MINISTRY OF HEALTH PROTECTION OF UKRAINE
ODESSA NATIONAL MEDICAL UNIVERSITY

Medical Faculty №2

Department of radiation diagnostics, therapy and radiation medicine and oncology

I APPROVE
Vice-rector for scientific and pedagogical work
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September 1, 2023

METHODOLOGICAL DEVELOPMENT TO PRACTICAL LESSONS FROM EDUCATIONAL DISCIPLINE

Faculty, MEDICAL course, 5th year

Educational discipline RADIATION MEDICINE

Odesa-2023

Approved:
Meeting of the Department of Radiation Diagnostics, Therapy and Radiation Medicine and Oncology
Odessa National Medical University

Protocol No. 1 dated 30.08. 2023

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PRACTICAL TRAINING

Practical lesson No. 1

Topic: The subject of radiation medicine and its connection with other disciplines

Goal: Acquaint applicants with the types of ionizing radiation and their main properties; the problem of hygienic regulation of the radiation factor (the concept of GDD for different population groups); the concept of "critical organ" in connection with radiation safety standards. To develop the ability to determine radiation sources and radiation doses using various methods - ionization, chemical, scintillation, colorimetric, photochemical, biological, calculation.

Basic concepts: Ionizing radiation, radiation, dosimetry, maximum permissible dose of ionizing radiation and its types and properties.

Equipment: educational premises, multimedia equipment, dosimetric and radiological equipment in the radiation diagnostics and therapy department.

Plan:

1. Organizational measures (greetings, verification of those present, announcement of the topic, purpose of the lesson, motivation of higher education seekers to study the topic).

2. Control of the reference level of knowledge

2.1. Knowledge requirements:

- know the definition of the main concepts of the topic;

- know the structure of the atom,

- to know radioactive transformations,

- to know the main properties of ionizing radiation.

- to know the types of ionizing radiation.

Skill requirements:

- be able to calculate the dose of ionizing radiation;

- to be able to determine radiation sources and exposure doses using various methods;

- to be able to prescribe a diagnostic and therapeutic dose of ionizing radiation in clinical X-ray radiology;

- to be able to determine units of measurement.

2.2. Questions for preparing for the lesson

1. Types of ionizing radiation: alpha, beta, gamma and X-rays.

2. Groups of radiation effects: somatic, somato-stochastic, genetic and psychological.

3. Levels of exposure at work by the amount of GDD, absorbed dose and exposure dose.

4. "Critical organs": 1-3 groups.

5. Methods of determining radiation safety for different population groups.

Reference summary for preparing for the lesson

Ionizing radiation is of the following origin: primarily X-rays and gamma rays. They represent energy transmitted in the form of waves without any movement of matter.

Other types of ionizing radiation are represented by rapidly moving particles of matter. Some of them carry an electronic charge, while others do not.

Neutrons are uncharged particles created during any radioactive transformation. They are the most important type of ionizing radiation. They are, as a rule, connected with the processes taking place in atomic bombs and nuclear reactors. Neutrons are electroneutral particles with a mass equal to the mass of a proton, but unlike the latter, they do not have an electric charge. Since these particles are electrically neutral, they penetrate deeply into any substance, including living tissue.

Electrons are light negatively charged particles that exist in all stable atoms. They are released during the radioactive decay of matter, and are then called beta rays. These particles can also be obtained in laboratory conditions.

Protons are positively charged particles found in the nuclei of all atoms. Their mass is approximately equal to the mass of a neutron and almost 2000 times greater than the mass of an electron. Protons are not normally emitted by radioactive substances, but they are found in outer space.

Alpha particles are nuclei of helium atoms, or helium atoms that have lost orbital electrons and consist of two protons and two neutrons bound together. They have a positive charge; are released during the radioactive decay of heavy isotopes (uranium or radium).

Heavy ions are nuclei of any atoms that have lost orbital electrons or that move at high speed.

Cosmic rays are a stream of elementary particles that come to the Earth's surface from outer space and increase its natural radioactive background at sea level by an average of 20-30%. They are characterized by high penetrating ability. Primary cosmic rays are heterogeneous: some are of solar origin, some are of intergalactic origin.

The natural radioactive background consists of naturally radioactive elements of rocks, as well as water, air, soil and cosmic radiation.

At the present time in the Odesa region, the power of the exposure dose of gamma radiation is due to natural radioactivity. According to the same data, the total radioactivity of beta radiation of atmospheric aerosols is of a low-variable nature, which is probably explained by the small content of aerosols of artificial origin. Exceeding the temporarily permissible levels (TDR-88) in food products was not found.

A significant number of people are exposed to ionizing radiation in occupational settings.

In the world of modern scientific ideas, the effects caused by the influence of radiation can be systematized into 3 groups:

- somatic (CRS and ARS, local radiation damage - cataract, non-malignant skin damage, etc.);
- somatic-stochastic (reduction of life expectancy, leukemia, tumors of various tissues and organs);
- genetic (dominant and recessive aberrations, deletions, etc.).

Somatic effects develop in a person exposed to radiation, and genetic (hereditary changes) in his descendants.

Exposure levels at work are normalized by the amount of MPD absorbed in the human body in the course of its professional activity. In recent years, a value equal to 5 ber/year was adopted as the traffic limit. It remains to this day.

The radiation safety standards are established separately for the working and restricted part of the population, taking into account the difference in the physical parameters of the influencing radiation (levels, quality, etc.), the age composition of the irradiated contingent. At the same time, single concepts are used to characterize normative levels: MPD – normative level of occupational exposure and MPD – normative level of radiation exposure to the organic part of the population.

"Critical organ" is an organ, tissue or system responsible for the end of the disease occurring at a given dose of radiation. Therefore, with sufficiently large doses (more than 10 Gr), not only hematopoietic organs, but also other organs of the body system can become a critical organ.

2.3. Tests for preparation for classes:

1. The third group of "critical" bodies includes:
A. Red bone marrow
B. Kidneys
C. Skin
D. The lens of the eye
E. Muscles
2. Somatic effects differ depending on the dose:
A. 4-5 Rad
B. 1.0 Gr
C. 6 Gr
D. 5 Ber
E. 10 Bk
3. What is included in the atomic nucleus?
A. Protons
B. Electrons
C. Positrons
D. Protons and neutrons
E. All of the above

2.4. Control testing at the beginning of the lesson:

1. Traffic regulations for group "A" are for a year:

A. 0.5 Ber
B. 1.5 Ber
C. 5.0 Ber
D. 10.0 Ber
E. 3.5 Ber

2. Traffic regulations for group "B" are for a year:
A. 0.5 Ber
B. 1.5 Ber
C. 5.0 Ber
D. D. 10.0 Ber
E. 3.5 Ber

3. The unit of measurement of PD is:
A. Ber
B. X-ray
C. Gray
D. Sievert
E. Curie

3. Formation of professional skills and abilities

3.1. Calculation of the dose of ionizing radiation (situational task) - example:

Determine the approximate dose of radiation and the degree of severity of acute radiation sickness caused by external uniform radiation when the victim A. has the following clinical signs: latent period - 30 days; in the blood: leukocytes – 3·109/l, platelets – 100·109/l, agranulocytosis and thrombocytopenia were not observed.

A. The correct answer is an irradiation dose of 7-8 Gr.
B. Irradiation dose – 2-4 Gr
S. Radiation dose – 8-10 Gr
D. Irradiation dose – 5-6 Gr
E. Irradiation dose – 1-2 Gr

3.2. Materials for final control during the lesson

Carrying out final control:

1. The victim S., as a result of external uniform irradiation, developed the following clinical signs during the initial reaction: repeated vomiting, general weakness, headache, mild transient hyperemia of the skin and visible mucous membranes, body temperature in the range of 37.0-37.5° C, gastrointestinal disorders. Determine the approximate radiation dose.

A. Irradiation dose – 1-2 Gr
B. Irradiation dose – 2-4 Gr
C. Irradiation dose – 5-6 Gr
D. Irradiation dose – 7-8 Gr

E. Irradiation dose – 8-10 Gr

2. In patient N., as a result of uniform external irradiation, the following clinical signs are determined during the peak of the disease: the duration of the latent period is 8-17 days; in the clinical picture – bleeding, hair loss, infectious complications; in the blood - the number of leukocytes - 0.5·109/l, the number of platelets <30·109/l, agranulocytosis appeared 8-20 days after irradiation, thrombocytopenia appeared 10-16 days after irradiation, SZE - 40 -80 mm/h.

A. Irradiation dose – 1-2 Gr
B. Irradiation dose – 2-4 Gr
C. Irradiation dose – 5-6 Gr
D. Irradiation dose – 7-8 Gr
E. Irradiation dose – 8-10 Gr

4. Summarizing the results of the lesson (evaluation of work in the lesson of education seekers):

Current evaluation criteria in practical training

Score	Assessment criterion
Excellent «5»	The student is fluent in the material, takes an active part in the discussion and solution of situational clinical problems, confidently demonstrates practical skills during the examination of a sick child and interpretation of clinical, laboratory and instrumental studies, expresses his opinion on the topic, demonstrates clinical thinking.
Good «4»	The student has a good command of the material, participates in the discussion and solution of a situational clinical problem, demonstrates practical skills during the examination of a patient and the interpretation of clinical, laboratory and instrumental research data with some errors, expresses his opinion on the topic of the lesson, demonstrates clinical thinking.
Satisfactory «3»	The student does not have enough material, insecurely participates in the discussion and solution of situational clinical problems, demonstrates practical skills during the examination of the patient and interpretation of clinical, laboratory and instrumental studies with significant errors.
Unsatisfactory «2»	The student does not possess the material, does not participate in the discussion and solution of the situational clinical problem, does not demonstrate practical skills during the examination of the patient and the interpretation of clinical, laboratory and instrumental research data.

5. List of recommended literature

Main:

1. Ovcharenko O.P., Lazar A.P., Matyushko R.P. Basics of radiation medicine. Odesa: Odesa Med. University, 2017. 208 p.
2. Bebeshko V.G., Kovalenko O.M., Bily D.O. Acute radiation syndrome and its consequences. Ternopil: TDMU, 2015. 424 p.

3. Radiation medicine: textbook / D.A. Bazika, G.V. Kulinich, M.I. Pylypenko; under the editorship E. Pylypenka Kyiv: VSV "Medicine", 2018. 232 p.
4. V.A. Vizir, O.V. Demidenko, V.V. Shkolovoy. Radiation damage: educational and methodological guide to practical classes in internal medicine (military therapy) for students of the 5th year of medical faculties / V.A. Vizier, O.V. Demidenko, V.V. Schoolboy Zaporizhzhia: ZDMU, 2019. 63 p.
5. Protection against chemical and radiation damage factors: training. manual for universities / O. E. Levchenko and others. Kyiv, 2015. 404 p.

Practical lesson No. 2-4

Topic: Biological effect of IR.

Acute radiation sickness.

Chronic radiation sickness

Goal: Acquaint applicants with the impact of ionizing radiation on the body, depending on the type of radiation and dose; features of the radiobiological impact of IR on the tissues of the human body; the basics of treatment and preventive measures for the removal of unabsorbed radionuclides from the body and the elimination of incorporated radioactive substances; with acute and chronic radiation sickness.

Basic concepts: biological effect of ionizing radiation on tissues of the human body; acute radiation sickness, chronic radiation sickness – classification, pathogenesis, diagnosis and treatment.

Equipment: educational premises, multimedia equipment, dosimetric and radiological equipment in the radiation diagnostics and therapy department.

Plan:

1. Organizational measures (greetings, verification of those present, announcement of the topic, purpose of the lesson, motivation of higher education seekers to study the topic).

2. Control of the reference level of knowledge

2.1. Knowledge requirements:

- know the definition of the main concepts of the topic;
- know the direct and indirect effects of ionizing radiation on biomolecules;
- to know the conditions of exposure to ionizing radiation, its effects;
- to know the importance of dose, exposure time and type of ionizing radiation in the development of acute and chronic radiation sickness (ARS, CRS);
- to know the forms and degrees of severity of acute radiation sickness.

Skill requirements:

- to be able to diagnose various forms of ARS taking into account the dose, duration and localization of the action of ionizing radiation;
- to be able to diagnose various degrees of severity of CRS taking into account the dose, duration and localization of the action of ionizing radiation;
- to be able to use the algorithm of treatment of ARS and CRS.

2.2. Questions for preparing for the lesson

1. Conditions of exposure to IR, modifying effects.
2. Patterns of distribution, metabolism and action of radionuclides in the body.
3. Effects of IR on organs and tissues.
4. The importance of the characteristics and factors of IR that lead to the development of radiation sickness.
5. Classification of ARS and CRS.
6. Syndromology of the disease.

Reference summary for preparing for the lesson

The biological effectiveness of external exposure to radiation depends to a certain extent on the dose and power, multiplicity (fineness) of irradiation, type of IR, etc. The lighter the particles and the greater their energy, the greater their penetrating power. Weakly penetrating through the skin beta particles and penetrating the epidermis alpha particles cause lesions limited to the place of their contact, while the flow of gamma quanta, protons and electrons penetrates through the entire thickness of the animal or human body. The higher the specific ionization, the greater the biological efficiency.

The biological efficiency of X-ray radiation of 180-300 kV is taken as a unit. For other types of radiation that create a higher ionization density, a coefficient of relative biological efficiency (RBE) has been introduced.

The final radiobiological effect depends on the amount of energy absorbed by the tissues. And the larger the single dose, the faster the impressive effect appears. When exposed to doses of more than 50,000-10,000 R (the lifespan of a gnat is 2 days), the leading factor in the pathogenesis of the lesion is a direct effect on the central nervous system. At doses of 15,000 R and above, death occurs "under the beam" or a few hours after exposure. In the dose range of 1,200-5,000 R (the life span of a gnat is 7 days), the gastrointestinal tract is affected in the clinic of the disease and the mechanism of death. At lower doses (200-1000 R), radiation sickness develops, the main importance in the pathogenesis of which is acquired by disorders of hematopoietic organs, hemorrhagic and infectious lesions.

A decrease in biological efficiency with long-term and fractional irradiation indicates that the body has the ability to regenerate the main part of the affected tissues. A general theory of damage and renewal was proposed at one time by Blair (1952).

The speed of regeneration processes in the body after irradiation is not always constant. It is most pronounced in the dose range that causes mild radiation damage. In both directions from this dose level, the rate of post-radiation recovery slows down. This is due to the fact that when exposed to smaller doses, the number of changes occurring in the body, which encourage the development of restorative processes, decreases. With large doses, on the contrary, biological mechanisms are already disrupted, with the help of which post-radiation recovery is carried out.

In addition, the speed of recovery processes depends on the dose rate (irradiation intensity).

All types of IR cause the formation of electrically charged particles - ions in any substance with which they interact. Ionization and excitation of atoms or molecules of the irradiated liquid are the most important primary physical processes that determine the triggering mechanism of the biological action of radiation.

The transfer of radiation energy to the atoms or molecules of the biosubstrate is only the very first, "physical act of the drama" that takes place in the cell, and then in the tissues and throughout the body. Then comes the next "act", which is called the chemical, or radiation-chemical, stage of radiation damage to the cell.

Primary radiation-chemical changes in molecules are based on 2 mechanisms:

1. Direct action, when a given molecule undergoes changes directly upon interaction with irradiation.
2. Indirect action, when the changed molecule does not directly absorb the energy of the incident radiation, but receives it through transmission from another molecule.

A significant role in the action of IV is played by the water phase of cells and tissues of organisms.

Currently, there is no doubt that in the development of radiation damage in biological objects, the primary activation is carried out with the help of radicals created during the radiolysis of water in the aqueous phases of colloids of cells and tissues.

The H, OH and HO2 radicals created during the radiolysis of water oxidize and reduce various organic compounds. But it can be considered established that in the primary stage of radiation damage, the decisive role belongs to oxidation reactions, and the biological effect is connected with the oxidizing radicals OH and HO2.

The probability of a successful interaction of IR energy quanta with the biosubstrate, i.e., that the ionization act will cause cells, is very small. When explaining this phenomenon, 2 provisions were formulated:

The first of them is the principle of hitting. This principle characterizes the peculiarities of the active agent - the discreteness of energy absorption, the second - takes into account the peculiarities of the irradiated object (cell), its high heterogeneity in physical and functional terms, and therefore the difference in response to the same hit - the principle of the target.

In the course of radiation sickness, 3 periods are distinguished: the period of formation, recovery and results and consequences.

The period of ARS formation, in turn, is divided into 4 phases:

1. Phase of the primary (general) reaction.
2. Phase of feigned clinical well-being (secret, latent phase).
3. The phase of distinct clinical manifestations (phase of inflammation).
4. Early recovery phase.

In addition, ARS is also distinguished by the degree of severity of the lesion:

1. The phase of the primary (general) reaction occurs rather quickly (in the first minutes, hours) and manifests itself in all cases of irradiation, at doses exceeding 2 Gr. There is nausea, vomiting, which worsens after taking liquid, appetite disappears. Sometimes there is dryness and bitterness in the mouth, headache, general weakness, drowsiness. The duration of the phase is 1-3 days.

Unfavorable from a prognostic point of view, signs that cause a very severe course of the disease are the development of a shock-like state with a drop in arterial tics, short-term loss of consciousness, fever, diarrhea.

In the peripheral blood - neutrophilic leukocytosis with a shift to the left, as well as absolute and relative lymphopenia.

2. After 2-4 days, a hidden, or latent, phase occurs, in which there are no clinically visible signs of the disease. Duration - from 14 to 32 days.

Clinical signs include hair loss and neurological symptoms, which gradually subside.

When examining the blood in this phase, there is lymphopenia and a decrease in the number of neutrophils, and later - thrombophiles and reticulocytes. During this period, ovarian atrophy and suppression of spermatogenesis take place.

3. By the end of the latent period, the condition worsens, the disease flare-up phase begins. A hemorrhagic syndrome occurs - hemorrhage into the skin, mucous membranes of the gastrointestinal tract, brain, heart, lungs.

There are solid lymphocytes in the blood. By the end of the phase, anemia is detected and begins to progress.

Patients have a sharp decrease in body weight due to metabolic disorders. In the treatment of patients, the third phase lasts from 1 to 3 weeks, and then, in cases with a favorable outcome, passes into

4. The fourth phase is recovery. Its beginning is characterized by normalization of temperature, improvement of well-being. Bleeding stops, body weight increases. Reticulocytes and young leukocytes, regenerative forms of platelets, already appear in the peripheral blood. But anemia increases up to 5-6 weeks, and then the number of erythrocytes after 2-3 months reaches the initial level.

The recovery phase lasts 2-2.5 months.

CRS is an independent nosological form of radiation damage that develops during long-term irradiation of the body in small doses.

Pronounced CRS syndrome develops with total doses of 0.7-1 Gr and radiation intensity of 0.001-0.005 Gr/day.

There are 3 degrees of CRS: mild, moderate and severe.

The mild form is characterized by easy fatigue and loss of appetite. In the blood - at first a slight increase in the number of leukocytes, then a decrease to 2-4 thousand in 1 mm3.

The second degree is characterized by a wave-like flow. Work capacity is sharply reduced, an unbearable headache is noted. BP decreases. In the blood - a further decrease in the number of leukocytes (below 2 thousand) and platelets, the number of erythrocytes is below normal.

People suffering from the third degree of CRS are seriously ill people who need bed rest. In the blood, the number of leukocytes is below hundreds and even dozens per 1 mm3, the number of erythrocytes is up to 1.5-2 million per 1 mm3, and platelets are up to several thousand. Death occurs with the catastrophic destruction of blood-forming organs, as well as as a result of sepsis, which caused by loss of immunity.

Treatment of CRS is based on the principles of anti-infective and supportive therapy (isolation, systemic antibiotics and replacement transfusions of cellular blood components), and in the case of myelodepression – transplantation of allogeneic bone marrow and human embryonic liver cells.

2.3. Tests for preparation for classes:

1. The most typical form of ARS is:
A. Bone marrow
B. Intestinal
C. Thermal
D. Transitional
E. Cerebral
2. Death in toxic form occurs on:
A. 2-4 days
B. 4-8 days
C. 10-12 days
D. 12-14 days
E. 14-16 days
3. The number of leukocytes in the blood for 3-6 days in the latent period of the III degree is (G/l):
A. 1.0-0.8 g/l
B. 0.8-0.5 g/l
C. 0.5-0.3 g/l
D. 0.1-0.2 g/l
E. 0.01-0.05 g/l

2.4. Control testing at the beginning of the lesson:

1. What is the leading feature in characterizing all degrees of severity of ARS?
A. General weakness
B. Body temperature
C. Headache
D. Vomiting
E. Hyperemia of the skin
2. According to the clinical course, the following degrees of severity of CRS are distinguished:
A. 1,2,3 stages
B. 1,2,3,4 stages
C. 1,2,3,4,5 stages
D. 1,2,3,4,5,6 stages
E. 1-10 stages
3. How long is the period of the first clinical manifestations (initial period) of ARS depending on the severity of the disease, respectively:
A. 3-5 minutes
B. 30 minutes - 1 hour
C. 1-3 hours
D. 3 hours - 1 day
E. 30 min - 3 days

3. Formation of professional skills and abilities

3.1. Determination of the form of acute radiation sickness (situational task) - example:

During the period of severe radiation sickness, patient S. had profuse diarrhea. The tongue is coated with a white coating, there is an ulcer on the mucous membrane of the mouth, the stomach is soft, and there is rumbling on palpation. Establish a form of radiation sickness.
A. Intestinal is the correct answer
B. Toxic
C. Cerebral
D. Bone marrow
E. Transitional

3.2. Materials for final control during the lesson

Carrying out final control:
1. Patient V. had severe radiation sickness and pain in his mouth. The opening of the mouth is incomplete, chewing and swallowing are severely impaired, the mucous membranes of the oral cavity are hyperemic, covered with viscous mucus and pus, and there are a large number of ulcers. Establish a form of radiation sickness.
A. Toxic
B. Intestinal
C. Ulcerative-necrotic radiation stomatitis
D. Bone marrow
E. Cerebral
2. Sick G., researcher. It was irradiated for 10 seconds with 48-cobalt rods 80 mm high and 9 m in diameter. The total activity was 36 kg-eq. glad After 2 hours - general weakness, dizziness, repeated vomiting, temperature 37.6°C, skin with hyperemia, sclera yellow, tongue moist. In the following days - general weakness, retardation, absence of peritoneal reflexes, decreased appetite, temperature rise to 38°C, intense hair loss in the frontal-temporal area. Diagnosis of the disease.
A. ARS I degree
B. ARS II degree
C. Intestinal form of ARS
D. ARS III degree
E. Toxic form of ARS
3. Sick P., a mechanic for adjusting the electronic engine. The total dose for 8 years of work is 24.8 Ber. During the examination, he complains of a headache, poor appetite. An objective study did not reveal any changes in the state of health. Picture of peripheral blood and bone marrow without deviations from the norm. Make a diagnosis.
A. ARS of a mild degree
B. ARS of moderate degree
C. CRS of the first degree
D. CRS II degree
E. ARS of severe degree

4. Summarizing the results of the lesson (evaluation of work in the lesson of education seekers):

Current evaluation criteria in practical training

Score	Assessment criterion
Excellent «5»	The student is fluent in the material, takes an active part in the discussion and solution of situational clinical problems, confidently demonstrates practical skills during the examination of a sick child and interpretation of clinical, laboratory and instrumental studies, expresses his opinion on the topic, demonstrates clinical thinking.
Good «4»	The student has a good command of the material, participates in the discussion and solution of a situational clinical problem, demonstrates practical skills during the examination of a patient and the interpretation of clinical, laboratory and instrumental research data with some errors, expresses his opinion on the topic of the lesson, demonstrates clinical thinking.
Satisfactory «3»	The student does not have enough material, insecurely participates in the discussion and solution of situational clinical problems, demonstrates practical skills during the examination of the patient and interpretation of clinical, laboratory and instrumental studies with significant errors.
Unsatisfactory «2»	The student does not possess the material, does not participate in the discussion and solution of the situational clinical problem, does not demonstrate practical skills during the examination of the patient and the interpretation of clinical, laboratory and instrumental research data.

5. List of recommended literature

Main:

1. Ovcharenko O.P., Lazar A.P., Matyushko R.P. Basics of radiation medicine. Odesa: Odesa Med. University, 2017. 208 p.
2. Bebeshko V.G., Kovalenko O.M., Bily D.O. Acute radiation syndrome and its consequences. Ternopil: TDMU, 2015. 424 p.
3. Radiation medicine: textbook / D.A. Bazika, G.V. Kulinich, M.I. Pylypenko; under the editorship E. Pylypenka Kyiv: VSV "Medicine", 2018. 232 p.
4. V.A. Vizir, O.V. Demidenko, V.V. Shkolovoy. Radiation damage: educational and methodological guide to practical classes in internal medicine (military therapy) for students of the 5th year of medical faculties / V.A. Vizier, O.V. Demidenko, V.V. Schoolboy Zaporizhzhia: ZDMU, 2019. 63 p.
5. Protection against chemical and radiation damage factors: training. manual for universities / O. E. Levchenko and others. Kyiv, 2015. 404 p.

Practical lesson No. 5-7

Topic: Long-term consequences of IP.

Medical, social, ecological and psychological aspects of large-scale accidents at nuclear plants

Medical, social, ecological and psychological aspects of large-scale accidents at nuclear plants

Goal:

1. General purpose:

To acquaint miners with the long-term consequences of ionizing radiation based on the assessment of sanitary and hygienic conditions after a large-scale accident at the Chernobyl nuclear power plant. To form the ability to make a forecast in relation to the size and distribution of the effects of radiation damage, the impact of small doses of ionizing radiation and remote consequences; to form the skills of medical, social, ecological and psychological protection and prevention and treatment of radiation injuries.

Basic concepts: Radionuclides, half-life periods, remote effects of radionuclides on different population groups; radioactive contamination of the environment in the event of an accident at a nuclear power plant.

Equipment: educational premises, multimedia equipment, dosimetric and radiological equipment in the radiation diagnostics and therapy department.

Plan:

1. Organizational measures (greetings, verification of those present, announcement of the topic, purpose of the lesson, motivation of higher education seekers to study the topic).

2. Control of the reference level of knowledge

2.1. Knowledge requirements

- know the definition of the main concepts of the topic;
- to know the properties of radionuclides;
- know the types of radiation accidents.

Skill requirements:

- be able to calculate reactions of radioactive transformations;
- to be able to sort the persons evacuated from the radiation exposure zone according to groups of primary form;

2.2. Questions for preparing for the lesson

1. Radiobiological characteristics of radionuclides entering the environment during nuclear accidents.
2. The nature of the impact of radionuclides on different population groups.
3. Radioactive pollution of the environment during accidents at nuclear power plants.
4. General consequences after the accident at the nuclear power plant.

Reference summary for preparing for the lesson

In a broad sense, it is customary to call radiation accidents events associated with the loss of control over the source of IR, as a result of which radioactive products escape protective barriers in an amount that exceeds the established standards and can lead to exposure of personnel, and in certain circumstances part of the population.

If cases are related to damage to the heat-dissipating elements of a nuclear reactor, caused, for example, by a violation of control and management of the chain reaction of pressure in the reactor core or heat removal from heat-dissipating elements, and are accompanied by accidental exposure of people, they are usually called nuclear accidents.

As a result of the most serious radiation accidents, RRs are released into the environment from the damaged AER in the form of gases and aerosols that form a radioactive cloud. This cloud, moving in the atmosphere in the direction of the wind, causes radioactive pollution as a result of the fall of RR from the cloud, called the cloud trail.

According to the limit of spread of released radioactive substances and radiation consequences, accidents are divided into 3 types:

1. **Local accident**is an accident, the radiation consequences of which can be limited to one room or building, and in which there is a possibility of exposure of personnel and contamination of rooms and buildings located on the territory of the station above the levels established for normal operation.
2. **Local accident**- radioactive consequences are limited to the buildings and territory of the NPP and in which exposure of personnel and contamination of buildings and structures located on the territory of the station above the levels established for normal operation are possible.
3. **General accident**– radiation effects spread beyond the territory of the NPP and lead to population exposure and environmental pollution above all established levels.

According to different levels of radioactive contamination and the degree of danger to the population, zones of moderate (A), strong (B), dangerous (B), especially dangerous (D) contamination, as well as zone M (zone of radiation danger) are distinguished.

The zone of radiation danger is a section of the contaminated area, within which the radiation dose in the open area will be from 5 to 50 rads per year. The zone of moderate pollution is characterized by a radiation dose of 50 to 500 rads per year. In the zone of strong radioactive radiation, radiation doses in the area range from 500 to 1500 rads per year. The zone of dangerous radioactive contamination is characterized by a dose of 1,500 to 5,000 rads per year, and in the zone of particularly dangerous radioactive contamination, radiation doses will amount to more than 5,000 rads per year.

As a result of general radiation accidents, as was the case at the Chernobyl NPP, radioactive materials are released into the environment in the form of heated gases and aerosols from a damaged nuclear power plant (xenon, krypton are noble gases that do not accumulate in the body and quickly dissipate). Radioactive aerosols

emitting beta particles irritate the mucous surface of the respiratory tract, the oral cavity, the conjunctiva of the eyes, and the skin, causing people to feel a metallic taste in the mouth and tingling of the skin. However, these isotopes do not pose a serious danger to human life and health in quantities insufficient for intensive external irradiation.

The real danger is the entry into the body of those few radioactive isotopes, which, due to their solubility in water and body fluids, are able to get inside, into its tissues, and then selectively accumulate in them and cause local internal irradiation until their complete disintegration or removal from the body . These isotopes include radioactive iodine-131, strontium-90, and cesium-137.

Iodine-131 has a half-life of 8.08 days, that is, it decays relatively quickly. However, in the period after the radiation accident, it accounts for a significant part - up to 40-50% of the total radioactivity. In the human body, up to 43% of received iodine-131 accumulates in the thyroid gland, creating a local high dose in it.

Strontium-90 has a longer half-life - 28 years. It settles in the skeleton, it is very difficult and slowly removed. With a very large accumulation in the bones, long-term local radiation can be created, which is a potential danger in relation to the occurrence of osteosarcoma after many years.

Cesium-137 (half-life - 30 years) chemically similar to potassium. Entering the body with vegetable food, it is evenly distributed in soft tissues: muscles, liver, nervous system, being present in every living cell. Sources of cesium are vegetable (bread, vegetables, fruits) and animal products (meat, milk).

The biggest radio-ecological disaster of our time happened in Ukraine, in Chernobyl.

Already during the first 10 days after the accident, the direction of the wind changed by 36 degrees, actually describing a complete circle. This caused the contamination of large areas with radionuclides. Where it rained at that time, "stains" of radioactive pollution were formed.

The formation of the main part of the radioactive fallout ended in the first 4-5 days. However, the full formation of the radioactive "trace" and "spots" continued throughout May.

The generalized gamma radiation dose power map became the basis for making many decisions. It was along this line that the evacuation isolines of the population were finally determined: the zone of exclusion (20 mr/h), the resettlement zone (more than 5 mr/h) and the zone of strict control (3-5 mr/h) with the temporary resettlement of part of the population (pregnant women, children).

Exclusion zone It has an area of 982 km2, the Pripyat NPP, 15 settlements, 4,697 yards and 4 collective farms, 9 industrial enterprises, and 11 educational institutions are located on its territory. 62,852 people lived there.

Settlement zone (evacuations) has an area of 3300 km2, 23 settlements, 9 thousand yards, 5 collective farms, 8 industrial enterprises, 27 educational institutions were located on it. The population was 93 thousand people.

Zone of strict control has an area of 1,500 km2, on which 86 settlements, 3,000 yards, 22 collective farms, 16 industrial enterprises, and 40 educational institutions are located. The population is more than 46,000 people.

During the accident at the Chernobyl nuclear power plant, conditions arose when radioactive products could enter water bodies both through direct deposition on the water surface and through runoff from the contaminated area, as well as through migration with groundwater. In the first weeks and months of the accident, the most important thing was to find out the degree of pollution of the Pripyat River and the Kyiv Reservoir - sources of supply to the city of Kyiv.

2.3. Tests for preparation for classes:

1. The half-life of Sr90 is:
A. 8.3 days
B. 8 days
C. 28 days
D. 10 months
E. 25 minutes
2. The half-life of Au198:
A. 6 hours
B. 3 days
C. 8.3 days
D. 30 days
E. 30 minutes
3. How many people lived in the territory of the "voluntary and mandatory population" after the Chernobyl NPP accident?
A. 100
B. 1000
C. 20 thousand
D. 50 thousand
E. 93 thousand

3. Formation of professional skills and abilities

3.1. Calculate the drop in radiation when the distance from the source to the irradiated object is increased? (situational task) - example:

In which case will there not be a significant drop in radiation when the distance from the source to the irradiated object is increased?

A. From 1 cm to 5 cm is the correct answer
B. 5 cm to 25 cm
C. 20 cm to 50 cm
D. From 15 cm to 75 cm
E. From 20 cm to 100 cm

3.2. Materials for final control during the lesson

Carrying out final control:

1. What is the area of the radioactively contaminated "exclusion zone" after the accident at the Chernobyl nuclear power plant?
A. 1500 km2
B. 200 km2

C. 3300 km2
D. 150 km2
E. 982 km2
2. How many people live in the territory of enhanced radio-ecological control?
A. 5 thousand
B. 10 thousand
C. 15 thousand
D. 36 thousand
E. 46 thousand
3. How many people were registered with the established diagnosis of "BPH" after the Chernobyl nuclear power plant?
A. 500
B. 1000
C. 145
D. 250
E. 700

4. Summarizing the results of the lesson (evaluation of work in the lesson of education seekers):

Current evaluation criteria in practical training

Score	Assessment criterion
Excellent «5»	The student is fluent in the material, takes an active part in the discussion and solution of situational clinical problems, confidently demonstrates practical skills during the examination of a sick child and interpretation of clinical, laboratory and instrumental studies, expresses his opinion on the topic, demonstrates clinical thinking.
Good «4»	The student has a good command of the material, participates in the discussion and solution of a situational clinical problem, demonstrates practical skills during the examination of a patient and the interpretation of clinical, laboratory and instrumental research data with some errors, expresses his opinion on the topic of the lesson, demonstrates clinical thinking.
Satisfactory «3»	The student does not have enough material, insecurely participates in the discussion and solution of situational clinical problems, demonstrates practical skills during the examination of the patient and interpretation of clinical, laboratory and instrumental studies with significant errors.
Unsatisfactory «2»	The student does not possess the material, does not participate in the discussion and solution of the situational clinical problem, does not demonstrate practical skills during the examination of the patient and the interpretation of clinical, laboratory and instrumental research data.

5. List of recommended literature

Main:

1. Ovcharenko O.P., Lazar A.P., Matyushko R.P. Basics of radiation medicine. Odesa: Odesa Med. University, 2017. 208 p.
2. Bebeshko V.G., Kovalenko O.M., Bily D.O. Acute radiation syndrome and its consequences. Ternopil: TDMU, 2015. 424 p.
3. Radiation medicine: textbook / D.A. Bazika, G.V. Kulinich, M.I. Pylypenko; under the editorship E. Pylypenka Kyiv: VSV "Medicine", 2018. 232 p.
4. V.A. Vizir, O.V. Demidenko, V.V. Shkolovoy. Radiation damage: educational and methodological guide to practical classes in internal medicine (military therapy) for students of the 5th year of medical faculties / V.A. Vizier, O.V. Demidenko, V.V. Schoolboy Zaporizhzhia: ZDMU, 2019. 63 p.
5. Protection against chemical and radiation damage factors: training. manual for