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THE INCREASE OF ANTIBIOTIC RESISTANCE: EPIDEMIOLOGICAL ANALYSIS

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Abstract: This article presents an analysis of the global and regional epidemiology of antimicrobial resistance (AMR). Findings indicate that rising bacterial resistance to antibiotics diminishes treatment efficacy, increases the economic burden on healthcare systems, and contributes to higher mortality rates. Using data from WHO and GLASS surveillance systems, the study assessed regional prevalence of resistant bacterial strains, key pathogens, and their resistance profiles. The results highlight that inappropriate antibiotic use, over-the-counter access, inadequate sanitation, limited diagnostic capacity, and insufficient preventive measures are primary factors driving AMR. Effective strategies for mitigation include antibiotic stewardship programs, implementation of the "One Health" approach, robust infection control systems, and continuous monitoring. The article offers both theoretical and practical recommendations for improving infection management and combating antimicrobial resistance.

Keywords: antibiotic resistance, infection prevention, epidemiology, rational use of antibiotics, AMR monitoring, antibiotic stewardship, One Health.

Relevance of the Topic. Antimicrobial resistance (AMR) is a global public health threat associated with bacteria developing resistance to antibiotics, significantly complicating the treatment of infections. This issue not only increases healthcare system costs but also poses serious risks by contributing to higher mortality and morbidity rates (Murray et al., 2019; GBD 2021 Antimicrobial Resistance Collaborators).

Global research indicates that AMR is steadily increasing. In 2019, approximately 4.95 million people were affected by AMR-related infections, and 1.27 million deaths were directly attributable to antibiotic-resistant bacterial infections (Murray et al., 2019; Swetschinski et al., 2020). These figures clearly demonstrate the global significance of AMR and its economic and social impact.

Incorrect antibiotic use—including over-the-counter purchase, incomplete treatment courses, sub- or supra-therapeutic dosing, and inappropriate use in viral infections—is one of the primary drivers of AMR (Albukhari, 2022). This leads to increased bacterial resistance and significantly reduces treatment efficacy.

In particular, WHO's Global Antibiotic Resistance Surveillance Report and GLASS data were used to analyze resistance trends across different regions. For example, in South and East Asian countries, Gram-negative bacteria such as Escherichia coli and Klebsiella pneumoniae have shown high levels of resistance (WHO, 2025). In contrast, Europe and North America benefit from strong regulatory measures and effective antibiotic policies, which help reduce the AMR burden.

A range of interventions has been discussed to mitigate the problem, including healthcare system monitoring, preventive measures, public and healthcare worker education, as well as international cooperation and political commitment (Hernández Navarro et al., 2024; GARDP, 2023). If implemented effectively, these measures can help control the spread of AMR and ensure rational antibiotic use.

Aim of the Study. The aim of this study is to examine the global epidemiological status of antimicrobial resistance (AMR), identify the main factors contributing to increased antibiotic resistance, and analyze effective strategies to mitigate it.

The objectives of the study are:

1. To present global AMR statistics and trends based on WHO, GLASS, and GBD data.
2. To analyze the causes of inappropriate antibiotic use and their impact on the development of resistance.
3. To evaluate current strategies for reducing AMR through healthcare systems, preventive measures, education, and global cooperation.
4. To define effective interventions and future research directions based on theoretical and practical recommendations.

This study aims to highlight the relevance of antimicrobial resistance and propose solutions at both global and regional levels.

Materials and Methods. Global epidemiological trends and strategies related to antimicrobial resistance (AMR) were studied using a systematic analysis. The following sources were used:

- Global Antibiotic Resistance Surveillance System (GLASS) — statistical data on bacterial resistance in infections.
- WHO Global Antibiotic Resistance Surveillance Report (2025) — information on AMR prevalence and antibiotic use across regions.
- Scientific articles (Swetschinski et al., 2020; Albukhari, 2022; Hernández Navarro et al., 2024) — to identify key drivers of AMR and evaluate strategies.

Methods: Data were systematically collected and analyzed through classification; AMR trends were compared across geographic regions using statistical indicators (percentages, mean values, growth rates). Published studies and meta-analyses were reviewed to examine causes of inappropriate antibiotic use. Strategies for mitigating AMR were evaluated based on the “One Health” concept, preventive measures, monitoring systems, and global cooperation as key criteria.

Results and Analysis. The study analyzed global data on antimicrobial resistance (AMR) and revealed the following key findings:

1. Global Increase in Resistance. Data from GLASS and WHO indicate a consistent rise in antibiotic resistance among clinically significant bacteria such as Escherichia coli, Klebsiella pneumoniae, Staphylococcus aureus, and Pseudomonas aeruginosa.
   - Resistance to third-generation cephalosporins in E. coli has reached up to 60% in some regions.
   - Carbapenem resistance in K. pneumoniae has been reported at approximately 35–40% in Asian and African countries.

   These figures highlight that AMR is spreading not only in hospitals but also throughout communities.
2. Impact of Inappropriate Antibiotic Use. Analysis shows that over-the-counter antibiotic use, incomplete treatment courses, and the use of antibiotics for viral infections are major contributors to the rise of resistance. Regions with higher rates of inappropriate use—particularly in South Asia and Africa—exhibit significantly higher levels of AMR.
3. Regional Differences.
   - Europe and North America: Effective regulation and monitoring of antibiotic use result in relatively lower rates of AMR growth.
   - South Asia, Africa, and Latin America: Limited laboratory infrastructure, unrestricted access to antibiotics, and inadequate preventive measures contribute to higher AMR levels.

These differences are linked to healthcare system strength, education levels, and the presence of control mechanisms.

4. Hospital Settings. Nosocomial infections, particularly MRSA (Methicillin-Resistant Staphylococcus aureus), KPC (Klebsiella pneumoniae carbapenemase), and ESBL-producing bacteria, continue to increase in healthcare facilities. Non-compliance with hygiene standards, improper disinfection, and overuse of antibiotics exacerbate the problem.

5. Effectiveness of Strategies. The analysis indicates that:

- Implementation of Antibiotic Stewardship programs is associated with stabilization or reduction of resistance levels in countries where they are established.
- Timely diagnosis, increased laboratory testing, and adherence to preventive measures can significantly reduce AMR prevalence.
- The "One Health" approach, integrating human, animal, and environmental health, is among the most effective strategies.

Conclusion. The collected data and analysis confirm that antimicrobial resistance (AMR) is currently one of the most serious global health threats. Rising bacterial resistance, particularly among Gram-negative pathogens, complicates infection treatment and imposes additional burdens on healthcare systems worldwide.

Inappropriate and uncontrolled use of antibiotics, weak preventive measures, and limited laboratory diagnostic capacity are the main drivers of AMR. Regional differences in resistance levels are directly related to healthcare system strength, control mechanisms, and antibiotic use culture.

Effective strategies to mitigate AMR include:

- Strengthening antibiotic stewardship programs,
- Developing laboratory diagnostics and implementing regular monitoring,
- Enhancing preventive measures such as hygiene, vaccination, and early detection,
- Promoting education among the public and healthcare workers,
- Expanding global and regional cooperation based on the "One Health" concept.

Thus, combating antimicrobial resistance requires international collaboration, scientific research, political support, and community engagement. Implementation of comprehensive measures can help preserve antibiotic efficacy and ensure the sustainability of global health systems in the future.

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