RADIATION DAMAGE. THE CONCEPT OF RADIATION INJURY, MEDICAL CARE AT THE STAGES OF MEDICAL EVACUATION. ACUTE RADIATION SICKNESS. STAGE TREATMENT OF PATIENTS WITH ACUTE RADIATION SICKNESS. ATYPICAL FORMS OF RADIATION SICKNESS

Methodical instructions
for the 5th year students to the practical class

МІНІСТЕРСТВО ОХОРОНИ ЗДОРОВ’Я УКРАЇНИ
Харківський національний медичний університет

RADIATION DAMAGE. THE CONCEPT OF RADIATION INJURY, MEDICAL CARE AT THE STAGES OF MEDICAL EVACUATION. ACUTE RADIATION SICKNESS. STAGE TREATMENT OF PATIENTS WITH ACUTE RADIATION SICKNESS. ATYPICAL FORMS OF RADIATION SICKNESS

Methodical instructions
for the 5th year students to the practical class

РАДІАЦІЙНІ УРАЖЕННЯ. ПОНЯТТЯ ПРО ПРОМЕНЕВУ ТРАВМУ, НАДАННЯ МЕДИЧНОЇ ДОПОМОГИ НА ЕТАПАХ МЕДИЧНОЇ ЕВАКУАЦІЇ. ГОСТРА ПРОМЕНЕВА ХВОРОБА. ЕТАПНЕ ЛІКУВАННЯ ХВОРИХ З ГОСТРОЮ ПРОМЕНЕВОЮ ХВОРОБОЮ. АТИПОВІ ФОРМИ ПРОМЕНЕВОЇ ХВОРОБИ

Методичні вказівки
для здобувачів вищої освіти V року навчання
до проведення практичного заняття

Затверджено
Вченою радою ХНМУ
Протокол № 10 від 21.12.2022.

Харків
ХНМУ
2022

Radiation damage. The concept of radiation injury, medical care at the stages of medical evacuation. Acute radiation sickness. Stage treatment of patients with acute radiation sickness. Atypical forms of radiation sickness : methodical instructions for the 5th year students to the practical class / comp. B. Shelest, D. Martovytskyi, A. Melenevych, D. Molotyagin. Kharkiv : KhNMU, 2022. 16 p.

Compilers B. Shelest
D. Martovytskyi
A. Melenevych
D. Molotyagin

Радіаційні ураження. Поняття про променеву травму, надання медичної допомоги на етапах медичної евакуації. Гостра променева хвороба. Етапне лікування хворих з гострою променевою хворобою. Атипові форми променевої хвороби : метод. вказ. для здобувачів вищої освіти V року навчання / упоряд. Б.О. Шелест, Д.В. Мартовицький, А.Я. Меленевич, Д.Г. Молотягін. Харків: ХНМУ, 2022. 16 с.

Упорядники Б.О. Шелест
Д.В. Мартовицький
А.Я. Меленевич
Д.Г. Молотягін

Topic 1: «Radiation damage. The concept of radiation injury, medical care at the stages of medical evacuation. Acute radiation sickness. Stage treatment of patients with acute radiation sickness. Atypical forms of radiation sickness»

1. **Hours:** 5.

2. **Importance of the topic:**

Radioactivity and the accompanying ionizing radiation existed on Earth long before life began on it. But humanity, like all living things in general, has not previously been exposed to high doses of ionizing cures: in the process of evolution, neither the specific organs of perception of this type of impact, nor adaptive defense mechanisms have been formed. In recent decades, man has created hundreds of artificial radionuclides and learned to use atomic energy for a variety of purposes: to treat and create atomic weapons, to produce energy, and to make glowing clock faces. All this leads to an increase in the radiation dose of both individuals and the population of the Earth as a whole.

Over time, fear of radiation began to emerge. It is believed that at high doses, radiation causes severe tissue damage, and at low doses can cause cancer and induce genetic defects. Significantly, the variety of secondary effects themselves makes it very difficult to analyze the degree of harmfulness of radioactivity and to establish relatively simple criteria for determining biologically hazardous levels of radiation. As a result, the topic of radiation pollution has now become the most "voiced" in the media, and not always correctly.

Knowledge of the effects of ionizing radiation on humans, measures to protect against them, and treatment of victims is the best antidote to fear. It is important to imagine the point where radiation becomes really life threatening.

The urgency of the problem is connected not only with the adverse effects of radioactive radiation on the body of professionals who are systematically exposed to additional radiation in the course of work, but also with the study of the consequences of radioactive contamination of the area. The area of radionuclide contamination is quite large as a result of the Chernobyl explosion. In addition, there are cases of safety violations when working with radioactive substances, which leads to pathological changes in the civilian population. At the same time, scientific data on the effects of radiation, especially small doses, on the body are not well known to doctors of various specialties, and the flow of information on this issue in the pages of popular publications is often far from the truth.

3. **Aim of studying:** The aim of this theme is be able to expansion and deepening of students' general and medical horizons of knowledge, development of clinical thinking skills, continuation of the formation of the doctor's personality, training of medical professionals to work in emergencies associated with adverse radioactive situations.

Specific objectives to be achieved after conducting practical classes:

Students need to know:	Students will be able to:
1. Basic units and methods of measuring ionizing radiation. 2. Classification of radiation damage as a result of external irradiation. 3. Mechanism of biological action of ionizing radiation. 4. Clinical forms and characteristics of radiation injuries as a result of external irradiation. 5. Maximum permissible doses of radiation that do not cause pathology in the body	1. Diagnose radiation injuries as a result of external (total) irradiation. 2. To diagnose radiation damage under the influence of neutrons. 3. Treat acute local radiation injuries. 4. Treat combined radiation injuries. 5. Provide emergency aid for radiation attack.

4. **Indicative syllabus**

- Signs and symptoms of radiation damage
- Causes
- Pathophysiology
- Diagnosis
- Classification
- Differential diagnosis
- Prevention
- Management. Treatment of local and combined radiation injuries.
- Prognosis

5. Material and methodological support: Visual material, multimedia devices, visual material prepared presentations of Microsoft Power Point, tables, posters. Training manuals. Regulations Ministry of Health. Special patient.

6. Materials for practical classes:

The word radiation comes from the Latin radiatio – radiance, brilliance, and formally means any radiation. However, historically, this term refers to a more specific type of radiation – ionizing.

Ionizing radiation is the radiation of radioactive rays, which, when interacting with a substance, transmit energy to it, causing the ionization of atoms or molecules. The separation of an electron from an atom or molecule is called ionization. This leads to damage to their structure and the formation of free radicals, which play the role of oxidants and have increased reactivity.

All radiations are divided into two classes:

- corpuscular:

- alpha radiation (α)
- beta radiation electrons (β-)
- positrons (β +)
- protons (P ')
- neutrons (n°) and others (over 200 species)

- electromagnetic (photonic):

- quantum gamma (γ)
- X-rays

Each type of radiation has the following properties:

1) energy;
2) penetrating ability in air and matter;
3) thermal (ability to turn into heat);
4) ionizing (the ability to form a certain number of ion pairs when interacting with atoms of the medium);
5) biological (ability to cause changes in structural-metabolic and functional biological substrates: from the molecular level to the organism);
6) photochemical (ability to activate molecules of silver bromide or other chemical compounds);
7) luminescent (ability to glow).

A common property of nuclear radiation is the ability to cause excitation and ionization of atoms and molecules of the medium through which they pass (air, water, biological tissues). In this case, part of the radiation energy is absorbed by these media. The measurement of radiation doses is based on this property.

Dose is the energy transferred by ionizing radiation to an elementary volume or mass of an irradiated substance. The unit of kinetic energy in the international system of units is joule (J). In the SDS system, energy is measured in ergs or electron volts (eV).

Dosimetry is the measurement of the dose or rate of radiation radiation (i.e., dose per unit of time). Currently, the following radiation doses are distinguished.

The absorbed dose is the amount of ionizing radiation energy absorbed by the irradiated body (body tissues), calculated per unit mass. The SI unit of absorbed dose is joule per kilogram (J/kg), with the special name gray (Gy): 1 Gy = 1 J/kg.

Rad, equal to 0.01 Gy, is used as an off-system (traditional) unit. For human soft tissues in the field of X-ray or gamma radiation, the absorbed dose of 1 rad approximately corresponds to the exposure dose of 1 P (more precisely, 1 P = 0.93 rad). But this value does not take into account the fact that with the same absorbed dose, alpha radiation is much more dangerous than β – or γ – radiation.

If we take this fact into account, then the dose should be multiplied by a coefficient reflecting the ability of this type of radiation to damage the tissues of the body. The dose recalculated in this way is called the equivalent dose. It is measured in SI system in sievert (Sv, Sv) – one sievert corresponds to an absorbed dose of 1 J/kg (for X-ray, γ- and β-radiation). The non-systemic unit is rem, it is equal to 0.01 Sv. The equivalent dose is a measure for assessing the damage to human health due to the action of ionizing radiation.

An effective equivalent dose is an equivalent dose multiplied by a factor that takes into account the different sensitivity of different tissues to radiation. There are radiation risk coefficients for different tissues (organs) of a person with uniform irradiation of the whole body: 0.12 – red bone marrow and lungs; 0.03 – bone tissue and thyroid gland; 0.15 – mammary gland; 0.25 – sex glands; 0.30 – other fabrics. The effective equivalent dose reflects the total effect of radiation on the body and is also measured in sieverts.

These terms describe only the individually received doses.

To characterize the energy of ionizing radiation, the so-called exposure dose is used. The exposure dose is the total electric charge of ions of the same sign, formed in the air during irradiation (the amount of ionization created by X-ray or gamma radiation). The unit of exposure dose in the SI system is the coulomb per kilogram (C/kg), off-system – X-ray (P, R), 1 P = 2.58 × 10 C/kg, 1 C/kg = 3.786 × 10^3R.

Features of the action of ionizing radiation are as follows:

- a person does not have any sensations at the moment of the direct influence of ionizing radiation;
- the biological effect is directly proportional to the dose rate;
- instantaneous absorption of the energy of ionizing radiation by atoms and molecules, which significantly exceeds the rate of chemical interaction between them;
- lack of selective influence on certain morphological elements (radiation can interact with any atoms and molecules of the body);
- simultaneous action on different structures of the body (cells, tissues, organs), which is due to its penetrating ability;
- the presence of a radiobiological paradox – a discrepancy between an extremely small amount of absorbed energy of ionizing radiation and an extremely pronounced (up to a lethal effect) response of the body to it;
- different types of ionizing radiation cause the ionization process, but their biological effect depends on the ionization density (at low density, rapidly fading reactions occur, and at high density, a reaction with self-acceleration arises and leads to pronounced biological changes; the highest ionization density is characteristic of alpha particles and neutrons).

Impact of ionizing radiation on body tissues Red bone marrow and other elements of the hematopoietic system are most vulnerable and lose their ability to function normally even at doses of 0.5–1 Gy. Fortunately, they also have a remarkable ability to regenerate, and if the radiation dose is not so great as to cause damage to all cells, the hematopoietic system can fully restore its functions. If not the whole body was exposed to radiation, but some part of it, then the surviving brain cells are enough to completely replace the damaged cells.

Reproductive organs. Testicular cells are at different stages of development. The most radiosensitive cells are spermatogonia, the most radioresistant are spermatozoa. After a single irradiation with a dose of 0.15 Gy, the sperm count may decrease. After irradiation at a dose of 3.5–6 Gy, permanent sterility occurs. In this case, the testes are the only exception to the general rule: the total dose of radiation received in several doses is more, and not less dangerous, for them than the same dose received in one dose.

The ovaries are less sensitive to radiation, at least in adult women. But the effect of a single irradiation at a dose of 1–2 Gy on both ovaries causes temporary infertility and cessation of menstruation for 1–3 years. In case of acute irradiation in the dose range of 2.5–6 Gy, persistent infertility develops. Although even higher doses with fractional irradiation do not affect fertility in any way.

Clinical manifestations

The gastrointestinal tract. The gastrointestinal syndrome leading to death under irradiation with doses of 10–100 Gy is mainly due to the radiosensitivity of the small intestine. Further, according to the decrease in radiosensitivity, the oral cavity, tongue, salivary glands, esophagus, stomach, rectum and colon, pancreas, and liver follow.

The cardiovascular system. In vessels, the outer layer of the vascular wall is more radiosensitive, which is explained by the high content of collagen, a protein of connective tissue, which ensures the performance of stabilizing and supporting functions. The heart is considered a radioresistant organ, however, with local irradiation in doses of 5–10 Gy, changes in the myocardium can be detected. At a dose of 20 Gy, endocardial damage is noted.

Respiratory system. The lungs of an adult are a stable organ with low proliferative activity; therefore, the consequences of lung irradiation do not appear immediately. With local irradiation, radiation pneumonia can develop, accompanied by the death of epithelial cells, inflammation of the airways, pulmonary alveoli and blood vessels. These effects can cause lung failure and even death within a few months after chest irradiation. With a single exposure to gamma radiation, the LD50 for a person is 8–10 Gy.

Urinary system. The effect of radiation on the kidneys, with the exception of high doses, appears late. Irradiation in doses exceeding 30 Gy over 5 weeks can lead to the development of chronic nephritis.

The organ of vision. The most vulnerable part of the eye is the lens. Dead cells become opaque, and the growth of clouded areas leads first to cataracts, and then to blindness. Clouded areas can form with radiation doses of 2 Gy, and progressive cataracts – about 5 Gy. The most dangerous in terms of cataract development is neutron irradiation.

Nervous system. The nervous tissue is highly specialized and, therefore, radioresistant. The death of nerve cells is observed at radiation doses above 100 Gy.

Endocrine system. Endocrine glands are characterized by a low rate of cell renewal and in adults they are normally relatively radioresistant, but in a growing or proliferative state they are much more radiosensitive.

Musculoskeletal system. In adults, bone, cartilage and muscle tissues are radioresistant. However, in the proliferative state (in childhood or during the healing of fractures), the radiosensitivity of these tissues increases. The highest radiosensitivity of skeletal tissue is characteristic of the embryonic period (38–85 days of intrauterine development).

Classification:

1. By etiological factor, taking into account:

- type of radiation (gamma, neutron, X-ray, alpha, beta, etc.), its energy and dose.

- localization of the source (external – from a remote source, as well as when applying radioactive substances to the skin and mucous membranes; internally – when incorporating radioactive isotopes);

- dose distribution over time (short-term, prolonged, fractionated).

2. Clinical classification of acute radiation injuries:

• By prevalence:

- general radiation damage to the body;
- combination with a pronounced lesion of a certain part of the body;
- local radiation damage:
- early radiation reaction
- radial alopecia
- acute bullous dermatitis
- acute necrotic

• According to the severity and clinical form of radiation sickness:

1) the bone marrow form of ARS develops in the dose range from 1 Gy to 10 Gy and is divided into degrees:

- I degree, develops after exposure in the dose range (in Gray 30 %; 1 Gray = 100 rad) 1 ... 2 Gray (abbreviated as "Gr");
- II degree – 2 ... 4 Gy;
- III degree – 4 ... 6 Gy;
- IV degree – 6 ... 10 Gy.

2) intestinal form of ARS (10 ... 20 Gy);

3) vascular-toxemic form (20 ... 80 Gy);

4) cerebral form (at doses over 80 Gy).

At irradiation doses from 0.25 to 0.5 Gy, one speaks of a "state of over-exposure", and at doses from 0.5 to 1 Gy, when there may be mild manifestations of functional disorders and a moderate reaction from the blood – of "radiation reaction".

In the course of the disease, there are:

- initial period (primary reaction);
- latent (latent) period;
- peak period;
- recovery period. In addition, there are:
- local radiation damage (MCI)
- concomitant radiation injuries (PSA)
- combined radiation damage (CRP).

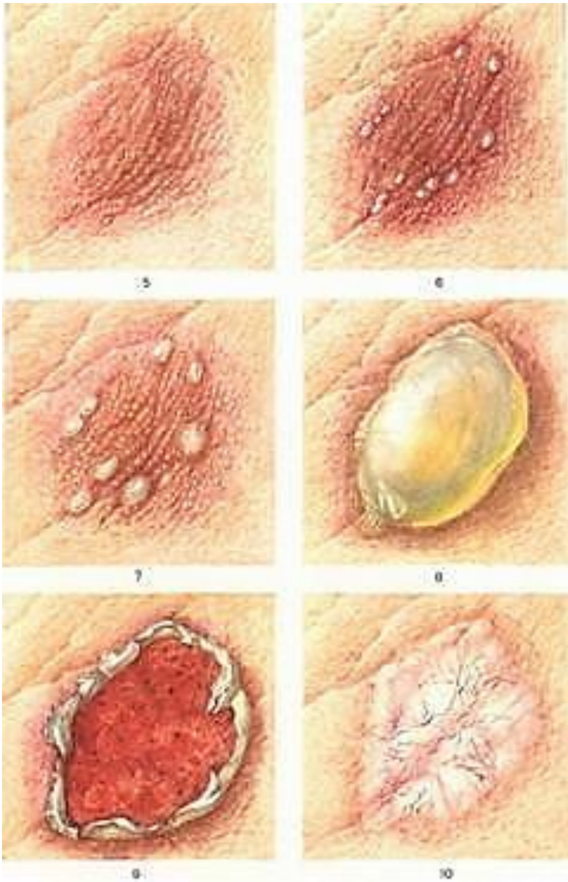
Treatment of radiation injuries

Early radiation reaction and radiation alopecia do not require treatment.

In acute erythematous radiodermatitis, corticosteroid ointments are prescribed to the erythema areas 2–3 times a day. On wet areas, apply lotions with a 2 % solution of boric acid or furacilin. The crust is covered with applications of creams that contain lanolin, peach or olive oil and distilled water in equal proportions, vitamins A, E. All local procedures are applied 3–4 times a day.

In acute bullosa radiodermatitis, diuretics are prescribed to reduce edema, with significant inflammation and a large area of lesions, corticosteroids are administered orally. After elimination of the inflammatory process, the dose of steroids is reduced and further the drug is canceled. Prescribed drugs that strengthen the vascular wall, improve microcirculation, trophism: prodectin, theonikol, solcoseryl, troxevasin. Topically used applications of creams with olive or peach oil, fluoride, corticosteroid ointments or aerosols "Polcortolone", "Oxycort" and others. Significant ulcerative defects are treated surgically. Periodically, preventive therapeutic measures are carried out in order to prevent late radiation complications from the skin.

In the treatment of patients with chronic radiodermatitis, angioprotectors (parmidin, theonikol), venotonics (troxevasin, venoruton), vitamins (A, B6, E, C) are prescribed. A good effect is given by periodic courses of solcoseryl injections. Local therapy is carried out: constant application of creams with vitamin A; at the site of hyperkeratosis 1–2 % salicylic cream; for warty growths – 10 % milk-Salicylic collodion "Ureaplast". Treatment-resistant trophic ulcers are incised with the following plasty.



Treatment of acute radiation sickness is carried out in a comprehensive manner, taking into account the form, period of the disease, severity and is aimed at stopping the main syndromes of the disease. It should be remembered that only the bone marrow form of ARS can be treated, the therapy of the most acute forms (intestinal, vascular toxaemic and cerebral), in terms of recovery, is not yet effective all over the world.

Emergency measures are carried out for radiation injuries during the period of the primary reaction to radiation, the development of intestinal and cerebral syndromes, for health reasons with combined radiation injuries, as well as when radioactive substances get inside.

With irradiation in doses (10–80 Gy) causing the development of intestinal or vascular-toxemic forms of acute radiation sickness, symptoms of intestinal damage, the so-called early primary radiation gastroenterocolitis, begin to come to the fore during the period of the primary reaction. The complex of emergency care in these cases should consist mainly of means of combating vomiting and dehydration of the body. When vomiting occurs, the use of dimetramide (2 % solution of 1 ml) or chlorpromazine (0.5 % solution of 1 ml) is indicated. However, it should be remembered that the administration of these drugs is contraindicated in case of collapse. Dinetrol is an effective means of stopping vomiting and diarrhea in the intestinal form of acute radiation sickness. In addition to antiemetic action, it has anesthetic and tranquilizing effect. In extremely severe cases, accompanied by diarrhea, signs of dehydration and hypochloremia, intravenous administration of 10 % sodium chloride solution, saline or 5 % glucose solution is advisable. For the purpose of detoxification, transfusion of low molecular weight polyvinylpyrrolidol, polyglucin and saline solutions is indicated. With a sharp decrease in blood pressure, caffeine and mezaton should be administered intramuscularly. In severe cases, these drugs are administered intravenously, and if their effectiveness is low, norepinephrine drip is added in combination with polyglucin. Camphor can also be used (subcutaneously), and for symptoms of heart failure, korglikon or strophanthin (intravenously).

When radioactive substances enter the gastrointestinal tract, emergency assistance consists of measures aimed at preventing their absorption into the bloodstream and accumulation in internal organs. For this, the victims are prescribed adsorbents. It should be remembered that adsorbents do not possess polyvalent properties and in each individual case it is necessary to use appropriate adsorbents that are effective for binding a specific type of radioisotope. For example, when strontium and barium isotopes enter the gastrointestinal tract, adsorbar, polysantimine, highly oxidized cellulose and calcium alginate are effective; when radioactive iodine enters the body – preparations of stable iodine.

During the peak period, therapeutic and prophylactic measures are carried out aimed primarily at:

- replacement therapy and restoration of hematopoiesis;
- prevention and treatment of hemorrhagic syndrome;
- prevention and treatment of infectious complications.

Treatment of acute radiation sickness should be carried out intensively and in a complex manner, using not only pathogenetically justified means, but also medications for symptomatic therapy.

Before entering the patient's room, the staff puts on gauze respirators, an additional gown and shoes on a mat soaked in 1 % chloramine solution. A systematic bacterial control of the air and objects of the ward is carried out. Careful oral care is required, hygienic treatment of the skin with an antiseptic solution. When choosing antibacterial agents, one should be guided by the results of determining the sensitivity of the microorganism to antibiotics. In cases where individual bacteriological control is not possible (for example, in case of mass admission of the affected), it is recommended to make a selective determination of antibiotic susceptibility to microorganisms secreted from individual victims.

Prevention of radiation injury

It includes a rational choice of the type of radiation energy, taking into account the peculiarities of the distribution of energy in the irradiated volume, as well as the distribution in time, the use of radio modifiers. Preventive measures include compulsory treatment of chronic concomitant diseases, the appointment of vitamins, enzymes, natural or artificial antioxidant drugs. Local prophylaxis involves not only the treatment of chronic processes in organs that fall into the volume of irradiation, but also additional exposure to drugs that improve tissue trophism. Treatment of early radiation reactions is important.

7. Practical skills:

1. Carry out diagnostics of radiation injuries as a result of external (total) irradiation.
2. Carry out diagnostics of radiation injuries when exposed to neutrons.
3. To treat acute local radiation injuries.
4. To treat combined radiation injuries.
5. Have an idea of the content of measures taken to protect the population, patients, personnel and property of medical institutions from external radiation exposure.

8. Questions for control of knowledge

1. Basic units and methods of measuring ionizing radiation.
2. Characteristics of radiation factors.
3. The mechanism of the biological action of ionizing radiation.
4. Classification of radiation injuries as a result of external irradiation.
5. Clinical forms and characteristics of radiation injuries as a result of external irradiation.
6. Maximum permissible radiation doses that do not cause pathology in the body.

9. Tests for self-assessment of knowledge:

1. The exposure dose rate of ionizing radiation is measured in:

a) ampere / kg (A/kg); *c) kilovolt;* *e) Becquerel (Bq).*
b) X-ray (R); *d) Glad;*

2. The absorbed dose of ionizing radiation is measured in:

a) gray (Gr); *c) ampere/kg (A/kg);* *e) Becquerel (Bq).*
b) curie (Ki); *d) roentgen/hour (R/h);*

3. Radioactivity is measured in:

a) curie (Ki); *c) X-ray (R);* *e) watt.*
b) ampere/kg (A/kg); *d) Glad;*

4. When examining the victim, who worked in the radionuclide laboratory, the doctor came to the conclusion that acute radiation sickness had occurred from the ingestion of a radioactive substance. What kind of radiation took place in this case?

a) α-radiation; *c) γ-radiation;* *e) neutron radiation.*
b) β – radiation; *d) X-rays;*

5. The maximum permissible single dose of radiation in wartime is set:

a) 50P; *b) 100P;* *c) 200R;* *d) 300R;* *e) 500R.*

6. The bone marrow form of acute radiation sickness develops at a dose of radiation:

a) 1–10 Gy; *c) 20–80 Gy;* *e) more than 100 Gy.*
b) 10–20 Gy; *d) 80–100 Gy;*

7. Damaging factors in an accident at a nuclear power plant:

a) shock wave;
b) light emission;
c) penetrating radiation;
d) radioactive contamination of the area;
e) psychological impact.

8. A single dose is the radiation dose received during:

a) months; *b) quarter;* *c) years;* *d) four days;* *e) ten days.*

9. A decrease in the radiation level by 10 times with a sevenfold increase in time is characteristic:

a) for products of a nuclear explosion;
b) for nuclear fission products (NPP);
c) when using radiological weapons;
d) when using chemical weapons;
e) when using biological weapons.

10. To protect personnel sent to eliminate the immediate consequences of a radiation accident, it is advisable to use the following drugs:

a) cystamine; *c) dimetcarb;* *e) potassium iodide;*
b) ipdralin; *d) Athens;* *f) methacin.*

11. When providing medical care at the prehospital stage to persons exposed to high doses, it is advisable to introduce:

a) cystamine; *c) deoxypate;* *e) chlorpromazine.*
b) latrapa; *d) lidocaine;*

12. The degree of radioactive contamination of the area after a nuclear explosion depends on:

a) the type of nuclear weapon;
b) the power of a nuclear weapon;
c) the type of nuclear explosion;
d) latitude of the area of explosion;
e) meteorological conditions.

13. The "Rule of Sevens" is formulated as follows:

a) with a tenfold increase in the time elapsed after a nuclear explosion, the radiation dose rate on the ground decreases by a factor of 7.
b) with a sevenfold increase in the time elapsed after a nuclear explosion, the radiation dose rate on the ground decreases by a factor of 10.

14. How does the activity of the products of a nuclear explosion change if the time after the explosion increases by 7 times?

a) will not change;
b) decrease by 10 times;
c) decrease by 7 times;
d) decrease by 17 times;
e) will decrease 77 times.

15. What is the dose of external irradiation, which does not lead to a decrease in combat effectiveness, for the personnel of the troops working on the trail of the radioactive cloud?

a) 5 glad;
b) 20 glad;
c) 100 glad;
d) 50 glad;
e) 150 glad.

16. As a result of the accident, a source of β – radiation appeared in the physics laboratory. The path length of β -particles in biological tissue reaches:

a) up to 50 microns;
b) up to 1 cm;
c) tens of centimeters;
d) tens of meters.

Answers:

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
A	*A*	*A*	*A*	*A*	*A*	*D, E*	*D*
9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
A	*A, B, C, E*	*A, B, C*	*B*	*B*	*B*	*A*	*B*

10. References and recommended reading:

1. G. V. Osyodlo [etc.] Military field therapy: a textbook / ed. A. V. Willow; Ukr. military medical acad., Kyiv, 2017. Ukrainian.

2. V. V. Chaplyk [etc.] Medicine of emergency, Vinnytsia, 2012. Ukrainian

3. Allied joint doctrine for medical support / NATO standard AJP-4.10 // With UK National elements. – 2015. – Edition B, Version 1.

4. T. Hughes, J. Cruickshank. Adult emergency medicine at glance, 2011.

5. Davidson's Essentials of Medicine: 2nd Edition / edited by J. Alastair Innes, with a contribution by Simon Maxwell / 2016 Elsevier Ltd.

6. Kumar and Clark`s Clinical Madicine: seventh edition: 2009, Elsevier Ltd.

Навчальне видання

РАДІАЦІЙНІ УРАЖЕННЯ. ПОНЯТТЯ ПРО ПРОМЕНЕВУ ТРАВМУ, НАДАННЯ МЕДИЧНОЇ ДОПОМОГИ НА ЕТАПАХ МЕДИЧНОЇ ЕВАКУАЦІЇ. ГОСТРА ПРОМЕНЕВА ХВОРОБА. ЕТАПНЕ ЛІКУВАННЯ ХВОРИХ З ГОСТРОЮ ПРОМЕНЕВОЮ ХВОРОБОЮ. АТИПОВІ ФОРМИ ПРОМЕНЕВОЇ ХВОРОБИ

Методичні вказівки
для здобувачів вищої освіти V року навчання
до проведення практичного заняття

Упорядники Шелест Борис Олексійович
Мартовицький Дмитро Володимирович
Меленевич Анастасія Ярославівна
Молотягін Дмитро Геннадійович

Відповідальний за випуск Б.О. Шелест

Комп'ютерна верстка М.Ю. Орлова, О.Ю. Лавриненко

Формат А5. Ум. друк. арк. 1,0. Зам. № 22-34247.

Редакційно-видавничий відділ
ХНМУ, пр. Науки, 4, м. Харків, 61022
izdatknmurio@gmail.com

Свідоцтво про внесення суб'єкта видавничої справи до Державного реєстру видавництв, виготівників і розповсюджувачів видавничої продукції серії ДК № 3242 від 18.07.2008 р.