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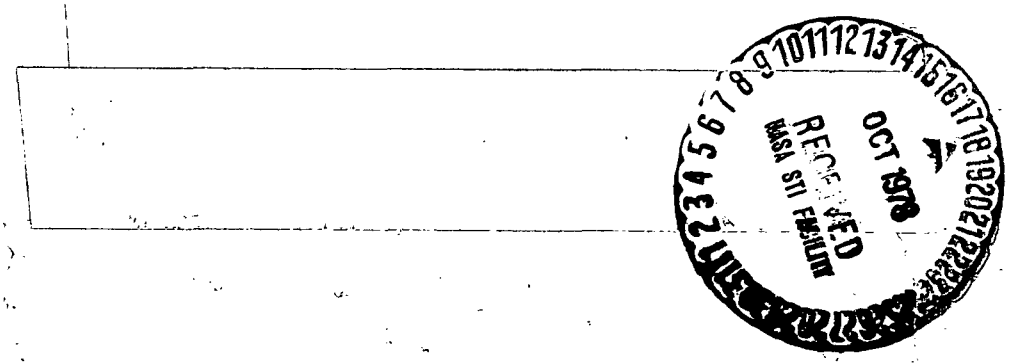

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THE PREVENTIVE ROLE OF ULTRAVIOLET RADIATION DURING EXPOSURE TO IONIZING RADIATION

G. S. Yatsula

The author studied the effect of suberythematous doses of ultraviolet and various doses of ionizing radiation on sulfhydryl groups, cholesterol and hemoglobin of the blood. More favorable indices of cholesterol and hemoglobin content of the blood were noted in those animals that during exposure to ionizing radiation were subjected to ultraviolet radiation.

A number of works (Ye. G. Zhuk; T. A. Sviderskaya, et al., and others) have /48* studied the combined action on animal organisms of ultraviolet, x-ray and γ-radiation. As a rule these studies employed single large doses of ionizing radiation. There are no published descriptions of the peculiarities of the effect on the organism of small and fractional doses in combination with ultraviolet irradiations.

We conducted four series of tests on albinorats using different doses of an external ionizing radiation in combination with ultraviolet. In all the series the animals in the second, fourth and sixth groups were irradiated daily by a mercury quartz lamp PRK-4 for $2\frac{1}{2}$ min. In this time they received 10 and 25 mcal of ultraviolet radiation per 1 cm^2 of body surface, which equalled $\frac{1}{2}$ erythema dose. Preliminary ultraviolet irradiation of the animals in these groups was conducted in the first series of tests for 90 days, in the second series--78, in the third series--

*Numbers in margin indicate pagination in the original foreign text.

TABLE 1

CHARACTERISTICS OF GROUPS OF ANIMALS IN TESTS WITH ULTRAVIOLET AND EXTERNAL IONIZING RADIATION

Group of rats	Number of erythema doses during ultraviolet irradiation		Ionizing irradiation		
	for days	for period of test	power of exposure dose, R/min	total exposure dose for test period, R	integral absorbed tissue dose in rads for test period
			I Series		
1-я	—	—	—	—	—
2-я	0,5	67,5	—	—	—
3-я	—	—	0,000017	1,08	1,04
4-я	0,5	67,5	0,000017	1,08	1,04
5-я	—	—	0,000034	2,16	2,01
6-я	0,5	67,5	0,000034	2,16	2,01
			II Series		
1-я	—	—	—	—	—
2-я	0,5	107,0	—	—	—
3-я	—	—	0,000051	9,80	9,11
4-я	0,5	107,0	0,000051	9,80	9,11
5-я	—	—	0,000068	13,10	12,18
6-я	0,5	107,0	0,000068	13,10	12,18
			III Series		
1-я	—	—	—	—	—
2-я	9,5	65,0	—	—	—
3-я	—	—	13,3—14,4	300	285
4-я	0,5	65,0	13,3—14,4	300	285
5-я	—	—	13,3—14,4	600	570
6-я	0,5	65,0	13,3—14,4	600	570
			IV Series		
1-я	—	—	—	—	—
2-я	0,5	64,5	—	—	—
3-я	—	—	13,3—14,4	750	712
4-я	0,5	64,5	13,3—14,4	750	712
5-я	—	—	13,3—14,4	900	855
6-я	0,5	64,5	13,3—14,4	900	855

80, in the fourth series--68 days. The total duration of the ultraviolet irradiations of animals, including in combination with the ionizing, was for the first series of tests 135 days, for the second--214 days, for the third--130 days, and for the fourth--129 days. /49

After the indicated preventive ultraviolet irradiations the animals in the third-sixth groups of all the test series began to be exposed to external ionizing radiation. For irradiation of animals in the first and second test series preparations were used that were made of uranyl nitrate which were placed in open lead boxes and arranged at a distance of 15 cm from the animal's back. The

TABLE 2

CONTENT OF SULFHYDRYL GROUPS IN BLOOD SERUM OF ALBINO RATS DURING ULTRAVIOLET AND EXTERNAL IONIZING IRRADIATION (M±m)

Group of rats	Sulfhydryl groups, μmole per 100 mg of blood serum			
	I series	II series	III series	IV series
1-	53±4,5	64±7,1	9,7±7,8	107±8,2
2-	45±2,3	67±3,2	105±7,4	119±3,1
3-	50±7,0	62±4,1	137±10,6	121±13,0
4-	61±2,7	72±4,2	115±8,8	101±11,2
5-	48±5,1	64±3,1	137±13,5	103±16,0
6-	84±1,5	67±4,1	115±8,7	129±7,2

preparations were plates 10x12 cm in size on which 10 g of uranyl nitrate were uniformly distributed. Irradiation of the animals in the first test series by these preparations went for 24 hours a day for 45 days, of the animals in the second series--136 days. The ultraviolet irradiation also continued for this same period. In the third and fourth series the animals received fractional doses of x-rays of 50-150 R for one session with the help of RUM-3 and RUM-11 apparatus. For the test period in each series 6 sessions were conducted of x-ray irradiation of the animals with 7-day intervals. With the help of the methods described in special works the integral absorbed dose of ionizing radiation was computed in rads for the entire test period.

In the first series of tests 65 male albino rats were used, in the second series--72, in the third series--79 and in the fourth series--72 which were distributed into six groups. Data on the nature of the effect on the animals by the studied factors are presented in table 1.

This report presents the results of an analysis of the sulfyhdryl groups, cholesterol and hemoglobin in the animals' blood. According to the data of a number of researchers (P. D. Gorizontov; T. A. Sviderskaya, N. N. Glushchenko, et al.) these indices can to a sufficient degree characterize the effect of radiant energy on the organism of humans and animals. The content of sulfhydryl groups in the blood serum was determined by the method of amperometric titration with the aid of 0.001 normal solution of mercuric chloride, and was expressed in micromoles per 100 ml of serum (S. N. Nistratova, Ye. M. Kedrova). The cholesterol content in the blood was established by the method of Engel'gardt and Smirnova, and was

expressed in milligram-percents. The amount of hemoglobin was computed by a Sali hemoglobinometer in relative percents. The average data on the changes in the content of sulfhydryl groups in the blood serum of animals under conditions of ultraviolet and external ionizing irradiation are presented in table 2.

A certain increase in the sulfhydryl group content in the blood serum as compared to the control was found in animals of the second group in the second-fourth series of tests with ultraviolet irradiation. In animals of the third and fifth groups of the first and second series the ionizing radiation in doses from 1.04 to 12.18 rads did not produce significant changes in the number of sulfhydryl groups in the blood serum as compared to the control. During ionizing irradiation of animals in the third and fifth groups of the third series with dose /50
285 and 570 rads a statistically reliable increase was established for the content of sulfhydryl groups as compared to the control. In the fourth series of tests irradiation of the animals in the third group with dose 712 rads caused a certain increase, while in rats of the fifth group that received 855 rads, a certain decrease in the number of sulfhydryl groups in the blood serum as compared to the control.

The combination of ultraviolet irradiation with ionizing in all the test series, as a rule, resulted in a higher content of sulfhydryl groups in the blood serum as compared to the control.

Ultraviolet irradiation of animals in the fourth and sixth groups of the first and second series of tests who received from 1.04 to 12.18 rads of ionizing radiation caused a higher content of sulfhydryl groups in the blood serum than in animals of the third and fifth groups that received only ionizing radiation in the indicated doses. With combined x-ray and ultraviolet irradiation of animals in the fourth and sixth groups of the third series the content of sulfhydryl groups in the blood serum was reduced as compared to animals in the third and fifth groups which were only exposed to x-rays. This decrease with a dose of 285 and 570 rads was 16% ($D > 0.05$), however the absolute number of sulfhydryl groups in these cases was higher than in the control, as a result of which one can speak of the normalizing effect of ultraviolet radiation on the content of sulfhydryl groups during x-ray irradiation of animals. Ultraviolet irradiation of

TABLE 3

CONTENT OF CHOLESTEROL IN BLOOD (in mg%) OF ALBINO RATS OF DIFFERENT TEST SERIES (M±m)

Group of rats	I series	II series	III series	IV series
1-	88±2,0	59±3,4	119±4,1	113±3,0
2-	89±1,6	65±2,4	114±3,1	109±4,0
3-	89±1,2	56±4,9	125±3,0	82±4,0
4-	84±2,4	55±3,1	121±6,5	101±2,0
5-	88±4,4	55±3,9	100±4,7	87±6,0
6-	85±1,6	51±2,8	124±6,5	89±4,0

animals in the fourth series of tests in combination with x-rays in a dose of 712 rads (fourth group) caused a decrease in the number of sulfhydryl groups in the blood serum by 17% (D>0.05) as compared to the animals that with the same dose of x-ray radiation did not receive ultraviolet. However the given number did not differ from the control, therefore one can evaluate the effect of the ultraviolet irradiation as normalizing. Under analogous conditions (sixth group) with a dose of 855 rads of x-ray radiation an increase was noted in the number of sulfhydryl groups in the blood serum by 25% (D > 0.05). On this basis one can consider that the ultraviolet irradiation of animals has a favorable effect on the organism.

Average data on the content of cholesterol in the blood under our test conditions are given in table 3.

As compared to the control the ultraviolet irradiations of animals in the second group of all the test series did not result in significant changes in the cholesterol content in the blood. In the first and second series no significant deviations were noted in this index under the influence of ultraviolet and ionizing radiation, which can indicate the lack of an effect by the studied factors on cholesterol exchange. In tests of the third series using ultraviolet and x-ray radiation fluctuations in the blood cholesterol content were within 4-16% as compared to the control. Ultraviolet irradiation of the animals in this series in combination with x-rays in an integral absorbed dose of 285 rads (fourth group) caused a drop in the cholesterol content by 3% (D >0.05) as compared to the animals that with these doses of x-rays did not receive ultraviolet irradiation (third group). However the amount of cholesterol in this case was close to the

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TABLE 4

AMOUNT OF HEMOGLOBIN IN BLOOD (in %) OF ALBINO RATS OF DIFFERENT TEST SERIES (M±m)

Group of rats	I series	II series	III series	IV series
1-	87±0,52	98±1,66	96±2,50	91±1,93
2-	91±1,30	101±1,11	97±0,80	94±2,25
3-	83±1,30	102±1,10	90±0,70	85±1,10
4-	90±1,30	100±0,92	94±1,10	91±1,17
5-	84±1,80	102±2,10	85±1,70	82±0,76
6-	89±0,80	102±1,39	93±1,50	90±1,40

control which indicates the normalizing effect of ultraviolet irradiation on the cholesterol exchange. Under analogous conditions with a dose of 570 rads (sixth group) an increase was noted in the blood cholesterol content by 24% ($D < 0.05$). Data from the fourth test series indicate that the amount of cholesterol in the blood under the influence of the studied factors is reduced by 3-33% as compared to the control which is apparently related to inhibition of the liver functioning.

Ultraviolet irradiation of animals in this series in combination with x-rays in a dose of 712 rads promoted an increase in the amount of cholesterol in the blood by 23% ($D < 0.05$), and with a dose of 855 rads--only by 2.3% ($D > 0.05$) as compared to the animals who with these doses of x-ray radiation did not receive ultraviolet rays. Consequently, the latter improved the cholesterol-forming function of the liver.

Average data on the amount of hemoglobin in the blood of animals under our test conditions are given in table 4.

Changes in the content of hemoglobin in the blood of animals in different groups of the first and second series of tests under the influence of the studied factors fluctuated within 2-5% as compared to the control. Ultraviolet irradiation of the animals in combination with ionizing in a dose from 1.04 to 12.18 rads had an effect to a lesser degree on the level of hemoglobin in the blood than in animals who with the same doses of ionizing radiation did not receive ultraviolet irradiation. In the third and fourth test series the amount of hemoglobin in the blood of animals of different groups was recorded as 1-15% of the control. Ultraviolet irradiations of the animals in these series in combination with x-rays in doses from 285 to

855 rads promoted an increase in the amount of hemoglobin in the blood by 5-10% ($D < 0.05$) as compared to the animals that were not exposed to ultraviolet irradiation.

The data obtained in our experiments on the amount of sulfhydryl groups, cholesterol and hemoglobin in the blood indicate the favorable role of ultraviolet irradiation of animals exposed to external ionizing irradiation.

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16. Abstract

The effect of suberythematous doses of ultraviolet and ionizing radiation on sulfhydryl groups, cholesterol and hemoglobin of the blood is studied.

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