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Federal State Budgetary Educational institution of higher education
"North Ossetian State Medical Academy"
Ministry of Health of the Russian Federation

CHAIR OF GENERAL HYGIENE
AND PHYSICAL CULTURE

Ultraviolet radiation and its applications with a therapeutic and prophylactic purpose. Artificial ultraviolet irradiation

Methodological recommendations
on the organization of independent work and study of the disciplines "Physical culture and sports" and "Elective course in physical culture and sports" of the mainthe main professional educational program of higher education – specialty program in the specialty 31.05.03 Dentistry (partially implemented in English)

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«Ultraviolet radiation and its use for therapeutic and prophylactic purposes. Artificial ultraviolet irradiation», guidelines for students; North Ossetian State Medical Academy: Vladikavkaz, 2016. – 16 p.

In these guidelines, a special place is given to the mechanisms of the biological effects of ultraviolet radiation, therapeutic effects, as well as the main indications, contraindications, equipment for the use of this method of treatment. Ultraviolet irradiation in all possible methods and methods of delivery to biological tissues is of high importance in modern practice. The paper contains valuable advice on the use of artificial ultraviolet radiation for prophylactic and therapeutic purposes.

Methodical recommendations for students “Ultraviolet radiation and its use for therapeutic and prophylactic purposes. Artificial ultraviolet irradiation "are intended for methodical physical education classes with students of a special medical group studying in the specialties" General Medicine "," Dentistry "," Pediatrics "," Medical and Preventive Care "," Pharmacy ". Compiled in accordance with the curriculum. The presented materials meet the requirements of the educational standard for medical students.

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PURPOSE OF THE LESSON: to acquaint and teach the technique of artificial ultraviolet irradiation

STUDENT SHOULD KNOW:

- the effects of ultraviolet radiation on the human body;
- bactericidal effect of short – range UV rays;
- indications, contraindications for the use of artificial ultraviolet radiation;
- methodology for the IUFO;
- devices for the IUFO.

A STUDENT SHOULD BE ABLE TO:

- use UF light technique to strengthen health, increased efficiency and hardening of the body

QUESTIONS TO BE SURRENDED:

- the value of artificial ultraviolet radiation;
- physiological mechanism of the IFU effect on the human body;
- positive and negative effects of ultraviolet radiation;
- indications and contraindications for the appointment of an IUFO;
- methodology for the IUFO.

RECOMMENDED LITERATURE:

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1. The value of artificial ultraviolet radiation

Parts of the solar spectrum that are invisible, but perceived by the human eye, are still perceived by our body. These are infrared and ultraviolet light – both of them have powerful biological and physiological effects on living organisms, but these electromagnetic radiation are very distinctive physically, their biological effects are different. UV – rays have a complex physicochemical, biological effect, which mainly cause photochemical reactions and act in essence only on the skin, because they cannot penetrate into tissues by more than 0.6 millimeters.

Ultraviolet radiation – electromagnetic radiation not visible to the eye in the wavelength range from 400 to 10 nm. UV rays, depending on the wavelength, have different and very diverse effects, which is why they have fairly wide indications for use.

Ultraviolet irradiation is the use of UV rays of various wavelengths for therapeutic, prophylactic and rehabilitation purposes. All living things need a certain dose of UV radiation. So, with its lack, the body's resistance decreases, phosphorus – calcium metabolism is disturbed (rickets in children). Excess UV radiation leads to neuroses, skin burns, increased growth of tumor cells. Dosed UV irradiation increases mental performance, stimulates the activity of the gonads and other endocrine glands. UFO has a stimulating effect on the immune system, on the functions of the sympathetic – adrenal system. The most bactericidal effect is short – range UF rays, which are used for disinfecting indoor air (hospital wards, operating rooms), drinking water, disinfecting dishes, etc.

Ultraviolet radiation from the Sun and artificial sources is a spectrum of electromagnetic waves in the range of 180–400 nm. Ultraviolet rays carry high energy and in their activity significantly surpass all other parts of the light spectrum. At the same time, ultraviolet radiation has the smallest depth of penetration into tissues – only up to 1 mm. Therefore, their direct effect is limited to the surface layers of the irradiated areas of the skin and mucous membranes. The most sensitive to ultraviolet light is the skin of the body surface, the least sensitive to the skin of the extremities. Sensitivity to ultraviolet rays is increased in children, especially at an early age.

The use of ultraviolet rays for therapeutic purposes at a well – chosen individual dose and strict control gives a high therapeutic effect in many diseases. It is made up of analgesic, anti – inflammatory, desensitizing, immunostimulating, restorative action. Their use promotes epithelialization of the wound surface, as well as the regeneration of nerve and bone tissue.

2. Physiological mechanism of the influence of IFU on the human body

According to the biological effect on the body and depending on the wavelength, the UV spectrum is divided into three parts:

- ✓ A (400–320 nm.) – long – wave UV radiation (UVA);
- ✓ B (320 – 280 nm.) – medium wave (UVB);
- ✓ C (280 – 180 nm.) – shortwave (UVC).

There are significant differences in the effect of long, medium – and short – wave ultraviolet radiation on cells, tissues and the body as a whole.

Shortwave irradiation – the use of ultraviolet radiation (180 – 280 nm) for therapeutic and prophylactic purposes. Under natural conditions, UVS radiation (UFR) is almost completely absorbed by the ozone layer of the atmosphere.

Short – wave ultraviolet rays cause a short – term spasm of the capillaries in the initial period of irradiation, followed by a more prolonged expansion of the subcapillary veins. As a result, a short – wave reddish erythema with a bluish tinge is formed on the irradiated area. It develops in a few hours and disappears within 1–2 days.

Short – wave ultraviolet irradiation of blood stimulates cellular respiration of its shaped elements, increases the ionic permeability of membranes. With autotransfusion of ultraviolet irradiated blood (AUFOK), the amount of oxyhemoglobin increases and the oxygen capacity of the blood increases. As a result of the activation of the processes of lipid peroxidation in the membranes of erythrocytes and leukocytes, as well as the destruction of thiol compounds and a – tocopherol, reactive radicals and hydroperoxides appear in the blood, which are capable of neutralizing toxic products.

As a result of the desorption of proteins and carbohydrates from the outer membrane layer of blood cells, caused by short – wave ultraviolet radiation, the probability of intercellular distance interactions with receptor – signaling proteins of various blood elements increases. These processes underlie the expressed nonspecific reactions of the blood system during its short – wave irradiation. These reactions include changes in the aggregation properties of erythrocytes and platelets, phase changes in the content of lymphocytes and immunoglobulins A, G and M, an increase in the bactericidal activity of the blood. Along with the reactions of the blood system, short – wave ultraviolet radiation causes the expansion of the vessels of the microvasculature, normalizes the blood coagulation system and activates the trophometabolic processes in the tissues.

When absorbing quanta of medium – wave ultraviolet radiation, which have significant energy, low – molecular products of protein photolysis and photoradicals are formed in the skin, among which lipid peroxidation products play a special role. They cause changes in the ultrastructural organization of biological

membranes, lipid – protein relationships of membrane enzymes and their most important physical and chemical properties (permeability, viscosity, etc.).

Different doses of ultraviolet radiation determine the unequal likelihood of erythema formation and the manifestation of therapeutic effects. Based on this, in physiotherapy, the action of medium – wave ultraviolet radiation in suberythemal and erythemal doses is considered separately.

In the first case, when exposed to medium – wave ultraviolet rays (280 – 310 nm) of the lipids of the surface layers of the skin, the 7 – dehydrocholesterol contained in their composition is converted into cholecalciferol – vitamin D3. With the blood flow, it is transferred to the liver, where, after hydroxylation, it is converted into 25 – hydroxycholecalciferol. After the formation of a complex with the Ca – binding protein, it regulates the absorption of calcium and phosphate ions in the intestine and the formation of certain organic compounds; is a necessary component of calcium – phosphorus metabolism in the body.

Along with the mobilization of inorganic phosphorus into metabolic processes, it activates blood alkaline phosphatase, initiates glycolysis in erythrocytes. Its product – 2,3 – diphosphoglycerate – increases oxygenation of hemoglobin and facilitates its release in tissues.

Ultraviolet radiation of the medium wavelength range in the first 30 – 60 minutes after irradiation changes the functional properties of the skin mechanoreceptors with the subsequent development of skin – visceral reflexes, which are realized at the segmental and cortical – subcortical levels. Reflex reactions arising from general irradiation stimulate the activity of almost all body systems. There is an activation of the adaptive – trophic function of the sympathetic nervous system and the restoration of disturbed processes of protein, carbohydrate and lipid metabolism in the body. With local irradiation, an improvement in myocardial contractility occurs, which significantly reduces the pressure in the pulmonary circulation. Medium – wave ultraviolet radiation restores mucociliary transport in the mucous membranes of the trachea and bronchi, stimulates hematopoiesis,

Long – wave ultraviolet irradiation (DUV) – therapeutic and prophylactic use of DUV radiation (320 – 400nm). Long – wave ultraviolet rays stimulate the proliferation of cells in the malpighian layer of the epidermis and decarboxylation of tyrosine, followed by the formation of melanin in the cells of the spiny layer. This leads to compensatory stimulation of the synthesis of ACTH and other hormones involved in humoral regulation. The products of photodegradation of proteins formed during irradiation stimulate processes leading to the proliferation of B – lymphocytes, degranulation of monocytes and tissue macrophages, and the formation of immunoglobulins. DUV rays have a weak erythema – forming effect. It is used in PUVA therapy for the treatment of skin diseases.

DUV – rays, like other areas of UV – radiation, cause a change in the functional state of the central nervous system and its higher part of the cerebral cortex. Due to the reflex reaction, blood circulation improves, the sectorial activity of the digestive organs and the functional state of the kidneys increase. DUV rays affect the metabolism, primarily mineral and nitrogen. Local applications of photosensitizers are widely used for limited forms of psoriasis. Recently, UV – B has been successfully used as a sensitizer as it has a greater biological activity. Combined UV – A and UV – B irradiation is called selective irradiation.

Long – wave ultraviolet irradiation is also used in installations for obtaining tanning – solariums. They contain various numbers of inflation reflex lamps (80 – 100 W) for tanning the body and metal – halogen lamps (400 W) for tanning the face.

Thus, the main therapeutic effects of DUV rays are:

- ✓ *pigment – forming;*
- ✓ *immunostimulating;*
- ✓ *photosensitizing.*

Small doses of long – wave and medium – wave ultraviolet radiation stimulate the formation of vitamin D, which is necessary for the normal functioning of the body (strengthening of bone tissue, nervous system and muscles), activate the action of vitamins A, C, E, B vitamins, and enhance the formation of skin epithelium.

UF radiation is absorbed by the skin and penetrates into tissues, causing protein breakdown. Prolonged and intense UV irradiation causes ultraviolet erythema, the manifestation of a visible reaction lasts 2 – 8 hours – the latent period of the reaction to irradiation. At the site of irradiation, the active products of protein destruction cause the expansion of blood vessels, migration of leukocytes, irritate many receptors of the skin and internal organs. This, in turn, leads to the emergence of reflex reactions. Protein degradation products are carried by the blood throughout the body and act on individual organs, the nervous and endocrine systems. Outwardly, clinical and morphological changes on the skin correspond to the picture of aseptic inflammation. The nature of the skin reaction depends on the individual characteristics of the organism (age, sex, constitution, localization of exposure, function of the endocrine glands, etc.). The formation of an erythemal reaction is accompanied by desensitization, a decrease in pain sensitivity, an increase in the phagocytic activity of cells, and the mobilization of the protective functions of the skin. Strengthening blood and lymph flow in the area of UV – erythema promotes regeneration of the epithelium, accelerates the formation of connective tissue – this is of great practical importance for accelerating the healing of wounds and ulcers.

Dosed UF irradiation increases mental performance, stimulates the activity of the gonads and other endocrine glands.

UFO has a stimulating effect on the immune system, on the functions of the sympathetic – adrenal system. Short – range UV rays have the highest bactericidal effect, which are used for disinfecting indoor air (hospital wards, operating rooms), drinking water, disinfecting dishes, etc. (70–80% of microbes die). Under the influence of UV rays, the ability of blood leukocytes to resist disease – causing viruses and microbes increases. UV radiation is a constant factor of the external environment, which is necessary to ensure the normal functioning of the organism, its physical and mental development, to maintain health and working capacity.

3. The positive and negative effects of ultraviolet radiation

In the twentieth century, it was first shown why UV radiation has a beneficial effect on humans. Physiological action of UV – rays was investigated by domestic and foreign researchers in the middle of the last century (G. Varshaver. G. Frank. N. Danzig, N. Galanin. N. Kaplun, A. Parfenov, E. Belikova. V. Dugger. J. Hassesser N. Ronge, E. Biekford et al.) It has been convincingly proved in hundreds of experiments that radiation in the UV region of the spectrum (290 – 400 nm) increases the tone of the sympathetic – adrenaline system, activates defense mechanisms, increases the level of nonspecific immunity, and increases the secretion of a number of hormones. Under the influence of UV radiation (UVR), histamine and similar substances are formed, which have a vasodilating effect, increase the permeability of skin vessels. Changes in carbohydrate and protein metabolism in the body. The action of optical radiation changes pulmonary ventilation – the frequency and rhythm of breathing; gas exchange, oxygen consumption increases, the activity of the endocrine system is activated.

Particularly significant is the role of UV radiation in the formation of vitamin D in the body, which strengthens the musculoskeletal system and has an antirachitic effect. It should be especially noted that long – term UVI deficiency can have adverse consequences for the human body, called "light starvation". The most common manifestation of this disease is a violation of mineral metabolism, decreased immunity, fatigue, etc. Particularly significant is the role of UV radiation in the formation of vitamin D in the body, which strengthens the musculoskeletal system and has an antirachitic effect. It should be especially noted that long – term UVI deficiency can have adverse consequences for the human body, called "light starvation". The most common manifestation of this disease is a violation of mineral metabolism, decreased immunity, fatigue, etc. Particularly significant is the role of UV radiation in the formation of vitamin D in the body, which strengthens the musculoskeletal system and has an antirachitic effect. It

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A number of negative effects arising from exposure to UV radiation on the human body are also well known, which can lead to a number of serious structural and functional damage to the skin. As you know, these injuries can be divided into:

- ✓ Acute, caused by a large dose of radiation received in a short time (for example, sunburn or acute photodermatosis). They occur mainly due to UV – B rays, the energy of which is many times higher than the energy of UV – A rays. Solar radiation is unevenly distributed: 70% of the dose of UV – B rays received by humans occurs in the summer and midday time of the day, when the rays fall almost vertically, and do not slide along a tangent – in these conditions the maximum amount of radiation is absorbed. Such damage is caused by the direct action of UV radiation on chromophores – these are the molecules that selectively absorb UV rays.
- ✓ Delayed, caused by prolonged exposure to moderate (suberythemal) doses (for example, such damage includes photoaging, skin neoplasms, some photodermatitis). They arise mainly due to the rays of spectrum A, which carry less energy, but are able to penetrate deeper into the skin, and their intensity varies little during the day and practically does not depend on the season. As a rule, this type of damage is the result of exposure to the products of free radical reactions (recall that free radicals are highly reactive molecules that actively interact with proteins, lipids and the genetic material of cells).

The role of UV – A rays in the etiology of photoaging has been proven by the works of many foreign and Russian scientists, but nevertheless, the mechanisms of photoaging continue to be studied using modern scientific and technical base, cell engineering, biochemistry and methods of cellular functional diagnostics.

The mucous membrane of the eye – the conjunctiva – does not have a protective stratum corneum, so it is more sensitive to UV radiation than the skin. Cutting in the eye, redness, lacrimation, partial blindness appear as a result of degeneration and death of cells of the conjunctiva and cornea. In this case, the cells become opaque. Long – wave ultraviolet rays, reaching the lens, in large doses can cause its clouding – cataracts.

4. Indications and contraindications for the appointment of IUFO

The indications for treatment with ultraviolet long – wave radiation are:

- ✓ chronic inflammatory processes in the respiratory system;
- ✓ diseases of the osteoarticular apparatus of an inflammatory nature;
- ✓ frostbite;
- ✓ burns;
- ✓ skin diseases – psoriasis, fungal mycosis, vitiligo, seborrhea and others;
- ✓ poorly treatable wounds;
- ✓ trophic ulcers.

For some diseases, the use of this method of physiotherapy is not recommended.

***Contraindications are*:**

- ✓ acute inflammatory processes in the body;
- ✓ severe chronic renal and hepatic failure;
- ✓ hyperfunction of the thyroid gland;
- ✓ individual hypersensitivity to ultraviolet light.

Indications for the use of medium – wave ultraviolet radiation are:

- ✓ inflammatory diseases of the respiratory system;
- ✓ post – traumatic changes in the musculoskeletal system;
- ✓ inflammatory diseases of bones and joints (arthritis, arthrosis);
- ✓ vertebrogenic radiculopathy, neuralgia, myositis, plexitis;
- ✓ solar starvation;
- ✓ metabolic diseases;
- ✓ erysipelas.

Contraindications are:

- ✓ individual hypersensitivity to UV rays;
- ✓ hyperfunction of the thyroid gland;
- ✓ chronic renal failure;
- ✓ systemic connective tissue diseases;
- ✓ malaria.

The use of short – wave ultraviolet radiation is effective in the following diseases:

- ✓ skin diseases (psoriasis, neurodermatitis);
- ✓ erysipelas;
- ✓ rhinitis, tonsillitis;
- ✓ otitis media;
- ✓ wounds;
- ✓ lupus;
- ✓ abscesses, boils, carbuncles;
- ✓ osteomyelitis;
- ✓ rheumatic heart valve disease;
- ✓ Ischemic heart disease;
- ✓ essential hypertension I – II;
- ✓ acute and chronic respiratory diseases;
- ✓ diseases of the digestive system (peptic ulcer and duodenal ulcer, gastritis with high acidity);
- ✓ diabetes;
- ✓ long – term non – healing ulcers;
- ✓ chronic pyelonephritis;
- ✓ acute adnexitis.

Contraindication to this **type of treatment is individual hypersensitivity to UV rays. Blood irradiation is contraindicated in the following diseases:**

- ➢ mental illness;
- ➢ chronic renal and hepatic failure;
- ➢ porphyria;
- ➢ thrombocytopenia;
- ➢ callous ulcer of the stomach and duodenum;
- ➢ decreased blood clotting ability;
- ➢ strokes;
- ➢ myocardial infarction.

5. Methodology for the IUFS

Long wavelength radiation. This type of radiation can affect the whole body at once or any part of it. If the patient is to be exposed to general radiation, he should undress and sit quietly for 5 – 10 minutes. No creams or ointments should be applied to the skin. The entire body is exposed at once or its parts in turn – it depends on the type of installation.

The patient is at least 12–15 cm away from the device, and his eyes are protected by special glasses. The duration of irradiation directly depends on the type of skin pigmentation – there is a table with irradiation schemes depending on this indicator. The minimum exposure time is 15 minutes, and the maximum is half an hour.

Devices. Sources of UV rays are divided into integral and selective. Integral ones emit UV rays of all three spectra, and selective ones – only region A or regions B + C. As a rule, in medicine, selective radiation is used, which is obtained using a LUF – 153 lamp in the UUD – 1 and 1A irradiators, OUG – 1 (for the head), OUK – 1 (for the extremities), EGD – 5, EOD – 10, PUVA , Psorymox and others. Also, long – wave UV radiation is used in tanning salons, designed to obtain an even tan.

Medium – wave ultraviolet radiation. There are 2 methods – local and general. Local exposure is carried out on an area of the skin, the area of which does not exceed 600 cm2. Apply, as a rule, erythemal doses of radiation. The procedure is carried out 1 time in 2 – 3 days, each time increasing the dose by 1 / 4 – 1 / 2 from the previous one. One area can be exposed no more than 3 – 4 times. A repeated course of treatment is recommended to the patient after 1 month. With the general exposure, the patient is in the supine position; the surface of his body is irradiated in turn. There are 3 treatment regimens – basic, accelerated and delayed, according to which the biodose is determined depending on the procedure number. The course of treatment is up to 25 exposures and can be repeated in 2 – 3 months.

Devices. Sources of radiation of this type, as well as the previous one, are divided into integral and selective. Integral sources are lamps of the DRT type of various power, which are installed in the irradiators OKN – 11M (quartz tabletop), ORK – 21M (mercury – quartz), UGN – 1 (for group irradiation of the nasopharynx), OUN 250 (table). Another type of lamps – DRK – 120 is intended for cavity irradiators OUP – 1 and OUP – 2.

A selective source is an LZ 153 luminescent lamp for OUSH – 1 (on a tripod) and OUN – 2 (tabletop) irradiators. Erythema lamps LE – 15 and LE – 30, made of glass that transmits UV rays, are also used in wall, pendant and mobile irradiators.

Dose ultraviolet radiation, as a rule, by a biological method, which is based on the ability of UV rays to cause redness of the skin after its irradiation – erythema. The unit of measurement is 1 biodose (the minimum time of ultraviolet irradiation of the patient's skin on any part of his body, causing the appearance of the least intense erythema during the day). Gorbachev's biodosimeter (Fig. 1) looks like a metal plate, on which there are 6 rectangular holes that are closed by a

shutter. The device is fixed on the patients body, UV radiation is directed at him and every 10 seconds one window of the plate is opened in turn. It turns out that the skin under the first hole is exposed to radiation for 1 minute, and under the last – only 10 seconds. After 12 – 24 hours, threshold erythema occurs.

There are the following types of doses:

- ✓ suberythemal (0.5 biodoses);
- ✓ small erythemal (1 – 2 biodoses);
- ✓ medium (3 – 4 biodoses);
- ✓ high (5–8 biodoses);
- ✓ hypererythemal (more than 8 biodoses).

Shortwave radiation. The affected areas of the skin and mucous membranes are treated according to the general UV – irradiation schemes. In diseases of the nasal mucosa, the patient is in a sitting position on a chair, his head slightly thrown back. The emitter is introduced to a shallow depth alternately into both nostrils. A special mirror is used to irradiate the tonsils. Reflecting from it, the rays are directed to the left and right tonsils. The patient's tongue is sticking out, he holds it with a gauze napkin.

Dose impacts by determining the biodose. In acute conditions, start with 1 biodose, gradually increasing it to 3. You can repeat the course of treatment after 1 month. The blood is irradiated for 10 – 15 minutes during 7 – 9 procedures with a possible repeat of the course in 3 – 6 months.

Devices... Integral radiation sources – DRK – 120 lamp for cavity irradiators OUP – 1 and OUP – 2, DRT – 4 lamp for nasopharynx irradiator. Selective sources are DB germicidal lamps of various power – from 15 to 60 W. They are installed in OBN, OBSh, OBP irradiators. For the purpose of carrying out autotransfusion with ultraviolet irradiated blood, the apparatus MD – 73M "Isolde" is used. The radiation source in it is the LB – 8 lamp. There is a possibility of adjusting the dose and the area of exposure.

Control and training tests:

1. **Under the influence of ultraviolet rays:**
   a) the ability of blood leukocytes to resistdisease – causingvirusesand microbes, education is stimulatedvitamin AD;
   b) regeneration of the epithelium occurs;
   c) hemoglobin increases;
   d) prevention occursmyopia

2. **Artificial ultraviolet irradiation is recommended taking into account the light and climatic features of the area during (indicate 2 correct answers):**
   a) the winter period;
   b) the spring period;
   c) the autumn period;
   d) autumn – winter period;
   e) winter – spring period

3. **By biological effect on the body and depending on the length UF – spectrum waves are divided into:**
   a) two parts;
   b) three parts;
   c) four parts

4. **Are there any significant differences in the effect of long – , medium – and short – wave ultraviolet radiation on cells, tissues and the body?**
   a) yes;
   b) no

5. **What two techniques are distinguished in conducting the medium wave ultraviolet radiation:**
   a) positive and negative;
   b) local and general;
   c) integral and selective

6. **What kind of radiation can affect the whole body at once:**
   a) shortwave radiation;
   b) medium wave radiation;
   c) long – wave radiation

7. **What kind of UV radiation is used in tanning salons intended for getting an even tan:**
   a) long – wave irradiation;
   b) medium wave irradiation;
   c) short – wave irradiation

8. **Who has increased sensitivity to ultraviolet rays:**
   a) children, especially at an early age;
   b) adults;
   c) the elderly

9. **UF rays have the most bactericidal effect:**
   a) short range;
   b) middle range;
   c) long range

10. **Reflex reactions arising from general exposure stimulate:**
   a) the immune system;
   b) blood circulation;
   c) the activity of all body systems

11. **Under the influence of large erythemal doses of ultraviolet radiation:**
   a) the sensitivity of nerve receptors decreases;
   b) inhibitory processes prevail in the central nervous system;
   c) blood sugar decreases;
   d) the permeability of the vascular wall improves;
   e) correct a and c

12. **For treatment with ultraviolet radiation, all the listed diseases, except:**
   a) atherosclerosis;
   b) thyrotoxicosis;
   c) rickets;
   d) rheumatoid arthritis;
   e) bedsores

13. **The long – wavelength part of the ultraviolet spectrum is predominantly absorbs:**
   a) mitochondria;
   b) the protoplasm of the cell;
   c) cell membrane;
   d) core;
   e) all structures are the same

14. **The depth of penetration of ultraviolet radiation into the tissue is:**
   a) up to 2–6 cm;
   b) up to 1 cm;
   c) up to 1 mm;
   d) up to 0,5 mm;
   e) up to 10 cm

15. When making prescriptions for local UV irradiation, all are indicated in the prescription, except for:

a) the number of procedures per course;
b) radiation doses;
c) the number of fields;
d) localization of impact;
e) power flux density

16. Biological effects accompanying the formation of erythema under ultraviolet radiation include all of the above, except:

a) education vitamin AD;
b) shift of acid – base balance in tissues;
c) increasing the phagocytic activity of leukocytes;
d) inhibition of phosphorus – calcium metabolism;
e) enhancing pigmentation

17. Selective sources of ultraviolet radiation are not include:

a) group nasopharynx irradiator – UGN;
b) wall – mounted bactericidal irradiator – OBN;
c) bactericidal irradiator – BOP – 4;
d) long – wave erythemal irradiator – EDI;
e) installation for PUVA – therapy – UFO – 1500

18. The irradiator is not an integral source of ultraviolet radiation:

a) mercury – quartz stationary – ORK – 21;
b) quartz desktop portable – OKN;
c) lighthouse type – "Big lighthouse" – UGD – 3;
d) bactericidal portable – BOP – 4.