Ministry of health of the Republic of Belarus
Educational institution
«Gomel State Medical University»

Department of general and clinical pharmacology

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METHODOLOGICAL RECOMMENDATIONS

for a practical lesson on the discipline "Pharmacology"
for the third-year students of the Faculty of Foreign Students,
studying at the specialty 1-79 01 01 "General medicine"

TOPIC 26: « **ANTIOXIDANTS. VITAMINS. ENZYMES AND ANTI-ENZYMES»**

Time: 3 hours

Approved at the meeting of the department of general and clinical pharmacology

the protocol № 18 of 30.06.2022

2022

LEARNING AND EDUCATIONAL GOALS, OBJECTIVES, MOTIVATION FOR LEARNING THE TOPIC

Vitamins are organic compounds that are mainly ingested with food and play the role of coenzymes in biochemical reactions that take place during metabolism. Most vitamins are not synthesised in the body. Their deficiency in food leads to the development of serious diseases, such as pernicious anemia, rickets, scurvy, neuritis, etc. Currently obtained a large number of vitamin preparations that are able to compensate for the deficiency of vitamins in the body and to relieve the phenomena of hypo-and avitaminosis of various etiologies. However, given the wide range of regulatory effect of vitamins on metabolism, they are often used in the complex treatment of organ and system dysfunctions arising from a variety of diseases. For scientifically grounded application of vitamin preparations the future doctor regardless of the chosen specialisation needs to know the characteristics of their pharmacological effects, side effects and measures of their prevention.

Antioxidants are substances that slow down oxidative processes by binding free radicals. It is now proven that pathological shifts of free-radical genesis underlie the development of many human diseases. They are often accompanied by hypoxic changes, as any hypoxia necessarily leads to the activation of free-radical processes. However, excessive increase in peroxidation of proteins and lipids can also represent the primary link in the pathology without preceding hypoxia, for example, in the initial stage of radiation injury, in some intoxications, etc. Disorders of hypoxic and free-radical origin as they increase can lead to cell destruction and, therefore, determine the fate of an organ and tissue and eventually of the whole organism. Hence the relevance of knowledge of pharmacology of highly effective antihypoxants and antioxidants, as well as methods of their rational application.

Learning objective:

– formation of scientific knowledge about the main pharmacological effects, providing therapeutic and preventive effect of drugs on the topic of the class, indications and contraindications for their use, the interaction of drugs, their combined use for use in medical and preventive activities.

Educational purpose:

– to develop their value-personal, spiritual potential, to form the qualities of a patriot and citizen, ready for active participation in the economic, industrial, socio-cultural and public life of the country; to realize the social significance of their future professional activities, to learn to follow academic and work discipline, standards of medical ethics and deontology.

Tasks:

As a result of the study lesson, the student should

know:

– classification and basic characteristics of the studied drugs, pharmacodynamics and pharmacokinetics, indications and contraindications for their use, side effects;

– features of pharmacokinetics and pharmacodynamics, advantages and disadvantages of different dosage forms of these drugs;

– principles of research and testing of new drugs; information and reference and search systems;

be able to:

– analyze the effect of the studied drugs on the set of their pharmacological properties and the possibility of their use in medical practice; to write them in prescriptions;

– use different dosage forms of these drugs, based on the peculiarities of their pharmacodynamics and pharmacokinetics;

– work with scientific literature, search for information about the use and action of the studied drugs;

possess:

– skills in choice of drugs on the topic of the lesson;

– the rules of prescribing the studied drugs in the treatment of various diseases and pathological conditions, taking into account the indications;

– skills of dosage regime correction in case of pathological changes in functions of organs or systems responsible for biotransformation and elimination of drugs or in case of joint use of different drugs;

– skills to search, analyze and summarize information about the use and effects of the studied drugs.

Motivation for learning the topic:

– the specifics of training doctors in this specialty determines the need for students to purposefully study the main pharmacological effects, providing therapeutic and preventive effects of drugs on the topic of the class, indications and contraindications for their use, the interaction of drugs, their combined use, which will successfully complete the specialized disciplines of the specialty.

MATERIAL EQUIPMENT

Reference and informational literature, charts, tables, presentations, drug collections.

CONTROL QUESTIONS FROM RELATED DISCIPLINES

1. Genesis, physiological role and involvement of antioxidants, vitamins, enzymes and antienzymes in biochemical processes in the human body.
2. Classification of vitamins according to chemical structure and solubility.
3. Daily vitamin requirements; causes of hypo- and avitaminosis, their types.

CONTROL QUESTIONS ON THE TOPIC OF THE CLASS

1. Lipid peroxidation and formation of reactive oxygen species. The role of free radical processes in disease pathogenesis. Endogenous and exogenous antioxidants. Modern drugs with antioxidant properties, their pharmacological characteristics.
2. Classification of vitamins by physical and chemical properties and pharmacotherapeutic use.
3. Pharmacological characteristics of fat-soluble vitamin preparations. Sources of production, daily requirement, participation in biochemical processes, indications for use, side effects, symptoms of hypervitaminosis.

The features of the pharmacology of vitamin preparations B1, B2, B3, B5, B6, Bp, B12 and B15. Sources of supply, daily requirement, participation in biochemical processes, indications for use, side effects, symptoms of hypervitaminosis.

5. Pharmacological characteristics of vitamin preparations C, P, U, lipoic acid. Sources of obtainment, daily requirement, participation in biochemical processes, indications for use, side effects, symptoms of hypervitaminosis.

6. Principles and significance of multivitamin complexes ("Alphavit", "Complivit", "Aevit", "Undevit", "Handevit", etc.).

7. Proteolytic enzyme preparations. Inhibitors of proteolytic enzymes. Basics of pharmacology.

PROCESS OF THE STUDY

Theoretical part

Theoretical questions are described in the appendix to the methodological recommendations.

Practical part

1. Take notes on theoretical material demonstrated by the teacher.

2. Master the methods of solving the tasks and writing out prescriptions on the topic of the class.

Theme learning control

Conducted in the form of independent written work (solution of practical problems and prescriptions for individual task).

METHODOLOGICAL RECOMMENDATIONS FOR ORGANIZATION AND EXECUTION OF STUDENTS' INDEPENDENT WORK (SIW)

The time given for independent work can be used by students for:

– preparing for the practical classes;
– completing the tasks on the topic of the class in the workbook;
– preparing thematic reports, essays and presentations;
– taking notes from academic literature.

The main methods of organizing independent work:

- completing tests and practical tasks of the electronic educational-methodical complex (EEMC) for self-monitoring and self-assessment.

The list of tasks of the SIW:

- solving practical problems in the EEMC;
- completing the test tasks of the EEMC.

Control of the SIW is carried out in the form of:

- assessment of an oral answer to a question, report, report, or solution of a task in a practical class;
- individual conversation.

METHODOLOGICAL RECOMMENDATIONS FOR ORGANIZATION AND EXECUTION OF CONTROLLED INDEPENDENT WORK OF STUDENTS (CIWS)

Recommended forms of CIWS organization:

- doing exercises on the topic of the class in the workbook;
- writing an essay on a given topic;
- preparing a report and a multimedia presentation on a given topic.

The list of tasks of the CIWS:

Topics of essays / multimedia presentations:

1. Interactions of vitamins with other medicines. Pharmacological incompatibilities.
2. medicinal plants containing vitamin K and their place in modern medicine.

Forms of control of CIWS realization:

- checking and grading an essay on a given topic;
- checking and grading a multimedia presentation on a given topic.

LIST OF REFERENCES

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2. Кратко о лекарственных средствах: учебно – методическое пособие для студентов 3 и 6 курсов факультета иностранных студентов, учреждений высшего мед. образования: в 2 ч.=Drugs in short: partical workbook for 3 and 6 year students Faculty for International Students of medical higher educational institutions: in 2 parts / Е.И. Михайлова [и др.]. – Ч. 1. – Гомель: ГомГМУ, 2020. – 56с. – Режим доступа: http://elib.gsmu.by/xmlui/handle/GomSMU/7128 – Дата доступа: 23.05.2022.
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4. Rang and Dale's Pharmacology / J.M. Ritter [et al.]. - 9th ed. - Edinburg [et al.]: Elsevier, 2020. - xvi, 789 p.: ill., tab. + Student consult online.

Vitamins are exogenous organic substances of various chemical structures necessary for normal metabolism maintaining**.**

FAT-SOLUBLE VITAMINS

Drugs	**Vitamin A, retinyl** **1. Retinyl acetate, retinyl palmitate** **2. Beta-caroten**	**Vitamin D, calciferols** **3. Ergocalciferol (D_2)** **4. Cholecalciferol (D_3)** **5. Calcitriol (D_3)**	**Vitamin E, tocopherol** **6. Tocoferol acetate**	**Vitamin K, naphthoquinones** **7. Phytomemandione (K_1)** **8. Menaquinone (K_2)** **9. Menadione (K_3, Vikasol)**
Mechanism of action	Bind to cytoplasmic receptors in the target tissues (muscles, heart, liver), penetrate into the nucleus and effect gens → synthesis of mucopolysaccarides, phospholipids and glycoproteins	↑ Calcium and phosphate absorption in the intestines and tissue transport	↓ free radical reactions; proteins and heme synthesis, tissue breathing, cells proliferation; some enzymes cofactor; ↓ unsaturated fatty acids oxidation	↓ prothrombin and proconvertin synthesis; ↑ blood coagulability due to ↑ in synthetases of II, VII, IX, X coagulating factors; take part in CPK and ATP synthesis
Pharmacological effects	1. Regulation of: • night vision; • epithelial tissue growth and differentiation; • calcium and phosphate metabolism	Regulation of calcium and phosphate metabolism	1. Regulation of: • Reproductive system • Muscles metabolism; 2. Antioxidant and regenerative action.	1. Anti hemorrhagic action
Indications for use	1. Hypo- and avitaminosis 2. Xerophthalmia 3. Intertrigo, burns, skin diseases 4. Rickets (in combination with vitamin D)	1. Hypocalcaemia, hypophosphatemia 2. Rickets, osteodistrophy, tetany seizures 3. Hypocalcaemia prevention in patients undergoing artificial kidney apparatus hemodialysis	1. Anemia 2. Dermatitis, hair loss 3. Miscarriage risk 4. Cardiac disease, bursitis, liver steatosis. 5. Improving of physical and sexual activity	1. Warfarin-induced bleeding (7) 2. Hemorrhagic disease of newborn (prevention and treatment)
Side effects	1. Drowsiness, slackness, headache 2. Nausea, vomiting, irritability, lower extremities bone pain 3. Nephro- and hepatotoxicity 4. In children: skin rush, hyperthermia, sweating, increased cerebrospinal fluid pressure with bulging fontanelles and hydrocephaly development	1. ↓ appetite, nausea, headache 2. Weakness, irritability, insomnia 3. Hyperthermia, nephrotoxicity, soft tissues calcification	1. Muscle weakness, trembling 2. Reduction of reproductive function 3. Disorders of the gastrointestinal tract	1. ↓ in blood cougulability (bleeding)
Contraindications	1. Pregnancy (teratogenicity).	1. Hypercalcemia, hyperphosphatemia 2. Pregnancy (suppresses parathyroid function of fetus)	1. Hypersensitivity 2. Cardiosclerosis, myocardial infarction	1. Hypersensitivity 2. Cholestatic jaundice 3. The tendency to thromboembolism and thrombosis, increased blood coagulability

WATER-SOLUBLE VITAMINS

Drugs	**Vitamin B1, thiamine** **1. Thiamine hydrochloride** **2. Thiamine pyrophosphate (co-carboxylase)**	**Vitamin B2, riboflavin** **3. Riboflavin**	**Vitamin B3, PP, nicotinic acid** **4. Nicotinic acid** **5. Nicotinamide** **6. Xanthinal nicotinate**	**Vitamin B5, pantothenic acid** **7. Calcium pantothenate** **8. Dexpanthenol**
Mechanism of action	It is decarboxylase co-enzyme (oxidative decarboxylation of α-keto acids, pyruvate) and transketolase (pentose phosphate pathway of glucose breakdown)	As a part of the FMN and FAD participates in the transport of electrons in the respiratory chain, deamination of amino acids, oxidative phosphorylation	As parts of NAD and NADP are involved in glycolysis and gluconeogenesis, oxidation of substrates in the respiratory chain	In the structure of acetyl-CoA is involved in the processes of acetylation and oxidation, carbohydrate and lipid metabolism, the synthesis of acetylcholine, triglycerides and steroids
Pharmacological effects	Neuroprotective, cardiotrophic, hypoglycemic action, elimination of metabolic acidosis	Stimulates the development of the fetus, the division of the epithelium of the mucous membranes and eye tissues	Vasodilator, cardiotrophic, hepatoprotective, detoxicating, anticholesterolemic, hypoglycemic, ↑ microcirculation	↑ Tissue metabolism, contractile activity of the myocardium
Indications	1. Vitamin deficiency 2. Neuritis, radiculitis, neuralgia, paralysis 3. Diabetes mellitus 4. Dermatoses, itching, pyoderma, eczema, psoriasis 5. Atony of the intestine 6. Myocardial dystrophy, endarteritis 7. Abstinence syndrome with alcoholism, drug addiction	1. Insufficiency of the vitamin 2. Diseases of the eyes (hemostalopia, conjunctivitis, iritis, keratitis, corneal ulcers, cataracts) 3. Non-healing wounds and ulcers 4. Radiation sickness 5. Asthenia 6. Sprue, viral hepatitis	1. Pellagra 2. Vascular spasm (obliterating endoarteritis, Raynaud's disease, migraine, etc.) 3. Diseases of the gastrointestinal tract (hepatitis, cirrhosis, etc.) 4. Neuritis of the facial nerve 5. Hyperlipidemia (in high doses) 6. Infectious diseases	1. Prevention of vitamin deficiency 2. Polyneuritis, neuralgia, paresthesia 3. Stress, depression 4. Trophic ulcers, eczema, burns 5. Malabsorption, atony of the intestine 6. Abstinence syndrome with alcoholism, drug addiction
Side effects	1. A slight decrease in blood pressure 2. Anaphylaxis (with intravenous administration), nausea, urticaria 3. Painful injections due to low pH of the solution	1. Yellow-orange coloration of urine 2. in subconjunctival administration - headache, dizziness, lacrimation	1. Flushing of the face and neck (increase in histamine release) 2. Itching, dry skin 3. Headache, dizziness, pain in the heart, hypotension 4. Pain in the injection site.	1. Nausea, vomiting, heartburn 2. Pain in the injection site.
Contraindications	1. Hypersensitivity	1. Hypersensitivity 2. Nephrolithiasis	1. Hypersensitivity 2. Gastro duodenal ulcers 3. Severe liver function disorders 4. Gout, hyperuricemia 5. Severe forms of hypertension (IV)	1. Hypersensitivity

WATER-SOLUBLE VITAMINS (continued)

Drugs	**Vitamin B6, pyridoxine** **1. Pyridoxine hydrochloride** **2. Magnesium-B6**	**Vitamin B9 or VC, Folic acid** **3. Folic acid**	**Vitamin B12, cyanocobalamin** **4. Cyanocobalamin** **5. Oxycobalamin**	**Vitamin C, Ascorbic acid** **6. Ascorbic acid**	**Vitamin R, Bioflavonoids** **7. Rutozid** **8. Ascorutin (6 + 7)**
Mechanism of action	In the process of metabolism, they are converted into pyridoxalphosphate, which participates in many processes of nitrogen metabolism (transamination, deamination of amino acids, metabolism of tryptophan, serotonin, etc.)	In the process of metabolism it is converted into tetrahydrofolic acid, which is necessary for meglobalasts forming and transformation into normoblasts. Participates in the exchange of purines and pyrimidines, amino acids, nucleic acids	Participates in the reducing of folic acid in tetra-hydrophilic, in the transfer of methyl fragments, which is necessary for the formation of methionine, choline, creatine, nucleic acids, maturation of erythrocytes	Regulates the transport of water in many biochemical reactions, improves the use of glucose in the Krebs cycle, and participates in the formation of THF, steroid hormones, collagen. Activates proteolytic enzymes, promotes phagocytosis	Reactivates the sulfhydryl groups of proteins and glutathione, vitamin C and tocopherol. Suppresses the activity of hyaluronidase.
Pharmacological effects	Neuroprotective, cardiotonic, hepatoprotective, antihypoxic, anti-cholesterolemic, stimulation of erythro- and leucopoiesis	Hematopoietic, anti-anemic, metabolic, regenerative	Hematopoietic, anti-anemic, metabolic, regenerative, influence on conduction of nerve impulse, immunostimulating, hepatoprotective, hypocholesterolemic	Metabolic, regulation of oxidation-reduction processes, antioxidant, regenerative, immunotropic, anti-inflammatory, antiallergic	Angioprotective (reduces permeability of capillaries, swelling, inflammation, strengthens the vessel wall, inhibits aggregation), antioxidant
Indications	1. Vitamin deficiency 2. Isoniazid intake 3. Hypochromic anemia, leukopenia 4. Parezy, paralysis, neuritis, neuralgia 5. Hepatitis, cholecystitis 6. Skin diseases	1. Megaloblastic anemia 2. Hypo-and avitaminosis (sprue, pregnancy, etc.) 3. Drug and radiation anemia	1. Hypo-and avitaminosis (sprue, pregnancy, etc.) 2. Chronic anemia (megaloblastic anemia, aplastic, etc.) 3. Diseases of the nervous system (neuralgia, polyneuritis, diabetic neuropathy, etc.) 4. Skin diseases (psoriasis, photodermatitis, etc.) 5. Chronic hepatitis, liver cirrhosis	1. Hypovitaminosis 2. Infectious diseases 3. Alcohol and nicotinic intoxication 4. Bleeding 5. Metabolic and respiratory acidosis	1. Varicose veins 2. Chronic venous insufficiency 3. Lymphostasis 4. Diabetic retinopathy 5. Radiation therapy

Side effects	1. Allergic reactions 2. Redness of the skin, heat sensation 3. Paresthesia, drowsiness 4. Burning and pain at the injection site 5. Increased gastric acidity	1. Allergic reactions (bronchospasm, erythema, fever, skin rashes) 2. Dyspepsia 3. In high doses - increased excitability of the central nervous system (up to seizures)	1. Allergic reactions 2. Nervous stimulation 3. Headache, head-spin 4. Pain in the heart, arrhythmia (decrease in the level of K^+)	1. Irritation of the mucosa of the gastrointestinal tract (nausea, vomiting, diarrhea) 2. Hyperglycemia, a decrease in the synthesis of insulin 3. Urolithiasis 4. Increased blood clotting 5. Headache, tachycardia 6. Ulcerogenicity	1. Dyspeptic disorders 2. Headache, pain 3. Rashes on the skin
Contraindications	1. Hypersensitivity	1. Hypersensitivity	1. Hypersensitivity 2. Hyper coagulation (including acute thrombosis) 3. Erythremia, erythrocytosis	1. Hypersensitivity 2. Thrombophlebitis, a tendency to thrombosis 3. Diabetes mellitus (in high doses and long-term use)	1. Hypersensitivity 2. Pregnancy (I trimester)
NB!	Take into account physico-chemical incompatibility of vitamins when prescribing a combination. Vitamins B1, B6, B12, PP and C cannot be mixed in the same syringe, as they are destroyed or oxidized. **Vitamin overdose**: vitamin A – adsorbents, vitamin C, hepatoprotectors, diuretics, glucocorticoids; vitamin D - glucocorticoids, vitamins A and E, sodium sulfate, Na2-EDTA, insulin + glucose, symptomatic therapy; vitamin E – plasma substitution solutions, antihypertensive, hepatoprotectors. The most severe complication of vitamin therapy is anaphylactic shock (B1, B6, B12, PP, and C). Preference is given in most cases to multivitamin preparations. In practice, multivitamins are used for combined use in order to provide a more powerful and versatile action.				

CPK - creatine phosphokinase, ATP - adenosine triphosphate, FMN - flavin mononucleotide, FAD – flavin adenindinucleotide, NAD - nicotinamide adenine dinucleotide, NADP - nicotinamide adenine dinucleotide phosphate, BP - blood pressure, arterial hypertension, THF - tetrahydrofolic acid, CNS - central nervous System, Na2-EDTA-disodium salt of ethylenediaminetetraacetic acid

Enzyme and antienzyme agents

Read study guide for the topic «Drugs affecting digestive system».