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 29: **« ANTIBIOTICS (FINAL). SYNTHETIC ANTIMICROBIALS AGENTS»**

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

Antibiotics and synthetic antimicrobials are currently the most common medications. The success of antibiotic therapy depends largely on the proper selection of the optimal chemotherapeutic agents or their combinations for the treatment of a given patient. Properly administered antibiotic therapy prevents the chronicity of the acute infectious and inflammatory process, slows the progression of chronically infectious diseases, and in severe infectious processes is crucial to the life of the patient. To use them effectively and safely, the future physician must learn the mechanisms and spectrum of their antimicrobial action, the characteristics of the individual drugs and the peculiarities of their use.

Learning objective:

– formation of specialized competence of the application of knowledge of 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.

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. Classification of microorganisms. Microbial cell structure. Aggression factors of pathogenic microorganisms and spectra of antimicrobial action.
2. Structure and properties of sulfonamides and other antimicrobials, role of PABA in the life of microorganisms, routes of infection and mechanisms of infections.
3. The importance of saprophytes in the life of organisms.

CONTROL QUESTIONS ON THE TOPIC OF THE CLASS

1. Antibiotics that inhibit cell wall synthesis. Glycopeptides (vancomycin, teicoplanin). General characteristics of the group and individual drugs. Spectrum and mechanism of action. Applications and side effects.
2. Antibiotics disrupting cytoplasmic membrane permeability. Polypeptides (polymyxins B, M). Pharmacological characteristics.
3. Antibiotics that inhibit nucleic acid synthesis. Ansamycins (rifampicin). Pharmacological characteristics.
4. Antibiotics that inhibit protein synthesis. Aminoglycosides (aminocyclitols) (streptomycin, gentamicin, amikacin). Amphenicols (chloramphenicol). Lincosamides (clindamycin). Steroidal antibiotics (fusidic acid). Oxazolidinones (linezolid). Streptogramines (quinupristine/dalfopristine). Classification, pharmacodynamics, spectrum of antibacterial action of antibiotics of different groups, routes of administration, dosing principles, side and toxic effects, contraindications for prescription. Principles of combination antibiotic therapy.
5. Synthetic antimicrobial agents. Classification. Sulfonamides: sulfadimidine, sulfadiazine, sulfadimethoxin, sulfalene, phthalylsulfathiazole, sulfacetamide, combinations of sulfonamides with trimethoprim (co-trimoxazole). Oxyquinolines (nitroxoline). Nitrofurans: nitrofurantoin, furazolidone. Quinolones and fluoroquinolones: nalidixic acid, ciprofloxacin, ofloxacin, levofloxacin. Nitroimidazoles (metronidazole). Pharmacodynamics of synthetic antimicrobials, spectrum of antimicrobial action, use, side effects and their prevention.

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. 5-aminosalicylic acid preparations and their role in modern practical medicine.
2. Fluoroquinolones. Application in dentistry.
3. Antibiotics for therapy of hospital infections.

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

1. Kharkevitch, D.A. Pharmacology: textbook for med. students: transl. of 12th ed. of Russ. textbook "Pharmacology" (2017) / D.A. Kharkevitch. - 2nd ed. - Москва: ГЭОТАР-Медиа, 2019. - 676 с.: ил., табл. - Рек. ФГАУ "ФИРО". – Режим доступа: http://www.studmedlib.ru/book/ISBN5970402648.html – Дата доступа: 23.05.2022.
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.

AMPHENICOLS AND AMINOGLYCOSIDES [1-4]

Classification	Amfenicols	Aminoglycosides		
		I generation	II generation	III generation
Drugs	**1. Chloramphenicol (Levomycetin)**	**1. Streptomycin** **2. Neomycin** **3. Kanamycin**	**4. Gentamicin** **5. Tobramycin (tobrex)** **6. Nethylmycin**	**7. Amikacin**
Mechanism of action	It binds to the 50S-subunit of the bacterial ribosome → inhibits aminoacids integration into the polypeptide chain → inhibition of protein synthesis (mainly bacteriostatic action)	Attach to the 30S-subunit of the ribosome → disruption of their binding to transfer RNA → disturbance of protein synthesis of the microbial cell → cell death (bactericidal action)		
Spectrum of action	1. Gr (+) cocci: streptococci 2. Gr (-) cocci: Neisseria 3. Gr (-) sticks: escherichia, salmonella, Haemophilus influenzae 4. Intracellular parasites: rickettsia, chlamydia, mycoplasma	*Susceptible:* 1. Gr (-) intestinal bacteria: Salmonella, Shigella, Escherichia coli, Proteus, Klebsiella, Enterobacter, Serratia; 2. Mycobacterium tuberculosis (1,3,7); 3. Pseudomonas aeruginosa (4-7).	*Moderate susceptible:* 1. Gr (+) cocci: penicillins (including resistant to penicillin and some MRSA strains), streptococci (including enterococci); 2. Gr (-) cocci: meningococci, gonococci. *Resistant*: anaerobes and pneumococcus (are useless when community-acquired pneumonia)	
Indications	*Topically:* 1. Eye infections 2. Purulent inflammatory skin diseases *Systemically – the 2nd line drug:* 1. Bacterial meningitis, brain abscess 2.Intra-abdominal infections and infections of the pelvic organs 3.Typhoid fever, plague, gas gangrene, rickettsiosis	1. Pseudomonas aeruginosa (4-7) 2. Sepsis 3. Infective endocarditis 4. Fever in patients with neutropenia 5. Nosocomial pneumonia 6. Intra-abdominal infections, pelvic organs infections 7. Specific therapy: plague (1), tularemia (1.4), brucellosis (1), tuberculosis (1,3,7) 8. Antibiotic prophylaxis: decontamination of the intestine before routine operations on the large intestine (inside) (2)		
Side effects	Hematotoxicity (dose-dependent reticulocytopenia, thrombocytopenia and anemia); "Gray syndrome of newborns" (vomiting, bloating, respiratory disorders, cyanosis, later vasomotor collapse, hypothermia, acidosis); gastrointestinal disorders (nausea, vomiting, diarrhea, superinfections)	**Nephrotoxicity** (significant increase or decrease in the amount of urine, a decrease in glomerular filtration, increased serum creatinine levels), ototoxicity (irreversible hearing loss!), vestibulotoxicity (dizziness, impaired coordination of movements, gait alteration), neuromuscular blockade (weakness of diaphragmatic and other respiratory muscles, respiratory paralysis), headache, drowsiness, paresthesia, seizures, allergic reactions (rare), local reactions (phlebitis, thrombophlebitis)		
Contraindications	Allergic reactions in the anamnesis, pregnancy and lactation period, newborns, blood diseases	Allergic reactions in the anamnesis, pregnancy (only for vital indications!), lactation period (2)		
NB!	It is extremely rare even with topical application may occur idiosyncrasy - aplastic anemia (100% lethality!). It is necessary to monitor 2 times a week the level of platelets and reticulocytes. «Gray syndrome of newborns" occurs at doses> 50 mg / kg due to a low rate of metabolism in the liver.	1. The risk of side effects increases with prolonged administration (more than 7-10 days), hypokalemia, dehydration, the use of large doses. If neuromuscular blockade occurs, calcium chloride should be introduced. 2**.** Dosing is done only on kg of body weight. The entire daily dose should be administered once a day (except for the treatment of newborns, endocarditis and meningitis). 3. Monitoring of kidney function (creatinine clearance).		

MRSA – Methicillin-resistant staphylococcus aureus

LINCOSAMIDES AND POLYMIXINES [1-4]

Classification	**Lincosamides**		**Polymyxin**
	Natural	**Semisynthetic**	
Drugs	**1. Lincomycin**	**2. Clindamycin (Dalacin)**	**1. Polymyxin B** **2. Polymyxin M** **3. Polymyxin E (colistat)**
Mechanism of action	Suppress the synthesis of the microbial cells protein in the ribosomes (bacteriostatic action, in large doses - bactericidal action)		Violate the integrity of the cytoplasmic membrane of the microbial cell (bactericidal action)
Spectrum of action	1. Gr (+) cocci: staphylococci (except MRSA), streptococci, pneumococci 2. Anaerobes (but Cl. Difficile is resistant) 3. Protozoa: toxoplasma, pneumocysts, tropical malaria (2)		1. Gr (-) bacteria: E. coli, Salmonella, Shigella, Klebsiella, Enterobacteria, Pseudomonas aeruginosa. 2. Anaerobes: Fusobacteria and bacteroides are moderately sensitive
Indications	*Drugs of last resort:* 1. Streptococcal and staphylococcal infections 2. Infections caused by non-spore forming anaerobes: infections of the lower respiratory tract, skin and soft tissues, bones and joints, intra-abdominal infections and pelvic infections Locally: acne, bacterial vaginosis (2)		1. *A drug of last resort* for resistant pseudomonas infection; severe gram-negative infections caused by multidrug-resistant hospital strains (1.3); 2. Bacterial infections of the eyes, ear (locally) (1) 3. Local treatment of Pseudomonas aeruginosa (2)
Side effects	Allergic reactions, gastrointestinal disorders, pseudomembranous colitis, neutropenia, thrombocytopenia		**Severe nephrotoxicity** (increased serum creatinine and urea levels, development of acute tubular necrosis with pronounced proteinuria and hematuria), **neurotoxicity** (paresthesia, peripheral poly-neuropathies, impaired consciousness, hearing impairment, neuromuscular blockade with the threat of development of the respiratory muscles paralysis), **hematotoxicity** (thrombocytopenia), hypokalemia, hypocalcemia
Contraindications	Allergic reactions in the anamnesis, pregnancy and lactation, gastrointestinal disease in prior period (ulcerative colitis, antibiotic-associated enteritis or colitis)		Allergic reactions in the anamnesis, renal failure, myasthenia gravis, botulism, the use of neuromuscular blockers
NB!	Cross-resistance with macrolides is possible. Clindamycin is better than lincomycin since it has a wider indication for use and a high stable bioavailability when taken orally. In severe infections and sepsis should be combined with fluoroquinolones or aminoglycosides		Simultaneous administration of polymyxin with aminoglycosides increases its nephrotoxicity, and with neuromuscular blockers – neural-muscular transmission disturbance.

GLYCOPEPTIDES, OXAZOLIDINONS AND FUZIDIC ACID [1-4]

Classification	Glycopeptides		Oxazolidinones	Antibiotics of different groups
	I generation	**II generation (lipoglycopeptides)**		
Drugs	**1. Vancomycin** **2. Teicoplanin**	**3. Telavancin** **4. Dalbavancin**	**1. Linezolid (zivox)**	**1. Fusidic acid (fusidate)**
Mechanism of action	Attache to peptidoglycans of bacterial cells → inhibition of bacterial cell wall synthesis (bactericidal action).		Suppress bacterial protein synthesis (bacteriostatic action)	
Spectrum of activity	1. Gr (+) cocci: staphylococci (including MRSA and MRSE), streptococci, pneumococci, enterococci, 2. Anaerobes: clostridia (including Cl. Difficile), listeria, corynebacteria		Gr (+) cocci: including PRSA, MRSA, vancomycin-resistant enterococci	1. Gr (+) cocci: staphylococci (S. aureus, including MRSA; S. Epidermidis, including MRSE) 2. Anaerobes: Clostridia (including Cl. Difficile)
Indications	*Systemic administration:* 1. Generalized infections caused by sensitive strains of bacteria 2. Prevention of postoperative complications *Oral administration:* 3. Pseudomembranous colitis (Cl. Difficile) 4. Staphylococcal enteritis		*Staphylococcal and pneumococcal infections resistant to other drugs:* *1.* Lower respiratory tract infections 2. Infections of the skin and soft tissues 3. Enterococcal infections caused by vancomycin-resistant strains of Enterococcus faecalis and faecium	*A drug of last resort:* 1. Staphylococcal infections (with allergy or resistance to β-lactam antibiotics) 2. Pseudomembranous colitis
Side effects	Allergic reactions, phlebitis, ototoxicity (tinnitus, hearing impairment), nephrotoxicity, neutropenia, thrombocytopenia, red neck syndrome (chest and neck hyperemia, nausea, hypotension)		Allergic reactions, gastrointestinal disorders, hepatotoxicity, reversible anemia, thrombocytopenia	Gastrointestinal disorders, in rare cases – violations of the liver function, jaundice
Contraindications	Allergic reactions in the anamnesis, pregnancy and lactation			
NB!	**Vancomycin** isn't administered i/m (tissue necrosis!); is administered i/v slowly (in push administration the "red neck" syndrome develops due to the release of histamine from mast cells). **Teykoplanin** unlike vancomycin is more active against MRSA and enterococci, better tolerated, lasts longer (1 time per day), i/m administration and i/v push are allowed. **II** generation is characterized by broader activity and longer duration of action (administration once a day (3) or once a week. (4)		Has a high bioavailability (bioavailability is 100% even in oral administration)	It is non-toxic, but the resistance of microorganisms develops quickly.

PRSA – Penicillin-resistant staphylococcus aureus, MRSE – Methicillin-resistant epidermal staphylococcus, i/v – внутривенно, i/m – intramuscularly

SULPHANILAMIDE [1-4]

Classification	For resorptive use (well absorbed in the digestive tract)			For topical administration	Combined drugs
	Short-acting	**Long-acting**	**Ultra long-acting**		
Drugs	**1. Streptocide** **2. Sulfacaramide** **3. Sulfadimezine**	**4. Sulfapyridazine** **5. Sulfadimethoxin**	**6. Sulfalene**	**7. Sulfacil sodium (albucid)** **8. Silver sulfadiazine (dermazin)** **9. Phthalazole**	**10. Sulfamethoxazole / trimethoprim (co-trimoxazole, biseptol)** **11. Sulfadoxine / pyrimethamine (fanzi-dar)** **12. Sulfapyridine / 5-ASA**
Mechanism of action	Being structural analogues of PABA (necessary for bacterial growth) competitively inhibit the enzyme dihydrofolate synthetase involved in the folic acid synthesis			+ **The silver ion,** when combined with DNA, accumulates on the surface of bacteria nucleus and inhibits their growth and division	+ **Trimethoprim and pyrimethamine** block the enzyme dihydrofolate reductase
Spectrum of action	*Highly susceptible pathogens:* cocci (pneumococci, gonococci, meningococci, streptococci), intestinal bacteria (Escherichia coli, salmonella, vibrio cholerae), large viruses (trachoma, inguinal lymphogranulomatosis), chlamydia, causative agents of gas gangrene, diphtheria, etc. *Moderately susceptible pathogens:* staphylococci, enterococci, klebsiella, mycobacteria, actinomycetes, causative agents of leprosy, tularemia, leishmaniasis				1. Gr (+) cocci: staphylococci (including MRSA and PRSA), streptococci (except for β-hemolytic streptococcus A) 2. Gr (-) cocci: meningococci, morocelles 3. Gr (-) rods: E. coli, salmonella, Klebsiella, Haemophilus influenzae 4. Nocardia, pneumocysts, toxoplasm
Indications	1. Acute coccal infections (pneumonia, tonsillitis, bronchitis, sinusitis, otitis, cholecystitis, meningitis, etc.) (4-6,10) 2. Acute infections of the urinary and genital tract (cystitis, prostatitis, etc.) (2.10) 3. Eye infections (conjunctivitis, blepharitis, etc.) (7)			4. Burns and infected skin wounds (8) 5. Acute intestinal infections (dysentery, enteritis, colitis, etc.) (9), ulcerative colitis and Crohn's disease (12) 6. Treatment of trachoma, malaria, chlamydia, toxoplasmosis, actinomycosis, leprosy	
Side effects	Allergic reactions (dermatitis, Stevens-Johnson syndrome, etc.); violation of hematopoiesis (leukopenia, agranulocytosis, sulmmemoglobinemia, anemia); urinary disruption (crystalluria, hematuria, urinary retention); hepatotoxicity (hepatitis, in children jaundice due to insufficiency of glucuronyltransferase); neurotoxicity (dizziness, headache, depressive conditions); immunosuppression (10).				
Contraindications	Allergic reactions to sulfanilamides, furosemide, thiazide diuretics, carbonic anhydrase inhibitors, sulfonylurea preparations; do not use in children under 2 months, except for children of HIV-infected mothers; pregnancy; severe renal insufficiency; severe liver dysfunction; megaloblastic anemia associated with a deficiency of folic acid.				
NB!	In the acidic medium of urine sulphanilamides crystallize in the renal tubules, increased alkaline fluids are recommended. Alkaline medium promotes sulfonamides ionization and improves the drugs uptake by a microbial cell. Photosensitivity is provoked. Sulfanilamides increase effects of neuromuscular blockers and can cause respiratory muscles paralysis. In pregnant women, sulfonamides can affect the binding of bilirubin to protein and cause fetus hyperbilirubinemia. Drugs have a teratogenic effect, can cause hemolysis, jaundice of newborns, methemoglobinemia, congenital disorders of the nervous and cardiovascular systems. Within long-term treatment with sulfonamides, mandatory hematological monitoring is necessary.				

HIV - human immunodeficiency virus, PABA - para-aminobenzoic acid

QUINOLONES AND FLUOROQUINOLONES [1-4]

Classification	Non-fluorinated quinolones	Fluoroquinolones		
		I generation ("Gram-negative" mono-fluoroquinolones)	**II generation ("Respiratory" difluoro-quinolones)**	**III generation ("Respiratory-anti-anaerobic" trifluoroquinolones)**
Drugs	**1. Nalidixic acid (nevigramon)** **2. Oxolinic acid** **3. Pipemidic acid (palin)**	**4. Norfloxacin** **5. Ofloxacin** **6. Pefloxacin** **7. Ciprofloxacin**	**8. Levofloxacin** **9. Sparfloxacin**	**10. Moxifloxacin** **11. Gemifloxacin** **12. Gatifloxacin**
Механизм действия	DNA gyrase is inhibited. Affect the RNA of bacteria and the synthesis of bacterial proteins, the stability of membranes and other life processes of bacterial cells (bactericidal action)			
Spectrum of action	Gr (-) bacteria: Escherichia coli, Shigella, Proteus	Gr (-) bacteria, S. aureus; Low activity against Streptococcus pneumoniae, Mycoplasma, Chlamydophila	Gr (-) bacteria, S. aureus + high activity against Streptococcus pneumoniae, Mycoplasma pneumoniae, Chlamydophila pneumoniae	The same + anaerobes, atypical pathogens
Indications	1. Urinary tract infections: acute cystitis, antiretroviral therapy for chronic forms of infection. Do not use for acute pyelonephritis. 2. Intestinal infections: shigellosis, bacterial enterocolitis (1).	1. Upper respiratory tract infections: sinusitis, especially caused by multiresistant strains, malignant external otitis media. Infections of the lower respiratory tract: exacerbation of chronic bronchitis, community-acquired and nosocomial pneumonia, legionellosis. 2. Intestinal infections: shigellosis, typhoid fever, generalized salmonellosis, iersiniosis, cholera. 3. Anthrax. 4. Intra-abdominal infections and infections of the pelvic organs. 5. Urinary tract infections: (cystitis, pyelonephritis). Prostatitis. Gonorrhea. 6. Infections of the skin, soft tissues, bones and joints. 7. Eye infections. 8. Sepsis. 9. Tuberculosis in combination therapy for drug-resistant tuberculosis (5,6).		
Side effects	Digestive disorders (heartburn, pain in the epigastric region, anorexia, nausea, vomiting, diarrhea); central nervous system disturbance (ototoxicity, drowsiness, insomnia, headache, dizziness, visual impairment, paresthesia, tremor, convulsions); allergic reactions (rash, itching, angioedema); photosensitization.			
Contraindications	Allergic reaction; deficiency of glucose-6-phosphate dehydrogenase; pregnancy.			
	+ Severe dysfunction of the liver and kidneys; severe cerebral atherosclerosis.	+ Childhood; lactation.		
NB!	Absorption of fluoroquinolones in the gastrointestinal tract (unlike non-fluorinated quinolones) is not disturbed by food, but it deteriorates sharply with the use of divalent calcium, iron, magnesium, aluminum, zinc cations. The combination of fluoroquinolones with theophylline, metronidazole, and NSAIDs can cause a convulsive reaction. Fluoroquinolones can increase the photosensitivity of tissues. In the course of treatment with fluoroquinolones and during 3 days after its termination, contact with UV-irradiation is excluded.			

NITROFURANES, OXYCHINOLINES AND NITROIMIDASEZOLES [1-4]

Classification	Nitrofurans	Nitroimidazoles	Oxyquinolines
Drugs	**1. Nitrofurantoin (furadonin)** **2. Furazidine (furamag)** **3. Nifuroxazide** **4. Furazolidone** **5. Nitrofural (furacilin)**	**6. Metronidazole (Trichopolum)** **7. Tinidazole** **8. Ornidazole**	**9. Nitroxoline**
Mechanism of action	Being oxygen acceptors, they break the process of cellular respiration of bacteria, inhibit the biosynthesis of nucleic acids (depending on the concentration have a bacteriostatic or bactericidal effect)	Active reduced forms of drugs disrupt DNA replication and protein synthesis in a microbial cell; inhibit tissue respiration (bactericidal action)	Violate protein synthesis, form chelates, enhancing oxidative processes in the cytoplasm (bactericidal action)
Spectrum of activity	1. Gr (+) cocci: streptococci, enterococci, staphylococci). 2. Gr (-) bacteria: intestinal group. 3. Protozoa: Giardia, Trichomonas (4).	1. Anaerobic bacteria 2. Helicobacter 3. The simplest (Trichomonas, Giardia, Amoeba, Balance-Tidia) 4. Gardnerella	1. Gr (+) and Gr (-) bacteria (staphylococci, enterobacteria, etc.) 2. The simplest (amoeba, lamblia, balantidia) 3. Pathogenic fungi (candida)
Indications	1. Infections of the lower sections of the urinary tract: acute cystitis, suppressive therapy of chronic infections (1, 2) 2. Preventive maintenance of infectious complications at urological operations, a cystoscopy, a catheterization of a bladder (1,2) 3. Intestinal infections: acute infectious diarrhea, enterocolitis (3) 4. Giardiasis, trichomoniasis (4) 5. Local washing of wounds and cavities (2.5)	*Systemically:* *1.* Anaerobic infections of different locations 2. Pseudomembranous colitis 3. Perioperative prophylaxis for intra-abdominal and gynecological interventions 4. Protozoal infections 5. Eradication of H. pylori in peptic ulcer disease *Topically:* vaginitis, bacterial vaginosis, rosacea, seborrheic dermatitis, perioral dermatitis.	Acute uncomplicated cystitis - treatment, prevention (as a drug of the II line)
Side effects	Allergic reactions (rash, eosinophilia, fever, arthralgia, myalgia, drug induced lupus erythematosus, rarely anaphylactic shock); disorders of the gastrointestinal function (nausea, vomiting, diarrhea), liver (transient increase in transaminase activity, cholestasis, hepatitis), lungs (pneumonitis, bronchospasm, cough, pain in the chest), nervous system (dizziness, headache, general weakness, drowsiness, peripheral polyneuropathies); hematological reactions (leukopenia, megaloblastic or hemolytic anemia).	Digestive disorders (bad taste in the mouth, abdominal pain, nausea, vomiting, diarrhea), CNS (headache, dizziness, impaired coordination of movements, impaired consciousness, seizures, in rare cases - epileptic seizures); allergic reactions (rash, itching); hematological reactions (leukopenia, neutropenia); topical reactions (phlebitis and thrombophlebitis after intravenous administration); cutaneous manifestations (photodermatitis).	Peripheral neuro- and myopathy, optic nerve damage, allergic reactions, abdominal pain and nausea.
Contraindications	Allergic reactions; renal failure (1,2); severe liver disease (4); deficiency of glucose-6-phosphate dehydrogenase; pregnancy - III trimester (1); newborn period.	Allergic reactions; organic diseases of the central nervous system with severe clinical manifestations; pregnancy (I trimester); lactation.	Diseases of the peripheral nervous system, liver; kidney failure; pregnancy, lactation; newborns.
NB!	Have disulfiram-like effect → can't be taken with alcohol. When taking nitrofurans tyrosine-contained products (cheese, cream, bananas) should be excluded from the diet due to the risk of increased blood pressure	The half-life of metronidazole is shorter than one of tinidazole and ornidazole, so it is prescribed 3 times a day, other drugs 1-2 times a day. They have a disulfiram-like effect (6, 7). May cause dark coloration of urine (6, 7).	During treatment with nitroxoline, saffron-yellow color of the tongue, urine and feces is possible.