNA.

Our investigation showed that the lymphocytic reserve mobilized by adrenalin primarily consists of lymphocytes rich in RNA. At least a part of this reserve could be obtained from the spleen, since lymphocytes predominate in its leukocytic reserve [5]. But judging by the hemoglobin curve, which reflects the degree of splenic contraction, the amount of blood extruded from the spleen was small—in the range of 10% of the total volume of circulating blood. It may be concluded from this that many of the lymphocytes saturated with RNA fell into the blood stream as a result of contraction of lymph nodes. Actually, perfusion of a lymph node with a weak solution of adrenalin, as well as its intravenous injection, causes contraction of the lymph node, and extrusion of a large number of lymphocytes into the lymph during the initial period of contraction [1].

Proof that these lymphocytes can contain a large amount of RNA can be seen from an investigation especially undertaken by us on the composition of the lymphocytes in the lymp of the thoracic duct within exsanguinated horses. While in normal animals the peripheral blood contained 11 ± 0.6% lymphocytes saturated with RNA, their number in the lymph of the thoracic duct reached 53 ± 3.2%.

The physiological significance of the process leading to enrichment of the blood with lymphocytes saturated with RNA, following an elevation in the concentration of adrenalin within the blood, i.e., at the moment of the "alarm reaction," requires further study. In connection with this, it should be noted that during the formation of a stressful antitoxic immunity, when the adaptation mechanism must work very intensively, the blood is also enriched with these lymphocytes, and this is manifested up to the observation of a rise in antitoxin titer [3]. We evaluated the rise in the number of these cells within the blood as a signal that intense immunogenesis has begun, i.e., an increase in the specific resistance of the organism to the toxin being studied [3, 4].

SUMMARY

A study was made of the effect of increased blood adrenalin level on the number of leukocytes, saturated with ribonucleic acid (RNA). A dose of 3 ml of a 0.1 per cent adrenalin solution was injected intravenously to 25 horses. Marked clinical "stress" symptoms appeared in 2 minutes. The number of RNA-saturated lymphocytes doubled in 4 minutes and increased 2.5-fold in 2 hours, 3-fold—in 24 hours, but in 48 hours it dropped almost to the normal level. Adrenal lymphocytosis occurred mainly at the expense of RNA-rich lymphocytes.

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