

ENTEROSORPTION AND ULTRAVIOLET IRRADIATION OF AUTOBLOOD IN COMPLEX TREATMENT OF PATIENTS WITH RADIOCESIUM INCORPORATION IN THEIR BODIES

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Comparative characterization is made of the efferent therapy methods (enterosorption and ultraviolet irradiation of blood) used in the complex treatment of patients with increased cesium (Cs) accumulation according to the data of a human radiation counter (HRC). It is shown that both methods are effective for decreasing the accumulated Cs activity in a human organism.

Radioactive substances released due to a nuclear accident exert an adverse influence on people in the following main ways: the influence of gamma-radiation following passage of a radioactive cloud; the influence of gamma- and beta-radiation of radioactive substances settled on a ground surface; contact irradiation from contaminated skin and clothes; internal radiation from aerosol inhalation; and use of water and foodstuff contaminated with nuclides [1, 2]. For the majority of people living in the territories with a low contamination density the major contribution to formation of the radiation dose comes from the internal irradiation dose [1].

Indeed, though much time has passed since the Chernobyl APS accident, the persons with increased nuclide (Cs-134, Cs-137) accumulation, the so-called radiocesium "incorporants," are still being admitted to hospitals.

One of the new aspects in the problem of the chronic influence of small ionizing radiation doses is the combined influence: the longer it is, the higher is the person's probability of coming across the other unfavorable factors both of the ambient and internal media. Old age and its concomitant pathology entail substantial modification of the state of the natural detoxication organs and systems, which leads to development of the endogeneous intoxication syndrome, whose correction by the efferent methods of therapy, namely, enterosorption (ES) and ultraviolet blood irradiation (UVBI) has become widely adopted [1].

This study is devoted to evaluation of the effectiveness of ES and UVBI in the course of decorporation and comparative investigation of possible mechanisms of the influence of these methods on the functional condition of immunocompetent blood cells (IBC).

We have examined 25 patients aged from 21 to 65 with different nosological forms and Cs incorporation according to the readings of an SIB-1 human radiation counter. The effective equivalent dose of internal irradiation of the examined patients was 0.2–7.54 mSv

Fourteen patients were subjected to the complex treatment involving UVBI following the standard procedure: "hard" (not filtered) irradiation using an MD 63M Isolda apparatus at a dose of 1–4 mSv per 1 kg of a body weight for a course of 3–5 sessions at 1 day intervals.

Eleven patients were exposed to enterosorption with the fibrous carbon "Belosorb" at a dose of 0.1 g per 1 kg of a body weight for 14 days, three doses a day [1].

Dosimetric control was accomplished by measuring the Cs activity from HRC readings before and after the treatment. In some patients urine radiometry was made on a Pripyat' II six-crystal gamma-spectrometer (the

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TABLE 1. Dynamics of Changing the Radiocesium Activity in a Human Organism According to the HRC Readings and the Equivalent Dose of Internal Irradiation in Use of the Methods of Enterosorption and Ultraviolet Irradiation or Blood

Index	Theraupetic Methods			
	ultraviolet irradiation of blood (n = 14)		enterosorption (n = 11)	
	before treatment	after treatment	before treatment	after treatment
Radiocesium activity according to HRC data (mCi)	0.78 ± 0.15	0.46 ± 0.17	0.84 ± 0.16	0.68 ± 0.11
Equivalent dose of internal irradiation (rem)	0.20 ± 0.03	0.08 ± 0.02*	0.16 ± 0.04	0.11 ± 0.02

*Reliable divergence between indices ($p < 0.05$).

Institute of Physics of the Academy of Sciences of Belarus) before the treatment, in mid-course, and after its cessation.

The functional modification of IBC before and after the treatment was evaluated from a luminescent microspectral analysis on a DMF-2 two-wave microfluorimeter-photometer (the Institute of Biophysics of the Russian Academy of Sciences) with supravital staining of blood preparation with 10^{-5} M acrydine-orange in a phosphate buffer solution (pH-4.2). We measured the following parameters: red luminescence intensity (RLI, the wavelength 640 nm characterizes the functional state of the lysosomal system of IBC in supravital staining), green luminescence intensity (GLI, the wavelength 530 nm is determined by the degree of fluorochrome incorporation into deoxyribonucleoprotein and characterizes the activity of the nuclear apparatus of IBC) and red-to-green luminescence intensity ratio (RLI/GLI being an integral parameter of the IBC activity determined both by passive transport of fluorochrome with respect to gradient pH and its active accumulation in the lysosomal system with the aim of its subsequent elimination, which characterizes, to some extent, the detoxication function of a separate cell) [3, 4].

Radiometric investigation of nuclides discharged with urine, involving dynamic observation of "incorporants," has shown that the urine activity is a constant for an examined patient. This has allowed us to assume in elimination calculations that the nuclide elimination is a linear process. We determined a decorporation volume (the difference between the activities of the incorporated Cs before and after treatment in %), a decorporation rate (the decrease in the Cs activity for 24 hours), time of nuclide half-elimination (the quotient of the initial nuclide activity and the double decorporation rate), and time for attaining the permissible Cs activity (a quotient of a difference of the initial and permissible activities and a decorporation rate).

The results obtained (Table 1) show that both therapeutic methods are accompanied by a decrease in the nuclide activity in the human organism, in the case of UVBI this decrease becomes statistically appreciable.

The enterosorption treatment decreases the Cs activity, on the average, by $11.25 \pm 5.78\%$, while UVBI – by $21.86 \pm 2.86\%$ ($p < 0.05$). An analysis of the decorporation rate has shown that in nuclide elimination due to ES 9.77 ± 3.16 nCi/day are lost, while in the case of UVBI the figure is 15.80 ± 5.42 nCi/day. It is pertinent to note that a rate of radiocesium elimination in the case of the UVBI treatment increases from 9.03 ± 4.000 nCi/day after the third procedure, up to 15.80 ± 5.42 after the fifth procedure, which is accompanied by emergence of the 1.5-fold "peak" of the nuclide activity in urine radiometry.

Of particular interest are the results calculated for a period of Cs half-elimination in an organism as a result of ES (67.39 ± 11.39 days) and UVBI (26.02 ± 7.62 days) treatment. Analogous results are obtained

TABLE 2. Influence of Enterosorption and Ultraviolet Irradiation of Blood on Modification of the Functional Condition of Immunocompetent Blood Cells in Patients with Radiocesium Incorporation

Functional parameters of IBC	Therapeutic Methods			
	enterosorption (<i>n</i> = 11)		UVBI (<i>n</i> = 14)	
	before treatment	after treatment	before treatment	after treatment
CLI (relative optical)	3.15 ± 0.63	2.34 ± 0.86	1.54 ± 0.76	3.00 ± 1.01
RLI (relative optical units)	0.95 ± 0.25	0.57 ± 0.25	0.53 ± 0.20	0.78 ± 0.24
RLI/GLI (conventional units)	0.42 ± 0.11	0.31 ± 0.07	0.55 ± 0.23	0.43 ± 0.21

in calculating the time for attaining the permissible nuclide accumulation: 67.54 ± 6.30 days for ES and 38.04 ± 4.82 days for UVBI, which is essentially shorter compared to the data on a half-elimination period reported in the literature [3].

It should be noted that the patients after the UVBI course were in a more serious somatic condition. After the enterosorption therapy the accumulated Cs activity almost did not change in older 4 patients; therefore they were subjected next to UVBI treatment.

Of keen interest are the results of investigation of the structural-functional modification of IBC in the case of treatment involving both methods of efferent therapy. First of all, it is worth noting the fact that in the five patients in whom the enterosorption therapy did not result in the desired clinical and decorporating effect, the initial decreased functional state of nuclear and lysosomal systems of IBC was accompanied, as a result of treatment, by the further depletion of their functional reserve. On the contrary, when UVBI was included in the complex treatment, this led to recovery of the functional reserve of IBC which, in turn, was followed by a decrease in the accumulated Cs level.

The results of luminescent microspectral analysis (Table 2) unexpectedly raised a number of problems, first of all, of a methodological aspect.

An analysis of the initial IBC condition has shown that the group of patients whose complex treatment included UVBI has more pronounced disorders in the functional IBC condition related with a decrease of the functional activity of nuclear and lysosomal mechanisms of cells, which corresponded to a more serious somatic condition of the patients entering this group.

As seen from the table, the RLI/GLI parameter (as an integral index of the functional IBC condition) decreases both after the ES and the UVBI treatment. However, a more careful analysis of microspectral data allows us to draw a conclusion about the influence of the used efferent methods exerted through different mechanisms at the level of various cellular structures.

Thus, with ES included in the complex treatment of radiocesium incorporants, there was observed a decrease both in the GLI characterizing the functional condition of the nuclear system of IBC and in the RLI that characterizes the lysosomal system ability to fluorochrome accumulation. The result testifies to a moderate suppressive ES influence on the functional condition of immunocompetent blood cells.

After the UVBI course the situation is reversed: the intensity of functioning of the nuclear mechanism of IBC increases along with moderate lysosomal activation, which is indicative of enhancement of synthesis processes at the cellular level.

Thus, the unidirectional decrease of the RLI/GLI parameter after the efferent therapy by the both methods is a result of opposite tendencies in changing of the functional IBC condition, which reduces the possibility of its independent use in evaluation of the effectiveness of the adopted therapeutic methods.

Correlation analysis of the resulting data has demonstrated a statistically appreciable decrease in the initial functional activity of the lysosomal mechanism of IBC depending on the effective dose of internal irradiation (Fig

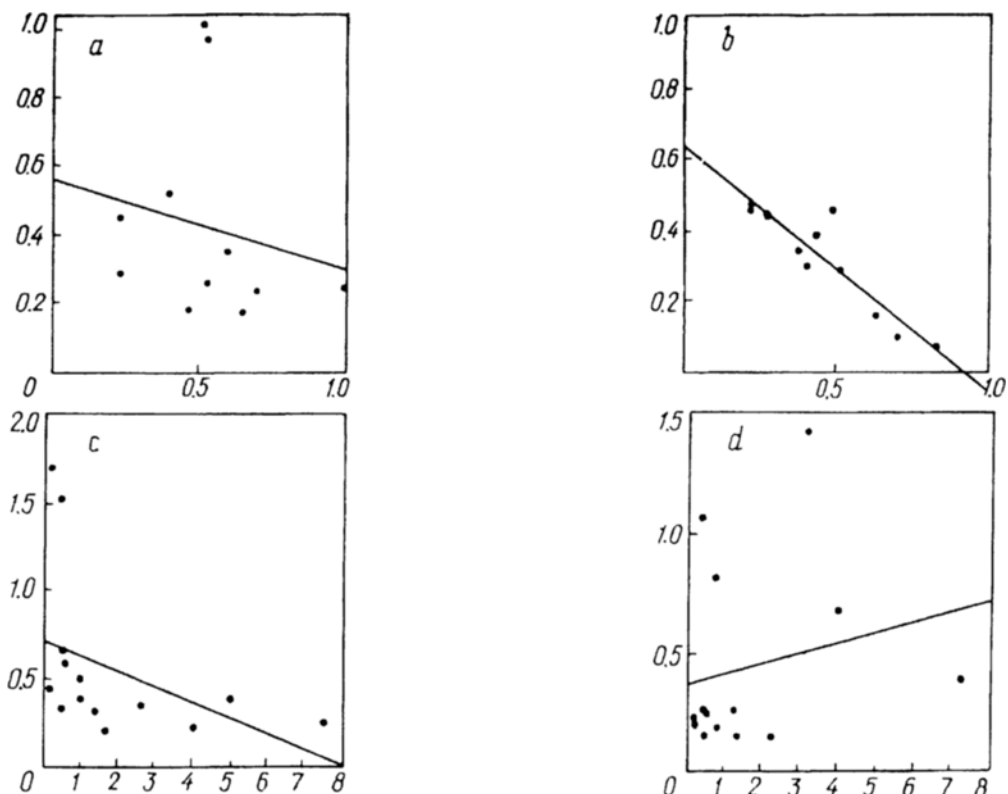


Fig. 1. Influence of the effective dose of internal irradiation on the functional state of immunocompetent blood cells: a, b) before and after enterosorption course; c, d) the same before and after the UVBI course. Along the vertical, RLI/GLI in conventional units; along the vertical, internal irradiation dose, mSv.

1). However, the results of such analysis pertaining to the post-treatment period are most interesting. The ES course conducted showed a strong statistically appreciable relationship between the internal irradiation dose and the functional condition of the lysosomal mechanism, which acquired a character of the functional dependence. On the contrary, after the UVBI course the relationship between the internal irradiation dose and the functional IBC activity disappeared.

Based on the findings reported, we can draw the following conclusions:

1. Both the ES and the UVBI are adequate methods of correcting increased Cs accumulation in an organism. The seriousness of major somatic pathology in older patients dictates the necessity of complex treatment by the efferent methods to improve the functioning of natural detoxication organs.

2. An important role in use of the depuration methods belongs to their influence on the functional IBC condition: it is shown that ES exerts a moderate suppressive action, the UVBI enhances synthesis processes in IBC, which makes it possible to differentiate their use.

3. Enhancement of nuclide elimination in the case of ES treatment cannot be explained by direct Cs absorption on a sorbent, as judged from the data reported. A more obvious explanation is the ES effect on mass transfer at the blood/intestinal wall interface that contains a large amount of IBC, which is accompanied by a change in the cell-cell and cellular-humoral cooperative communications. The effect of direct photodynamic action of UVBI on blood cells (without affecting a Cs level) is in fair agreement with this hypothesis.

4. The correlation analysis has shown that the influence of small doses of ionizing radiation is related to weak effects that are often masked by pathological processes in an organism. At the same time their correction "unmasks" this influence, which explains the paradoxical dose-dependent enhancement of suppression of the functional condition of the lysosomal system of IBC after the treatment.

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