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**DEPARTMENT OF GENERAL HYGIENE
AND PHYSICAL CULTURE**

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ORGANIZATION OF RADIATION SAFETY OF MEDICAL PERSONNEL WHEN WORKING WITH OPEN AND CLOSED SOURCES

Methodological recommendations for medical students

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This training manual contains material that reflects modern hygienic requirements for the location, planning and operation of hospitals operating with sources of ionizing radiation. The history of the discovery of radioactive elements, the basics of radiation hygiene, the causes and clinical course of radiation sickness are presented. Information on methods of protection against the harmful effects of this factor is provided.

The manual contains a list of questions for self-control, test tasks, a list of basic and recommended additional literature.

The manual contains a list of used and recommended literature. Educational and methodological manual "Organization of radiation safety of medical personnel when working with open and closed sources", prepared in the discipline "Hygiene" in accordance with the Federal State Educational Standard of Higher Professional Education for students studying in the specialty of Medicine (31.05.01).

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Radiation hygiene is a science that studies the conditions, types and consequences of exposure to ionizing radiation sources on humans and develops measures aimed at protecting their health.

Radiation (or ionizing radiation) has always been present in nature, and living organisms have constantly experienced its effects.

The radiation background is usually understood as ionizing radiation from natural sources of cosmic and terrestrial origin, as well as from artificial radionuclides scattered in the biosphere as a result of human activity. Different lengths of radio waves, light and radiation heat from the Sun are one of the varieties of radiation, however, it is not ionizing, because it is not able to break the chemical bonds of molecules of living organisms, causing biologically important changes.

Natural radioactive background is created by cosmic radiation and radiation from natural radioactive substances in the soil, water, atmosphere.

Due to the constant cycle of substances in nature, man with food, water and air gets all the natural radioactive elements. The tissues of the body contain negligible amounts of these elements.

Radioactive gases are products of decay of natural radioactive elements (radium, actinium and thorium) contained in the soil.

The release of radioactive gases from the soil is determined by the conditions of gas exchange between the soil air and the atmosphere. The value of the natural radioactivity of the air varies depending on the time of year and terrain. In winter, radioactivity is less than in summer and decreases with elevation.

Natural radioactivity does not have a harmful effect on the body and is a permanent environmental factor.

In the 20th century, artificial sources of radiation were created. Radioactive substances of artificial origin appeared as a result of environmental pollution during explosions of nuclear devices and in connection with the development of nuclear energy, the use of radioactive substances in science and industry.

The most powerful sources of air pollution of the planet - explosions of nuclear devices and major accidents at nuclear power plants. This produces a large number of radioactive substances with different half-lives. The environmental significance of radioactive isotopes varies. Radionuclides with a short half-life (less than 2 days) do not pose a great danger (except in cases of nuclear explosions and accidents), as they maintain a high level of radiation only for a short time. Substances with a very long half-life are also almost safe, because they emit weak radiation per unit time.

The most dangerous radioactive elements are those in which the half-life varies from several weeks to several years. The most dangerous are strontium-90 and cesium-137, which have a half-life of 29 years and 33 years, respectively. On physico-chemical properties strontium-90 is similar to calcium, cesium-137-potassium. In the cycle of substances in nature and in metabolic processes in the body, they participate on an equal basis with stable elements - calcium and potassium. Strontium-90, getting into the body, is deposited in the bones, and cesium-137 is evenly distributed among the organs, which provides internal irradiation of the body for many years. Radioactive impurities deposited on the ground, initially dispersed in the atmosphere, enter the soil and can penetrate into the groundwater. Contamination of soil and water contributes to the accumulation of radioactive substances in terrestrial and aquatic plants, animal feed, in their bodies. At the same time, the concentration of radioactive substances in plants, animals, fish, inhabitants of water bodies is many times higher than that in air, soil and water, which is associated with the ability of biological objects to accumulate in their structures certain radioactive substances. Radioactive substances to humans via the food chain: soil-grass-cattle-milk (meat) - man. The nuclear industry can also be a source of radioactive contamination in three stages:

1. In the extraction and enrichment of fossil raw materials
2. When used in reactors
3. In the processing of nuclear fuel in installations

The main principles of protection when working with radiation sources in the open form;

A) compliance with the principles of protection when working with radiation sources in

closed view;

B) sealing of production equipment;

C) the layout of the premises;

D) optimization of sanitary facilities and equipment;

E) use of personal protective equipment;

(E) sanitary conditions;

G) compliance with the rules of personal hygiene.

If the extraction of fossil raw materials and its processing pollution is small, the potential risk of pollution from nuclear reactors is much higher, especially in the factories for the production of nuclear weapons, the production of nuclear fuel. Most of the radioactive elements are contained in wastewater.

Decontamination of radioactive waste to its full safety requires approximately 20 half-lives. This means that the duration of waste storage outside the biosphere is extremely long: for example, 640 years for waste contaminated with cesium-137 (half-life of 25,000 years).

The Treaty banning the testing of nuclear weapons in the atmosphere, outer space and under water is not only of political importance, but also a serious environmental programme for radioactive contamination. Radiation safety issues at the international level are regulated by the International Committee on radiation protection.

For quantitative characteristics of ionizing radiation, the concept of "exposure dose"is used. The system unit of exposure dose is a pendant divided by kilogram (CL/kg), non — systemic-x-ray (P).

To characterize the degree of impact of x-ray or u—radiation on biological objects use the concept of "absorbed dose", which is expressed by the system unit gray (Gr) or off-system-rad.

To assess the degree of radiation hazard of chronic radiation exposure and radiation of arbitrary composition introduced the concept of "equivalent dose". As a unit of equivalent dose - sievert (system unit) and REM (special unit).

Dose rate is the radiation dose received by an object per unit of time .

The dose limit is the value of the annual equivalent dose of radiation, which can not be exceeded in normal operation. Radiation safety standards are developed and processed on the basis of the recommendations of the International Commission on radiation protection.

Natural radioactivity is a spontaneous transformation of the nuclei of atoms of one element into another, accompanied by the emission of ionizing radiation. The unit of activity is Becquerel-one decay per second.

Radiation sickness is a disease that occurs as a result of exposure to ionizing radiation, the symptoms depend on the type of damaging radiation, its dose, localization of the source of radioactive substances, distribution.

In humans, radiation sickness can be caused by external and internal radiation-when radioactive substances enter the body with inhaled air, through the gastrointestinal tract or through the skin and mucous membranes, as well as through injection.

Acute radiation syndrome (ARS) — comes as a result of a single irradiation.

Chronic LB-develops as a result of long-term continuous or fractionated irradiation of the body. CLB in external irradiation is a complex clinical syndrome involving a number of organs and systems. Affected nervous, cardiovascular and endocrine systems, observed dystrophic changes. There are the following clinical forms of chronic radiation sickness:

A) clinical forms, the occurrence of which is mainly due to the action of General external radiation or the entry into the body of isotopes, rapidly and evenly distributed in all organs and tissues;

B) clinical forms with a slowly developing clinical syndrome of predominant damage to individual organs, tissues and body segments.

Characteristic changes in the blood picture in chronic radiation sickness are the gradual development of leukopenia, neutropenia and thrombocytopenia, and in severe radiation injury - severe anemia.

Long - term effects of irradiation — somatic and stochastic effects, appear after a long time (several months or years) after a single or as a result of chronic irradiation.

Include: changes in the reproductive system; sclerotic processes; radiation cataracts; immune disease: radiocarcinogenesis; reduced life expectancy; genetic and teratogenic effects. It is common to distinguish between two types of long-term effects-somatic, developing in the irradiated individuals themselves, and genetic — hereditary diseases developing in the offspring of irradiated parents.

The somatic long-term effects include primarily a reduction in life expectancy, malignant neoplasms and cataracts.

In addition, the long-term effects of radiation are noted in the skin, connective tissue, blood vessels of the kidneys and lungs in the form of seals and atrophy of irradiated areas, loss of elasticity, leading to fibrosis and sclerosis.

The unusual layout of the radiology Department.

These offices are arranged in order of increasing amounts of radioactive substances.

When placing a work space is considered a common planning principle: the separation of areas on the radiation-dangerous (dirty area) and clean room.

In the Department of radionuclide diagnostics there are procedural, where radionuclide substances are introduced, and rooms, where radiometric studies (radiometry of individual organs and biological media) and scanning of various organs are performed.

In the offices of open and closed radionuclides premises are divided into 2 groups:

- the first consists of the premises where prepared and entered to patients a radioactive substance;

- the second group consists of wards for patients.

The first group of premises includes storage of radioactive substances, packing of radionuclides, sterilization, washing, procedural and operational-all these rooms are radiation dangerous.

After the introduction of the radioactive drug, patients enter the wards.

Remote radiotherapy departments have a treatment room with a monitoring room, the walls are thick and made of concrete.

When planning radiological departments takes into account the need to protect adjacent premises from radiation, so the thickness of the walls, floors, Windows and doors is calculated in accordance with the requirements of radiation safety.

In all divisions of radiation office allocate "clean" and "dirty" elevators for reception of containers with radioactive substances, removal of the polluted linen and radioactive waste.

For serving food in the office gets overload the gateway, protecting the containers and utensils from contamination.

Basics of radiation protection when using ionising radiation

he effects of radiation on humans can be deadly, causing severe tissue damage at high doses and cancer and genetic defects in subsequent generations of people exposed to radiation at low doses.

Ionizing radiation is any radiation that leads to the formation of electric charges of different signs and is a stream of particles that can directly or indirectly cause the ionization of atoms and molecules in the irradiated object.

When exposed to human body ionizing radiation can cause two types of effects that clinical medicine refers to diseases:

- deterministic (radiation sickness, radiation dermatitis, radiation cataract, radiation infertility, fetal abnormalities);

- stochastic (probable) non-threshold effects (malignant tumors, leukemia, hereditary diseases).

At present, x - ray and gamma-ray units, as well as radiopharmaceuticals, are widely used in medicine for the purposes of diagnosis and therapy

Such procedures help to clarify the diagnosis, have an effect on cancer.

However, the widespread unnecessary use of x-ray, gamma and other radiation can cause sometimes more harm than benefit to human health and leads to higher radiation exposure of personnel, patients and population.

In recent decades, medical procedures using RP for the treatment of diseases have become widespread.

Radiopharmaceuticals (radiopharmaceuticals) - is negligible in weight terms of the number of radionuclides, which when administered to the body used for diagnosis or for application, intracavitary and intra-tissue therapy.

The most common diagnostic procedure is a radioisotope scan of organs to identify the tumor and determine its nature (malignant or benign) by the level of exchange and accumulation of radionuclides in it. There are 22 million scans per year in the world, indicating a high probability of exposure to a significant number of people.

Radiation safety in x-ray rooms

In modern devices, the x-ray tube is enclosed in a special protective casing. The screen for transmission shall be provided with lead protective glass. Use a leaded apron to protect the doctor. To protect personnel in the control panel, there is a large protective screen, also use protective lead gloves, chest aprons and skirts.

Radiation safety in case of intracavitary, interstitial and application of radiation therapy

Cobalt - 60 preparations enclosed in a stainless steel shell are used as closed sources of gamma radiation.

Intra-cavity irradiation is carried out for the treatment of malignant tumors in the abdominal organs. The activity of the drug depends on the location and size of the lesion. This therapy requires manual manipulation of the drug itself (removal from the container, preparation, sterilization, introduction of the drug into the patient's cavity, its extraction). This leads to dangerous exposure of personnel. Currently, for oral therapy began to use small-scale mechanization. In particular, special hose gamma - therapeutic devices have been created, with the help of which radioactive preparations are moved by compressed air from the container through flexible hoses - ampoules to the patient's cavity. After the irradiation session, the drugs are automatically returned to the container. When a hook method of introduction of radioactive substances radiation exposure of personnel will be negligible.

Principles of protection when working with open radioactive sources

Work with open radioactive sources is associated with the risk of exposure to penetrating radiation and ingress of radioactive substances into the body, which leads to the possibility of both external and internal exposure of personnel - possible contamination of the working environment, clothing and hands, getting them into the air, the formation of radioactive gases.

The most often radioactive substances are inhaled, to a lesser extent swallowed. Many building materials (brick, concrete, wood, asphalt, linoleum) adsorb radioactive substances and are difficult to decontaminate, which exacerbates the risk of radiation exposure to personnel.

There are three classes of work with radioactive sources in open form.

Class I works can be carried out in a separate building or in an isolated part of the building with a separate entrance. The basis of the layout of the premises for the work of class I is the principle of dividing them into three zones according to the degree of possible radioactive contamination.

Rooms for works of the II class shall be placed in isolation from other rooms.

Works of class III can be performed in a one-room laboratory, conditionally divided into zones in which the potential for contamination is different.

Basic principles of protection

- In case of external radiation, all methods of protection used when working with closed substances are used.

- Work with open radioactive substances should exclude their entry into the environment.

This is achieved by rational planning and equipment of the working premises, sanitary devices for the removal and decontamination of liquid, solid and gaseous radioactive waste, maximum Mechanization and automation of work operations. It is necessary to avoid contamination of the skin of hands and face of personnel, as well as work surfaces. To do this, use personal protective equipment and sanitary treatment. The personnel must observe the rules of personal hygiene and safety.

To means of individual protection include: overalls, footwear, means of protection of respiratory organs and eyes. To protect the respiratory system use respirators. To protect the respiratory system from beta - fluxes and neutrons, special Plexiglas shields are used. All types of work must be performed in rubber gloves.

Overalls are washed in special laundries and then subjected to dosimetric control.

The purpose of medical control is to identify persons with contraindications to work with ionizing radiation, as well as the detection of early signs of radiation damage. Periodic medical examinations are carried out at least once a year, in case of overexposure of the employee or in emergency situations, medical examination is carried out according to the indications.

The main way to check the effectiveness of radiation protection of personnel is dosimetric control, which includes:

1) Determination of individual radiation doses received by each worker;

2) Systematic monitoring of radiation exposures in the workplace and in adjacent premises;

3) application of instruments that signal the exceeding of permissible doses of radiation.

In accordance with this, the devices used for dosimetric control are divided into three groups.

1. Individual control dosimeters designed to measure the doses of external radiation is received by each employee exposed to ionizing radiation.

2. Stationary or portable devices are designed to measure the power of radiation doses.

3. Fixed installation to record the power of radiation used in the premises. Sensors of such devices are placed in the field of measurement, and the control panel can be removed. Devices of this type are equipped with signaling devices that give sound signals in case of exceeding the permissible dose rate.