# PRIMARY RESPONSE OF THE HYPOPHYSEO-ADRENOCORTICAL SYSTEM TO THE ACTION OF IONIZING RADIATION

O. O. Romashko and V. D. Rogozkin

UDC 612.432+612.45].014.482

The primary response of the hypophyseo-adrenal system to irradiation in doses of 650, 850, and 1,000 R was studied. The primary response of activation of hormone formation and secretion in the adrenals of the irradiated rats was shown to be biphasic in character during the first few hours after exposure. The first phase of the early response appeared 5 min after irradiation, the second 1-5 h after whole-body irradiation with all doses of ionizing radiation used. It is postulated that the first phase of the early response is the ordinary nonspecific stress reaction, which also takes place in response to other extremal stimuli, while the second phase is evidently specific for irradiation and is induced by disturbances taking place during the "latent period of radiation sickness."

Ionizing radiation is known to cause an increase in hormone formation and in the secretion of corticosteroids in the adrenals of rats during the first few minutes after exposure [4, 10]. As previous experiments have shown, an increased level of corticosterone is observed both in the peripheral blood plasma of rats and also in the adrenals during the first 20 min after irradiation in a dose of 650 R [4]. At the same time, in most investigations of adrenal activity during irradiation it is pointed out that the "primary activation response" arises 1-5 h after irradiation [1, 3, 13]. The data in the literature on the time of onset of activation and the dynamics of the changes in adrenal activity during the first few hours after irradiation are thus clearly contradictory.

The object of the present investigation was to study the dynamics of changes in hormone formation and secretion in the adrenals of rats during the first few minutes and hours after irradiation.

## EXPERIMENTAL METHOD

Experiments were carried out on 280 noninbred male albino rats weighing 200-250 g. The animals were subjected for 14 days to mock irradiation so as to habituate them to the experimental situation. They were then divided into 4 groups: the animals of group 1 (control) received mock irradiation; the rats of groups 2, 3, and 4 were irradiated in doses of 650, 850, and 1,000 R, respectively, by means of an EGO-2 apparatus. True and mock irradiation were given at the same time of day. The rats were sacrificed by decapitation 5 min and 20 min and 1, 2, 3, 4, 5, and 6 h after true or mock irradiation. Corticosterone in the plasma and adrenals was determined fluorometrically [6, 9, 11]. Fluorescence was measured by means of a Hitachi MPF-2A spectrofluorometer at wavelengths of excitation of 470 nm and fluorescence of 530 nm. Student's criterion was used for the statistical analysis.

## EXPERIMENTAL RESULTS

Activation of hormone formation and secretion in the adrenal cortex was virtually absent in the rats of group 1 receiving mock irradiation, indicating that the animals were adequately adapted to the experimental conditions (Fig. 1: 1; Fig. 2: 1). In the rats of groups 2, 3, and 4, irradiated in doses of 650, 850,

(Presented by Academician of the Academy of Medical Sciences of the USSR P. D. Gorizontov.)
Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 74, No. 8, pp. 23-25, August, 1972. Original article submitted December 3, 1971.

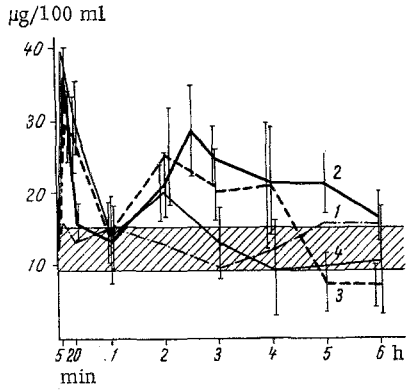


Fig. 1

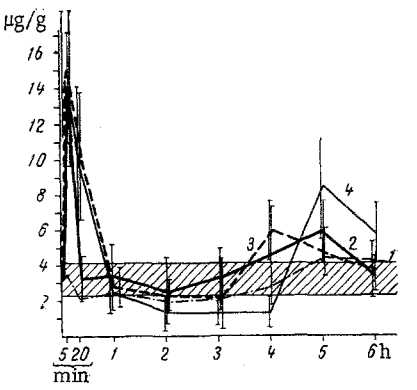


Fig. 2

Fig. 1. Dynamics of changes in corticosterone concentration in plasma of rats during first few hours after irradiation: 1) mock irradiation; 2) dose 650 R, 3) 850 R, 4) 1,000 R. Confidence limits for $P \leq 0.05$. Abscissa, time after irradiation; ordinate, corticosterone concentration (in μg/100 ml plasma).

Fig. 2. Dynamics of changes in corticosterone concentration in adrenals during first few hours after irradiation. Ordinate, corticosterone concentration in adrenals (in μg/g adrenal tissue). Remainder of legend as in Fig. 1.

and 1,000 R, respectively, a biphasic response of activation of adrenal activity was observed during the first few hours after irradiation. The first phase of the early response appeared during the first 5 min, when the corticosterone level rose both in the blood and in the adrenals; this phase was of high intensity but short duration (Fig. 1, 2-4, Fig. 2, 2-4). The corticosterone concentration both in the plasma and in the adrenals fell 20 min after irradiation in a dose of 650 R and 40 min after irradiation in doses of 850 and 1,000 R and it was indistinguishable from the initial level. The second phase of activation of hormone formation and corticosteroid secretion then took place in the adrenals of the irradiated animals whatever the dose of irradiation given (Fig. 1, 2-4; Fig. 2, 2-4) becoming visible 1-5 h after irradiation.

The results of these experiments thus show that the early response of activation of adrenal activity to irradiation consists of two phases of activation of hormone formation and secretion, whereas in the overwhelming majority of investigations aimed at studying the dynamics of stress reactions to various extremal stimuli, other than irradiation, the monophasic character of these responses during the first few hours after exposure is emphasized [5, 8, 12]. The rapid intensification of hormone formation and secretion during irradiation demonstrated in the present investigation is in agreement with data in the literature [10], but no mention is made in the investigations cited of the phasic character of changes in activity of the hypophyseo-adrenocortical system during the first few hours after irradiation. This may be because in the present investigations more frequent time intervals were used when studying hypophyseo-adrenocortical activity during the first few hours after exposure to ionizing radiation. The first phase of the early response is evidently an ordinary nonspecific stress reaction, such as is found in response to the action of widely different pathogenic agents [5, 8, 12]. The second phase of the early response, however, is probably specific for irradiation and is produced by the pathological processes which take place during the "latent period of radiation sickness" (i.e., breakdown of lymphoid tissue, biochemical disturbances in several organs and systems, etc.) [2, 7].

## LITERATURE CITED

1. L. Ya. Borisova, Radiobiologiya, No. 2, 246 (1969).
2. G. P. Gruzdev, The Problem of the Lesion of the Hematopoietic Tissue in Acute Radiation Sickness [in Russian], Moscow (1968).
3. B. B. Moroz and A. D. Dubrovin, Radiobiologiya, No. 1, 172 (1970).
4. V. D. Rogozkin and O. O. Romashko, Byull. Éksperim. Biol. i Med., No. 1, 14 (1970).
5. V. M. Rozental', The State of the Hypophyseo-Adrenocortical System in the Course of the Stress Reaction. Author's Abstract of Candidate's Dissertation, Moscow (1969).

6. V. M. Rozental', Probl. Endocrinol., No. 1, 49 (1969).
7. E. F. Romantsev, Early Radiation-Biochemical Reactions [in Russian], Moscow (1966).
8. A. M. Barrett and M. A. Stockham, J. Endocrinol., 26, 97 (1963).
9. G. De Moor, Acta Endocrinol. (Copenhagen), 33, 297 (1960).
10. K. Flemming, Strahlentherapie, 137, 82 (1969).
11. R. Guillemin et al., J. Lab. Clin. Med., 53, 830 (1959).
12. J. E. Hartfield, Acta Endocrinol. (Copenhagen), 30, 219 (1959).
13. Z. B. Zsebok et al., Radiobiol. Radiother. (Berlin), 8, 172 (1967).