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DEVELOPMENT OF FUNCTIONAL NANOSTRUCTURES EFFECTIVE AGAINST BACTERIA BIOFILMS INCLUDING MULTIDRUG RESISTANT BACTERIA

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The emergence and distribution of antibiotic resistant strains of bacteria is one of the most world's pressing public health problems. Multidrug resistant (MDR) bacteria exhibit resistances to most antibiotics and, sometimes, to nearly all commercially available antibiotics. Besides, the persistence of bacteria in the body mainly in the state of biofilm reduces significantly the effectiveness of antibacterial therapy. Even antibiotic-sensitive strains in the state of the biofilm are weakly responsive towards antibiotics. There is an urgent need for development of new antibiotic treatment strategies against MDR bacteria and bacteria biofilms. The most potentially successful strategy may be the transition from classical therapy to the use of high-tech tools based on nanomaterials.

The purpose of this study was the development of new antimicrobial agents based on nanostructured materials of organic and inorganic origin. Antibacterial properties of nanostructured classical antibiotics (tetracycline), metal particles and their oxides, magnetically controlled nanocomposites with encapsulated antibiotic (ciprofloxacin) were investigated.

The preliminary results demonstrate the high antimicrobial activity of the developed materials. Nanostructuring of tetracycline increased its effectiveness up to 40% against a resistant strain, compared with the original antibiotic form. Particles of metals and their oxides showed excellent antimicrobial properties, including against antibiotic-resistant strains, but many of them can cause some cytotoxic effect in the macroorganism. Magnetically controlled nanocomposites with encapsulated ciprofloxacin demonstrated an increase in efficiency of up to 76% compared to the initial form of the antibiotic due to magnetically controlled effects of mechanical disintegration of the biofilm, accumulation and release of the composite inside the biofilm. Also, synergism in antibacterial action may be due to local alkalization due to recrystallization of calcium carbonate.

Thus, the results of this study can create a scientific basis for the development of new antimicrobial agents based on nanostructured materials effective against biofilms and antibiotic-resistant strains of bacteria.

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KLEBSIELLA PNEUMONIAE AND ITS GENES OF RESISTANCE TO BETA-LACTAMAMS IN PSYCHIATRIC HOSPITAL

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The aim of the study was to characterise of phenotype and genotype of antibiotic resistance in *Klebsiella pneumoniae*, isolated in psychiatric hospital.

215 strains of *K. pneumoniae*, isolated from sputum, urine, wounds and blood of the patients in 2016 were studied. Bacteria were identified using classical methods, antibiotic resistance was studied according to MUK 2004, Clinical guidelines for antimicrobial sensitivity determination, 2015. Beta-lactamases gene detection was performed by PCR.

Klebsiella showed high resistance levels to inhibitor-protected penicillins (86.5%) and cephalosporins (77.7%). Resistant to fluorochinolones were 51.6% strains, to carbapenems (meropenem) — 32.6% of isolated strains. The lowest resistance level was observed in amikacin and fosfomycin — 17.2% and 4.6% resistant strains respectively. Multidrug resistant were 59.3% of isolated *K. pneumoniae* strains. Almost a quarter — 24.7%, of strains showed associated resistance to inhibitor-protected penicillins, cephalosporins, fluoroxhinolones and carbapenems. Extreme antibiotic resistance was observed in 9.8% isolates — they were sensitive to colistin. Detection of beta-lactamases genes was performed in 30 cultures, bla_{CTX} was found in 80.0% of strains, bla_{TEM} — in 70.0%, bla_{OXA-48} and bla_{NDM-1} were found in 6.7% and 86.7% of strains respectively; bla_{OXA-48} gene was combined with bla_{NDM-1} in 6.7% isolates. The most frequently encountered beta lactamases were combination of bla_{CTX}, bla_{TEM} and bla_{NDM-1} (70.0%). Other genes combinations were revealed less frequently: bla_{CTX}, bla_{TEM} and bla_{NDM-1} were present in 6.7% strains, bla_{CTX} and bla_{NDM-1} — in 3.3%. Bla_{NDM-1} only was detected in 6.7% *K. pneumoniae*,

Resistant to antibiotics strains of *K. pneumoniae* prevailed in psychiatric hospital, third of isolates were resistant to carbapenems. The most common combination of resistance determinants for carbapenem-resistant strains was bla_{CTX}, bla_{TEM} and bla_{NDM-1} — 70%. Spread of carbapenemases, mostly NDM-1 producing *K. pneumoniae* strains, is a dangerous sign of the significant decrease in carbapenems efficacy towards infections, caused by *K. pneumoniae* and confirm the necessity of antimicrobial resistance monitoring in hospitals strains.

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RESISTANCE TO ANTIBIOTICS OF DIARRHEAGENIC *ESCHERICHIA COLI* IN PSYCHIATRIC HOSPITAL

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The aim of the study was estimation of antibiotic resistance in diarrheagenic *Escherichia coli*, isolated in psychiatric hospital in St. Petersburg.

Study of susceptibility to antibiotics in 123 strains of *E. coli* was carried out according to guidelines MUK 4.2.1890-04, 2004. Cultures were isolated from feces of patients of a psychiatric hospital in 2016–2017.

Diarrheagenic *E. coli* in psychiatric hospital were represented by enteroinvasive (48.0%) and enterotoxigenic *E. coli* (47.2%) mainly. Ratio of enterohemorrhagic *E. coli* (EHEC) was small (4.9%). Enteroinvasive *E. coli* (EIEC) included representatives of 3 serogroups, with prevalence (34.1%) of O144. Other serogroups were rare (8.1% for O151 and 5.7% for O124 strains). Enterotoxigenic *E. coli* (ETEC) included representatives of 3 serogroups, most common were O6 (26.1%) and O25 (20.3%). Only one strain of O85 serogroup (0.8%) was isolated in 2017. EHEC was presented with one serogroup O1 (4.9%). Number of strains of diarrheagenic *E. coli* increased two-fold in 2017 compared with 2016. The proportion of the EIEC O144 increased eight-fold. There was more than two-fold increase of ETEC O25. Proportion of *E. coli* belonging to other serogroups changed slightly with the exception of EHEC O1, the number of strains decreased from 5 in 2016 to 1