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Mechanisms of The Emergence of Resistance of Bacteria to Antibiotics, Methods of Combating Them in Medicine

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Abstract: This article analyzes the nature of bacterial resistance to antibiotics and drugs, the mechanisms of its occurrence, its impact on human health and ways to prevent it. Resistance in bacterial populations is caused by improper antibiotic administration, genetic mutation of bacteria, antibiotic resistance, and adaptive properties. Complex mechanisms such as DNA-mediated gene transfer in plasmids, efflux pumps, help ensure the duration of the life activity of bacteria. The study of the emergence of an antibiotic resistance property serves as a basis in medicine to prevent and combat the incidence of pathogenic bacteria

Key words: resistance, antibiotic, genetic mutation, plasmid, Efflux pumps, bacterial population, pathogenic bacteria

INTRODUCTION

Antibiotics, discovered in the 20th century, have played a critical role in treating various diseases like pneumonia, sepsis, ulcerative infections, and urinary tract inflammation. However, the emergence of antibiotic resistance among bacteria is creating significant challenges for global health systems. The World Health Organization (WHO) estimates that by 2050, bacterial resistance could lead to 10 million deaths annually, compared to the 700,000 deaths recorded in

2024. In response, efforts such as stricter antibiotic control and limiting over-the-counter sales of antibiotics are being implemented. Non-compliance with medical prescriptions, including taking antibiotics without a doctor's advice or altering prescribed dosages, contributes significantly to this growing issue. According to a study published in *The Lancet* in 2023, 70% of antibiotic resistance-related deaths occur in low- and middle-income countries, exacerbated by inadequate hygiene practices in hospitals and poor disease control. The misuse of antibiotics, particularly among outpatients, leads to the development of resistance, and the spread of resistant bacteria has extended beyond clinical settings into wastewater systems, livestock, and agricultural products.

Goal

The aim of this study is to assess the spread of antibiotic-resistant bacteria, analyze their genetic, physiological, and biochemical mechanisms, and evaluate laboratory findings from health institutions in Uzbekistan. A specific focus will be on the role of plasmids in promoting antibiotic resistance. Additionally, this research aims to develop methods for early detection of antibiotic-resistant bacterial strains in clinical settings and propose preventive measures to address this growing issue. The study also explores modern approaches, including bacteriophage therapy, probiotics, and novel antimicrobial agents, to combat antibiotic resistance.

Materials and Methods

Samples from laboratory tests conducted in 2023-2024 at the Bukhara State Medical Institute's microbiology department were analyzed. A total of 180 bacteriological samples (blood, urine, wound swabs) were examined. Research methods included:

1. **Cultivation** - Growing bacteria on nutrient media to observe growth patterns and colony morphology.
2. **Antibiotic Sensitivity Determination** - Utilizing the Kirby-Bauer disk diffusion method.
3. **Genetic Identification** - Using PCR (Polymerase Chain Reaction) for genetic analysis.

These methods helped identify NDM-1 and MRSA genes, and the data was analyzed using the SPSS 26.0 program. Statistical analysis was conducted three times, and bacterial species were confirmed when significant differences ($P < 0.05$) were observed. The experiments adhered to biosafety level 2 (BSL-2) conditions to ensure high-resolution data quality.

Results

Analysis of the 180 bacteriological samples revealed that 34% contained *Staphylococcus aureus*, 29% *Escherichia coli*, 22% *Klebsiella pneumoniae*, and 15% other Gram-negative bacteria. Among the species, 38% were methicillin-resistant *Staphylococcus aureus* (MRSA), 41% of *Escherichia coli* were ESBL-producing, and 19% of *Klebsiella pneumoniae* were carbapenem-resistant. Moreover, 6% of all bacteria carried the NDM-1 gene, indicating widespread antibiotic resistance in Uzbekistan’s hospitals. The samples from blood (45%), urine (33%), and wound exudates (22%) all showed significant bacterial growth.

The study also found that antibiotic resistance was most prevalent in patients aged 18-45, likely due to improper self-medication and antibiotic misuse. Additionally, improper storage and incorrect dosing of antibiotics further enhance bacterial resistance. The prolonged treatment duration, increased healthcare costs, and higher complication rates are long-term consequences of this issue.

Discussion

Antibiotic-resistant bacteria, particularly MRSA, ESBL-producing *Escherichia coli*, and carbapenem-resistant *Klebsiella pneumoniae*, are increasingly prevalent in Uzbekistan. These bacteria are resistant to multiple antibiotics, making infections harder to treat and control. Social factors, such as the widespread use of antibiotics without proper medical supervision and the improper storage of drugs, contribute significantly to the development of resistance. Moreover, antibiotic resistance is exacerbated by insufficient hygiene in healthcare facilities and inadequate infection control measures.

The development of a new generation of antibiotics and the proper use of existing antibiotics are essential to combating this problem. Additionally, bacteriophage therapy, which involves using viruses to target specific bacteria, is a promising solution for treating resistant infections. Uzbekistan's new antimicrobial policy, launched in 2024, aims to control the sale of antibiotics and strengthen laboratory checks, while the "AMR Watch Uzbekistan" project, in collaboration with the WHO, enables real-time monitoring of antibiotic resistance.

Conclusion

Antibiotic resistance is a pressing global issue that threatens to render many existing treatments ineffective. The results from this study highlight the increasing prevalence of resistant bacteria such as MRSA, ESBL-producing *Escherichia coli*, and carbapenem-resistant *Klebsiella pneumoniae* in Uzbekistan. Addressing this issue requires stringent infection control measures, improved antibiotic stewardship, and the development of new therapeutic options such as bacteriophage therapy and probiotics. The introduction of policies like the AMR Watch Uzbekistan project and educational programs on the rational use of antibiotics is a step in the right direction. Continued scientific research and collaboration between health sectors are crucial for combating antibiotic resistance and ensuring the effectiveness of current medical treatments.

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