CHANGE IN THE BODY TEMPERATURE OF WHITE MICE FOLLOWING TOTAL IRRADIATION WITH ROENTGEN RAYS

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It is known that at the peak period of radiation sickness an elevation is observed in the body temperature, which, in the previous periods of the illness, does not change or shows a tendency toward lowering [1—6]. It should be emphasized that these data were obtained mainly in experiments on large animals (rabbits, dogs, apes), and on the basis of clinical observations. There have been practically no systematic investigations of body temperature in small laboratory animals following radiation exposure.

There are certain data on phasic changes in the body temperature following irradiation. At the same time, information on its changes as dependent upon the dose of radiation exposure is rather fragmentary and inconsistent.

We systematically studied the body temperature in small experimental animals, particularly white mice, as dependent upon the dose of irradiation and the time elapsing after the moment of radiation exposure.

EXPERIMENTAL METHOD

The investigation was carried out on male white mice, 3—4 months of age. A total of 203 animals was used. The mice were subjected to total roentgen irradiation in a dose of 80, 160, 360, 720, 1440, 22500, and 45000 r. The irradiation was carried out on the RUM-3 apparatus, under the following technical conditions: current force of 180 kv, current intensity of 20 ma, filters of 0,5 mm Cu and 1 mm Al, without a tube, a half weakening layer of 0,97 mm Cu, a radiation dose output in air of 80 r per min at a distance of 24 cm . With the 22500 and 45000 r doses, the animals were irradiated at a distance of 24 cm under the same technical conditions, but without the filters; in this case, the irradiation dose output in air was equal to 450 r per min.

The body temperature was determined in the rectum, using a copper-constantan thermocouple, both before irradiation and over the course of 5 days after the radiation exposure. An exception involved the series of experiments where the mice were irradiated in a dose of 1400—45000 r; in this case, the animals died 20—72 h after the exposure. No less than 10 animals were used in each series of experiments.

The experimental data were subjected to analysis according to the laws of variation statistics.

EXPERIMENTAL RESULTS

Following radiation exposure the body temperature of white mice undergoes substantial changes, the character of which depends on the body temperature before the irradiation. Out of 203 mice, in 133 the starting temperature ranged from 37° to 39.5°, while in the remaining—from 34.5° to 37°.

In the animals with a starting body temperature of 37°—39.5°, a statistically significant decrease in body temperature was observed in the first hours after irradiation, the maximum of which was noted $1\frac{1}{2}$ h after the radiation exposure (Fig. 1, 2). With radiation in a dose of 360—45000 r, this drop in temperature began immediately after the exposure. With lower doses (80—160 r), it occurred only $1\frac{1}{2}$ h after the irradiation.

Subsequently, in the animals irradiated with doses of 80—22500 r, the body temperature returned to the starting level. A second lowering was observed during the preagonal period in the animals irradiated with a dose of 720—22500 r.

When the mice were irradiated with 4500 r, the drop in body temperature which began immediately after the exposure progressed right up to the moment of death of the animals (see Fig. 2).

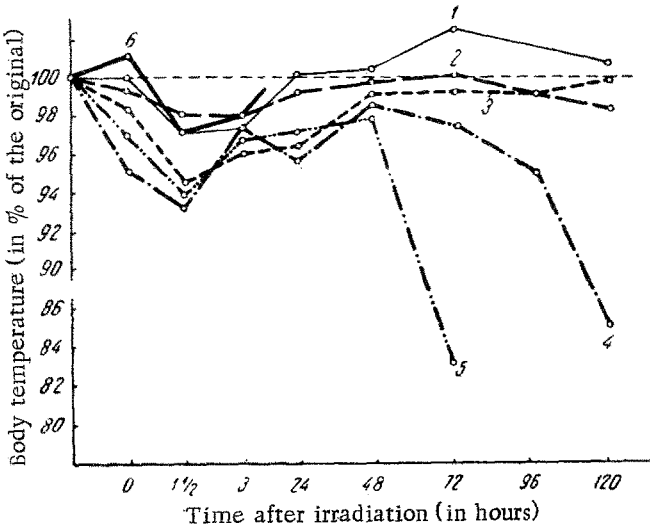

Fig. 1. Change in the body temperature of white mice following total irradiation in a dose of 80 r (1), 160 r (2), 360 r (3), 720 r (4), 1440 r (5), and the injection of ACTH (6).

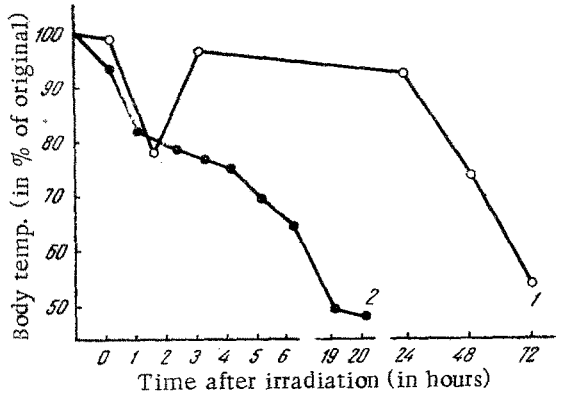

Fig. 2. Change in the body temperature of white mice following total irradiation in a dose of 22500 r (1) and 45000 r (2).

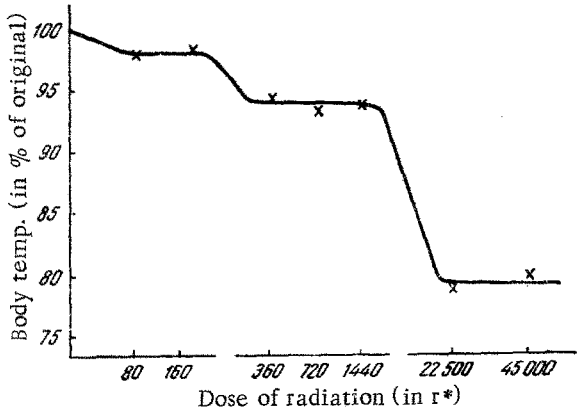

Fig. 3. Dependence of the changes in body temperature, determined 1 ½ hours after irradiation, on the dose of radiation exposure.

Studying the dosage relationship of the maximal drop in body temperature during the first period after irradiation demonstrated 3 ranges, within the bounds of which the degree of body temperature drop did not depend on the radiation dose: 1) 80–160 r, 2) 360–1440r, 3) 22500–45000 r (Fig. 3).

The mice with the starting body temperature of 34,5°–37° were subjected to irradiation in a dose of 80–1440 r. Immediately after the irradiation, a statistically significant elevation in temperature was observed in them, the magnitude of which did not depend on the dose of radiation within the bounds of 160–1400 r. Subsequently, a significant drop in temperature was observed only in the preagonal period of the animals that were irradiated with a dose of 720–1440 r.

Thus, as shown by the observations, the character of change in body temperature during the first hours after irradiation essentially depended on the starting indices: in mice with a body temperature of 37°–39,5° it fell, while with a body temperature of 34,5°–37° it rose.

The observed dependency of the degree of body temperature decrease within the first hours after irradiation on the severity of radiation injury allows postulating that with increases in the dose of radiation exposure there is a consecutive disruption of a series of the organism responsible for thermoregulation.

Investigators, particularly in foreign countries, attach major significance in the pathogenesis of radiation sickness to disturbances in the endocrine regulation of the organism [7–9]. In particular, Selye connects the appearance of a number of symptoms, including the drop in body temperature during the first hours after radiation exposure, with an increase in the activity of the hypophyseal-adrenal system.

To test the hypothesis that this system participates in the disruption of thermoregulation in the irradiated organism, and to elucidate the specific importance of these disturbances, an additional series of experiments were set up, involving the injection of intact animals with ACTH. It was shown that injection of this preparation, in a dosage of 1,5 units per animal, actually leads to a decrease in the body temperature comparable only with the drop observed from irradiation in a dose of 80–160 r (see Fig. 1).

Some authors have tried to explain the drop in body temperature during the first hours after irradiation by a disturbance in physical thermoregulation [4–6]. Others regard the drop in body temperature during the first hours after irradiation as an index of disturbance in chemical thermoregulation, due to disruption of the special, oxidative, metal-containing enzymes by the

ionizing radiation [3]. It is difficult to say what is specifically connected with the thermoregulatory disturbance in the irradiated organism following exposure to minimally or absolutely lethal doses of radiation (360–1440 r). It is possibly related to a disturbance in both physical and chemical thermoregulation. The latter factor apparently plays a rather essential role when the organism is exposed to very high doses of radiation (22500–45000 r), causing disruption, and possibly complete destruction, of the biochemical systems which ensure the normal course of oxidation - reduction processes.

It is necessary to stop on another fact of definite interest. According to the data obtained, the organism irradiated even with very high doses of radiation (22500 r), causing the development of a very acute form of radiation sickness, retains the ability to compensate almost completely for the serious disturbances in thermoregulation, as early as in the first hours following the irradiation (see Fig. 2). Only with exposure to radiation in doses twice as large (45000 r) do irreversible changes occur.

Thus, radiation exposure in white mice causes essential changes in thermoregulation, the nature of which depends on the body temperature before the irradiation, the period of development of the radiation injury, and the dose of radiation exposure.

SUMMARY

As established, total X-irradiation caused significant disturbances of thermoregulation in albino mice. The character of these changes depends on three circumstances: body temperature prior to the irradiation, period of radiation injury development and radiation dose. Thus, if the body temperature prior to the irradiation was 37.0°–39.5° C, it decreased during the first hours after the irradiation and this reduction was the greater, the higher the radiation dose. A rise in body temperature was noted in mice whose body temperature was 34.5°–37.0°C prior to this procedure. Irrespective of the character of body temperature variations during the first hours after the irradiation, temperature fell during the peak of radiation sickness.

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