

The Global Threat Of Antibiotic-Resistant Microorganisms

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Annotation

This article discusses the causes of the formation of antibiotic-resistant microorganisms, the mechanisms of their spread, and the global medical and socio-economic risks. The emergence of resistant strains as a result of the improper and uncontrolled use of antibiotics, as well as their widespread use in veterinary medicine and agriculture, is scientifically analyzed. The complexity of the treatment of infectious diseases due to resistant microorganisms, increased mortality rates, and increased healthcare costs are shown. The main directions of combating antibiotic resistance, including rational antibiotic therapy, preventive measures, and the prospects for the development of new antibacterial drugs, are also discussed. The results of the article justify the need for a comprehensive and systematic approach to ensuring global health security.

Keywords: antibiotic resistance, microorganisms, global risk, infectious diseases, healthcare, biofilm, enzymes.

INTRODUCTION

Today, antibiotic-resistant microorganisms are recognized as a serious global threat to the world's health system. The fact that the effectiveness of antibiotics widely used in the treatment of infectious diseases is decreasing every year is directly related to the rapid spread of resistant strains. In particular, the incorrect, excessive and uncontrolled use of antibiotics increases the adaptability of microorganisms and forms their resistance mechanisms at the genetic level. The ability of microorganisms to form biofilms plays an important role in the development of antibiotic resistance. Biofilms protect bacteria from the effects of the external environment, including antibiotics and immune system factors, complicating the treatment process. Microorganisms contained in biofilms are several times more resistant than free-form bacteria, causing the development of chronic and recurrent infections. Also, various enzymes produced by microorganisms, in particular β -lactamases, modifying enzymes and efflux systems, play an important role in the inactivation of antibiotics. These enzymatic mechanisms

enhance resistance by degrading the antibiotic molecule or limiting its entry into the cell. As a result, standard treatment methods are ineffective. In this regard, a deep study of the properties of biofilm formation and enzymatic mechanisms of antibiotic-resistant microorganisms is of great importance in developing effective strategies against resistance. This article aims to reveal the global significance of the problem of antibiotic resistance, analyze its main biological mechanisms, and scientifically substantiate modern preventive and therapeutic approaches. The discovery of antibiotics revolutionized 20th-century medicine. The discovery of penicillin by Alexander Fleming in 1928 ushered in a new era in the fight against infectious diseases. Since then, various classes of antibiotics have been developed, making it possible to effectively treat previously fatal diseases such as pneumonia, tuberculosis, and sepsis. However, the widespread and often uncontrolled use of antibiotics has reduced their effectiveness and led to the emergence of resistant forms of bacteria.

LITERATURE REVIEW AND METHODOLOGY

In recent decades, antibiotic resistance (AMR) has become one of the most pressing problems for the global health system. According to the World Health Organization (WHO), antibiotic-resistant infections threaten the lives of millions of people every year, and this figure is increasing year by year. The scientific literature indicates that the main causes of antibiotic resistance are uncontrolled and inappropriate use of antibiotics, their widespread use in veterinary medicine and agriculture, as well as inadequate implementation of infection control measures.

1. Davies and Davies (2010) argued that antibiotic resistance is the result of genetic adaptation of bacteria, justifying the rapid spread of resistance genes via plasmids

2. Livermore (2012) studies have noted the increasing number of multidrug-resistant strains among gram-negative bacteria, in particular *Escherichia coli*, *Klebsiella pneumoniae* and *Pseudomonas aeruginosa*. These microorganisms

inactivate antibiotics by producing beta-lactamase, carbapenemase and other enzymes.

In recent years, the role of microorganisms that form biofilms in resistance has received special attention. Donlan (2001) proved that bacteria in a biofilm state are several times more resistant to antibiotics than free cells. Biofilms contain high levels of enzymes (beta-lactamases, proteases), which sharply reduce the effectiveness of drugs. Local and regional studies have also noted an increase in antibiotic-resistant strains.

Methodology: This article is based on the method of systematic analysis of scientific sources. Selected articles and books highlight modern, antibiotic-resistant microorganisms and their global threat, their effectiveness. The data is taken from the most recent scientific studies in terms of quality, between 2015 and 2025.

DISCUSSION AND RESULTS

Some types of microorganisms were tested for antibiotic resistance.

Microorganisms resistant to certain antibiotics and their clinical significance

Mikroorganism	Endurance type	Research results	Source
<i>Staphylococcus aureus</i>	Methicillin-resistant	Treatment has become more difficult, hospital infections have increased	WHO, 2020
<i>Mycobacterium tuberculosis</i>	Multidrug resistance	Treatment duration extended, risk of death increased	CDC, 2021
<i>Escherichia coli</i>	β -lactamase producer	Sepsis and urinary tract infections have increased	Johnson et al., 2022
<i>Pseudomonas aeruginosa</i>	Carbapenem-resistant	Antibiotics are ineffective in severe diseases	Lee et al., 2023

Note: Data shows that antibiotic-resistant microorganisms are complicating the treatment of diseases and placing a significant economic and social burden on the healthcare system.

SUMMARY

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Antibiotic-resistant microorganisms are one of the most serious global problems for modern medicine. Studies show that as a result of the inappropriate and excessive use of antibiotics, many pathogenic bacteria are developing resistance. In particular,

microorganisms such as MRSA, MDR-Myco**acterium tuberculosis**, ESBL-producing *Escherichia coli* and carbapenem-resistant *Pseudomonas aeruginosa* complicate the treatment process. Biofilm formation, synthesis of antibiotic-degrading enzymes, alteration of target proteins and efflux pumps are shown as the main mechanisms of resistance. These processes sharply reduce the effectiveness of antibiotics, lead to a prolonged course of the disease, increased complications and mortality. The results show that antibiotic resistance is not only a clinical problem, but also a socio-economic and global health problem. Therefore, rational use of antibiotics, infection control, development of new therapeutic approaches against biofilms and enzymes, and the creation of a new generation of antimicrobial agents remain urgent tasks.

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