CHANGES IN COMPLEMENTARY FUNCTION OF THE BLOOD SERUM IN ANIMALS IRRADIATED ONCE AND TWICE

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After a single irradiation of dogs and rabbits with lethal doses of γ-rays the complementary function of the blood serum is stimulated during the first few days, falling below normal at the height of radiation sickness, and returning to normal during convalescence. After a second irradiation of the surviving animals stimulation of the complementary function of the serum takes place earlier and its depression at the height of radiation sickness is less marked.

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Data in the literature on the intensity of the complementary function of the blood serum (SCF) of irradiated animals are very contradictory, and as a rule the period of observation on this intensity has not exceeded two weeks. There are reports of depression of the SCF on the 10th day after irradiation of guinea pigs in a dose of 625 R [2], of a normal SCF after irradiation in sublethal doses [8], and of stimulation of the SCF of rats by irradiation in doses of 500 and 600 R during the first two weeks of observation [10, 11]. No reports were found in the accessible literature of studies of the SCF in animals irradiated a second time.

Because of the conflicting and insufficient nature of the published data, it was decided to study the dynamics of changes in the SCF after irradiation of animals once and twice.

EXPERIMENTAL METHOD

Experiments were carried out on 50 mongrel dogs of both sexes with a mean weight of 16.5 kg and on 10 male rabbits with a mean weight of 3 kg, irradiated with Co^{60} γ-rays.

The dogs were irradiated on the ÉGO-20 μ apparatus in a dose of 600 R (dose rate 160 R/min, $LD_{70/30}$) and on the ÉGO-2 apparatus in a dose of 360 R (dose rate 640 R/min, $LD_{90-100/30}$).

The rabbits were irradiated on the ÉGO-2 apparatus in a dose of 600 R ($LD_{15/30}$). The animals surviving after these procedures were again irradiated with the same dose of γ-rays 50-90 days after the first exposure. Animals irradiated on the ÉGO-20 μ apparatus (12 dogs irradiated for the first time and 19 for the second time) were investigated simultaneously with control, unirradiated animals (11 dogs), whose indices of the intensity of SCF were taken as normal. The control of normal intensity of SCF for the animals irradiated on the ÉGO-2 apparatus consisted of the original indices.

The SCF intensity in the first experiments was determined by the method of Hudomel and co-workers [6], the SCF being expressed in international complement units relative to 100% hemolysis (C'H−100), and subsequently by the method of Mayer and co-workers [9], determining the complement units relative to 50% hemolysis (C'H−50) in view of the greater sensitivity of the second method.

EXPERIMENTAL RESULTS

The experimental results are given in Figs. 1-3. They show that changes in the SCF of animals irradiated once were cyclic in nature, against the background of the different phases of the disease: the SCF was increased in the first days after irradiation, fell below normal at the height of the radiation sickness, and returned to normal during convalescence. It is therefore considered that the results explain the apparent conflicting nature of published data for the effect of single whole-body irradiation of animals on the intensity of SCF, because phases of both an increase and a decrease in SCF were noted.

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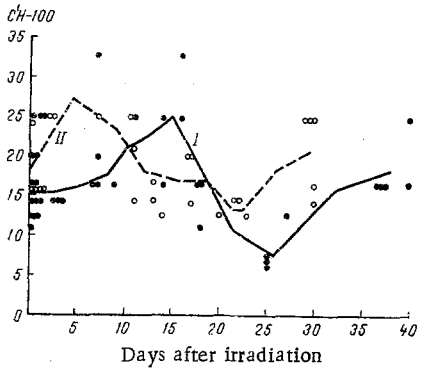

Fig. 1. Dynamics of changes in SCF of dogs irradiated once (I) and twice (II) in a dose of 600 R.

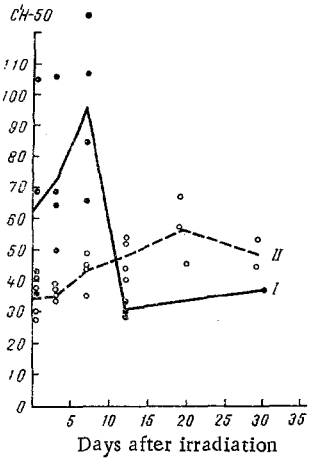

Fig. 2. Dynamics of changes in SCF of dogs irradiated once (I) and twice (II) in dose of 360 R.

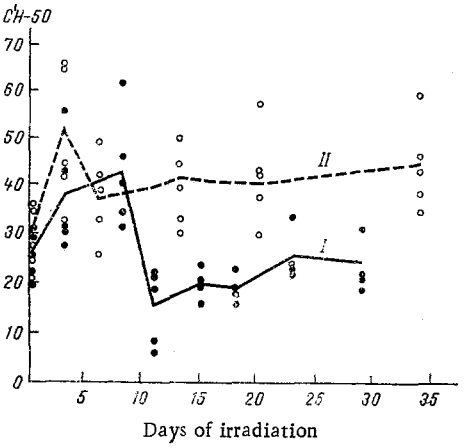

Fig. 3. Dynamics of changes in SCF of rabbits irradiated once (I) and twice (II) in a dose of 600 R.

The distinguishing features of the dynamics of SCF changes in animals irradiated a second time were the earlier increase in the intensity of this function, by the 3rd-4th day after irradiation, and its less marked decrease, or even the total absence of a decrease, at the height of the radiation sickness.

The intensities of the SCF for the group of dogs irradiated in a dose of 600 R are shown as curves plotted by the moving average method [5]. The increase in SCF during the first 1-16 days, and its decrease below the initial level from the 17th to the 29th days after irradiation, discovered in this group of animals, were found not to be accidental by the use of a sequential test [1]. The values of S_{05} for periods in the group of animals irradiated once only were 8 and 3 respectively, and for the group of animals irradiated twice, 4 and 3 respectively. Since the data for changes in SCF of animals irradiated on the ÉGO-2 apparatus are the result of dynamic observations on the same animals, in this case the method of comparing aggregates with paired variables was used [5].

In the group of dogs irradiated in a dose of 360 R, the increase in SCF on the 7th day and its decrease below the initial level on the 12th day after primary irradiation were significant: $P < 0.05$, $t = 0.984$ and 0.824 respectively. In the group of rabbits irradiated in a dose of 600 R, the increase in SCF in the animals irradiated for the first time on the 8th day ($P < 0.01$, $t = 0.907$) and on the 3rd day after irradiation a second time ($P < 0.05$, $t = 0.798$), and also the decrease in this function below the initial level in animals on the 12th day after the first irradiation ($P < 0.05$, $t = 0.618$) were significant. Differences in the intensity of SCF in the period of convalescence compared with the original data were not statistically significant in any group of animals, so that recovery of this function in the period of convalescence can be taken as significant. Statistical analysis of the numerical results thus confirmed its high degree of significance.

In the accessible literature no explanation could be found for the increase in intensity of SCF in animals after whole-body irradiation. The increase in titer of complement during local irradiation has been attributed by some workers to the release of complement from disintegrating leukocytes [4]. The increase in SCF recorded during whole-body irradiation can presumably be attributed to the entry of tissue breakdown products, possessing complementary properties [7], into the blood stream, because the increase in SCF takes place at a time of marked tissue breakdown. The decrease in SCF at the height of radiation sickness is associated by Kiselev and co-workers [3] with the accumulation of products in the body possessing marked antecomplementary action (denaturation products of tissue elements, heparin, free sulfhydryl groups), and also with a decrease in complement production. The earlier and more marked increase and the smaller decrease in SCF in animals irradiated a second time evidently reflects a more severe injury to tissues acting as the source of complement during repeated irradiation.

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