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Pocherniaeva V. F., Zhukova T. O., Vasko L. M., Nestulia K. I., Sokolova N. A.

PREVENTION OF FREE RADICAL-INDUCED PATHOLOGY IN THE STAFF DEALING WITH SOURCES OF IONIZING RADIATION

Ukrainian Medical Stomatological Academy (Poltava)

zctym2012@gmail.com

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Introduction. The rapid development of nuclear energy and the widespread applying sources of ionizing radiation in various fields of science and practice have constituted a potential threat of radiation hazard for humanity. Nowadays, some medical procedures and treatment are known as the major and the most common ways of exposure to man-made sources of ionizing radiation. Thereupon, the issues on personnel protection against occupational ionizing radiation and prevention of excess exposure to occupational ionizing radiation are one among the most healthcare-related topical questions and this, in turn, predetermines the objectives of our study [1,2].

Under the influence of ionizing radiation, atoms and molecules of living cells become ionized, resulting in complex physical and chemical processes that affect the character of further human body functioning. As it is well known, not ionizing radiation, which causes DNA breaks, but induced by it strengthening the processes of free radical oxidation of lipids and biopolymers is ruinous for cell functioning [3,4,5].

As a result, this triggers the following:

• oncogenic mutations related to the genes of growth factors, their receptors, the genes responsible for DNA repair in case of its damage (marker: expression of the mutated gene p53) [3,4];

• decrease in the immune system functioning (markers: impaired maturation of T-killers, malfunction of antigen-presenting cells, increased activity of tumour growth factors (interleukin 2, interleukin 6) [4];

• a sharp rise in glycolysis, which reduces the share of aerobic-mitochondrial oxidation. As a result, the impairment of the cellular respiration occurs (markers: activity indicators of the glutathione system and coenzyme Q (ubiquinone)) [4];

• impairment of the detoxifying function of the liver and kidneys (markers: increased alkaline phosphatase, GGTP, AlAT, AsAT, bilirubin);

• impaired functioning of connective tissue in the removal of toxins (cellular drainage and lymph drainage) [3,4];

• developing resistance to apoptosis (loss of the receptor to tumour necrosis factor) [5].

The aim of the study. All these changes are considered as hazardous as they contribute in the fast development free radical-induced pathologies and pre-cancerous cell degeneration. Pre-cancerous degeneration is promoted by the growing processes of cell aging and the weakening of protection systems, lack of oxygen supply, exicosis, delayed or impaired transport of toxins from cells and tissues, and the development of endogenous intoxication.

Moreover, the clinical manifestations of moderate chronic endotoxicosis include nervousness, aggressiveness, frequent mood changes and increased depression, headache, delayed concentration and decision making, sleep disturbance, memory impairment. Attempts of the body to compensate malfunctioning of the liver by overloading the excretory functions of the skin lead to excess sweating and oil production, the appearance of boils, papillomas, acne, eczema, warts. Changes in the bowel habits, stool, heartburn, intolerance to certain foods are the gastrointestinal signs of chronic endotoxicosis. The body overloading with toxins is evidenced by more frequent urination (including nocturia), the gravel excreted with urine, the formation of kidney stones. Patients can also present complaints of joint pain, associated with tendonitis, gout, arthritis. Among the common signs of metabolic disorders there is hypoglycemia, tissue pastosity, obesity, cellulite.

Taking into consideration risks mentioned above, the staff dealing with sources of ionizing radiation should strictly adhere to the program of preventive measures to curb the development of free radical pathology, which includes a number of important points:

1. Avoiding the effects of factors enhancing the processes of lipid free radical oxidation and suppressing the immune system (solar radiation, powerful electromagnetic fields, neuro-emotional stress, toxicants of different nature).

2. Sound sleep (melatonin synthesis).

Object and methods of research. Melatonin is important for two main functions: hormonal regulation and antioxidant protection. So, one of the key actions of melatonin is to regulate sleep cycle. With age, the activity of the epiphysis decreases, so the amount of melatonin decreases as well, the sleep becomes superficial, and insomnia may occur. The use of exogenous melatonin promotes the elimination of insomnia, prevents the disorders of the daily regime and body biorhythms. During a sound deep sleep, the body normalizes the functioning of all internal organs and systems, muscles become relaxed, and the nervous system is at rest. The body activity at this time is aimed at restoring vital forces and rejuvenation.

Melatonin has an effect on the functioning of the endocrine glands: it regulates the menstrual cycle, improves reproductive and sexual functions. Melatonin is involved in the regulation of blood pressure, the functions of the gastrointestinal tract, stimulates immunity, thus slowing down aging. On antioxidant potential of melatonin equates to tocopherol system, the key segment of antioxidant protection system. As experimental studies show, melatonin inhibits the growth of some types of cancer cells, especially in the mammary gland and prostate [2,3,6].

3. Treatment of infection foci (odontogenic infections, tonsils, etc.), including helminth infestation. Helminthiasis may mask as a variety of diseases: from dysbacteriosis to allergies and bronchial asthma, from respiratory diseases to migraines. Helminths wastes possess general toxic effects, suppress hematopoiesis, can cause anemia and leukopenia. Parasites can provoke appendicitis, intestinal obstruction, intestinal and biliary tract dyskinesia.

Results. According to WHO report, almost 80% of all existing diseases are either directly caused by parasites, or are a consequence of their life activity in human body. Parasitic diseases can result in serious pathological changes accompanied by continuing decrease in immunity, impaired functioning of the gastrointestinal tract and the liver. Taking into account the contribution of parasitic diseases into the development of neoplastic conditions and endotoxicosis, the treatment of helminthic invasions and other parasitic diseases is mandatory in programs for the rehabilitation of cancer patients. Schemes and treatment regimens are typically developed as patient-centred.

4. Overcoming of hypoxia and renewal of respiratory enzymes.

Under the influence of free radical processes, mitochondrial dysfunction occurs resulting in energy metabolism disorder and increased hypoxia. Regardless of the specificity of the damaging factor, hypoxia accompanies virtually all forms of pathology. Correction of energy imbalance is a difficult and laborious task, which is based on understanding the functioning of the respiratory chain and the Krebs cycle.

The strategy of energotropic therapy includes the following tasks:

1. To accelerate the oxygen delivery.

2. To inhibit the glycolysis activity.

3. To normalize the functioning of oxygen-transport energy supply systems.

4. To enhance mitochondrial energy supply systems.

The current strategy of metabolic energotropic therapy therapy is aimed at increasing the effectiveness of tissue respiration and oxidative phosphorylation through additional administration of the following substances:

• coenzymes and vitamins (thiamine, riboflavin, nicotinamide, pyridoxine, etc.);

• medicines that improve the transport of electrons in the respiratory chain (Co Q10, cytochrome, cytoflavin, amber acid, ascorbic acid, vitamins K, K3, coenzyme-composite, citric acid catalysts);

• drugs that enhance antioxidant protection and prevent free radical damage to mitochondrial membranes: ascorbic acid, tocopherol, bioflavanoid, β-carotene, α-lipoic acid, N-acetylcysteine, a precursor of glutathione. The content of glutathione in the cell is increased by using turmeric (yellow pigment of curry spices).

5. Plant antihypoxants. A number of studies on the development of methods and means to correct metabolic disorders caused by ischemia and reperfusion, hypoxia and reoxygenation of cells are focused on the search for drugs possessing antioxidant and membrane-protective properties, especially for the protection of membranes of mitochondria, and having no or negligible side effects when used. From this standpoint, plant antihypoxants favorably differ from synthetic ones, as they have a longer effect, a wide spectrum of action, and a combination with antioxidant action. The antihypoxic effect of plants is associated with the content of flavonoids, carotenoids, citric acid components, vitamins and trace elements (selenium, zinc, copper, magnesium, etc.). Striking examples of plants with the most expressive antihypoxic and antioxidant effects are ginkgo biloba, bitter wort, elderberry black, common rowan, mountain ash blackberries, common tansy, hawthorn, arnica mountain, etc [2,3,6].

6. Periodic detoxification and drainage therapy. Effective detoxification and drainage therapy is possible in the conditions of complex influence on all the levels of metabolism (strengthening of detoxification function of the liver, strengthening of the energy potential of hepatocytes, elimination of cholestasis), transport (hemosorption, small volume infusion therapy, cellular drainage), toxin excretion (improvement of kidney functioning, strengthening the intestine functioning, enhancing the toxin elimination through the skin).

7. Strict adhering to preventive anti-carcinogenic nutrition. Among the means of personal protection against the accumulation of radionuclides in the body, the proper diet rich in nutrients evidenced as having padioprotective properties is of great importance for personnel dealing with sources of ionizing radiation. It is desirable to consume nutrients of natural origin or close to them in their chemical structure, which have been known to have sufficiently pronounced radioactive effect. Among these nutrients there is dairy, vitamins, pectins, and others [4,5].

The protective effect of pectins can be explained due to the fact that they, together with other edible fibers, improve bowel peristalsis, contributing to faster removal of metals with feces. In addition, pectins are complexing compounds (complexes, chelates), the main property of which is their ability to form stable complexes with many heavy metals and rare earth elements, as well as their salts. When forming such complexes in the body, they are relatively quickly removed with the urine.

A diet aimed at preventing radiation damage to the body, should include vitamins in sufficient quantities. Negative impact of their lack on the body resistance to ionizing radiation has been quite well known as well as an increase in their deficiency under the exposure to ionizing radiation. The use of vitamins aims to replenish their lack and to intensify vitamin-related functions. The most important specific mechanisms of the influence of vitamins, associated with the ability to inactivate free radicals and inhibit the processes of lipid peroxidation, are dramatically activated at the exposure to ionizing radiation.

Conclusions. Thus, preventive programs must be implemented and strictly followed by anyone who is exposed to adverse environmental factors, and especially personnel working with sources of ionizing radiation. The preventive program described is directed to eliminate radionuclides and other toxic substances from the body, to significantly inhibit the development of free radical pathology, to provide the body with the necessary vitamins, micro- and trace elements, biologically active substances, to normalize the hormonal state and to strengthen the nervous and immune systems, i.e. promotes maintaining the homeostasis and improvement the life quality of people.

Prospects for further research. The study of the impact of ionizing research on personnel working in X-ray and radiotherapy units for the purpose of developing and implementing means and methods of protection is relevant and appropriate.

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ПРОФІЛАКТИКА ВІЛЬНОРАДИКАЛЬНОЇ ПАТОЛОГІЇ У ПЕРСОНАЛУ, ЯКИЙ ПРАЦЮЄ ІЗ ДЖЕРЕЛАМИ ІОНІЗУЮЧОГО ВИПРОМІНЮВАННЯ

Почерняєва В. Ф., Жукова Т. О., Васько Л. М., Нестуля К. І., Соколова Н. А.

Резюме. Під впливом іонізуючого випромінювання атоми і молекули живих клітин іонізуються, в результаті чого відбуваються складні фізико-хімічні процеси, які впливають на характер подальшої життєдіяльності людини. Як відомо, небезпеку для життєдіяльності клітини являє не тільки саме іонізуюче опромінення, яке викликає розриви ДНК, але і індуковане ним посилення процесів вільнорадикального окислення ліпідів і біополімерів.

В роботі аналізуються механізми розвитку вільнорадикальної патології при дії іонізуючого опромінення на організм персоналу, який працює із джерелами іонізуючого випромінювання. Наведена програма превентивних заходів по стримуванню розвитку вільнорадикальної патології, яка включає заходи по ліквідації гіпоксії, поновлення активності дихальних ферментів і детоксикаційно-дренажну терапію. Представлену програму повинна свідомо виконувати кожна людина, яка знаходиться в умовах дії несприятливих чинників зовнішнього середовища, а особливо персонал, що працює з джерелами іонізуючого опромінення.

Ключові слова: джерела іонізуючого випромінювання, вільнорадикальна патологія, рослинні антигіпоксанти, детоксикаційно-дренажна терапія.

ПРОФИЛАКТИКА СВОБОДНОРАДИКАЛЬНОЙ ПАТОЛОГИИ У ПЕРСОНАЛА, РАБОТАЮЩЕГО С ИСТОЧНИКАМИ ИОНИЗИРУЮЩЕГО ИЗЛУЧЕНИЯ

Почерняева В. Ф., Жукова Т. А., Васько Л. Н., Нестуля К. И., Соколова Н. А.

Резюме. Под воздействием ионизирующего излучения атомы и молекулы живых клеток ионизируются, в результате чего происходят сложные физико-химические процессы, которые влияют на характер последующей жизнедеятельности человека. Как известно, опасность для жизнедеятельности клетки представляет не только именно ионизирующее облучение, которое вызывает разрывы ДНК, но и индуцируемое им усиление процессов свободнорадикального окисления липидов и биополимеров.

В работе анализируются механизмы развития свободнорадикальной патологии при воздействии ионизирующего излучения на организм персонала, работающего с источниками ионизирующего излучения. Приведенная программа превентивных мер по сдерживанию развития свободнорадикальной патологии, включая меры по ликвидации гипоксии, обновления активности дыхательных ферментов и детоксикационно-дренажную терапию. Представленную программу должен сознательно выполнять каждый человек, находящийся в условиях воздействия неблагоприятных факторов внешней среды, особенно персонал, работающий с источниками ионизирующего облучения.

Ключевые слова: источники ионизирующего излучения, свободнорадикальная патология, растительные антигипоксанты, детоксикационно-дренажная терапия.

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Abstract. Under the influence of ionizing radiation, atoms and molecules of living cells become ionized, resulting in complex physical and chemical processes that affect the character of further human body functioning. As it is well known, not ionizing radiation, which causes DNA breaks, but induced by it strengthening the processes of free radical oxidation of lipids and biopolymers is ruinous for cell functioning.

This paper highlights the mechanisms of the development of free radical-induced pathology under the exposure to ionizing radiation of personnel dealing with sources of ionizing radiation. The program of preventive measures described aims at curbing the development of free radical-induced pathology and includes measures to reduce hypoxia and to restore the activity of respiratory enzymes as well as detoxification and drainage therapy. A diet aimed at preventing radiation damage to the body, should include vitamins in sufficient quantities. Negative impact of their lack on the body resistance to ionizing radiation has been quite well known as well as an increase in their deficiency under the exposure to ionizing radiation. The most important specific mechanisms of the influence of vitamins, associated with the ability to inactivate free radicals and inhibit the processes of lipid peroxidation, are dramatically activated at the exposure to ionizing radiation. Thus, preventive programs must be implemented and strictly followed by anyone who is exposed to adverse environmental factors, and especially personnel working with sources of ionizing radiation.

The study of the impact of ionizing research on personnel working in X-ray and radiotherapy units for the purpose of developing and implementing means and methods of protection is relevant and appropriate.

Key words: sources of ionizing radiation, free radical-induced pathology, plant antihypoxants, detoxification and drainage therapy.

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