Balagrae University

Faculty of Medicine

Antibiotic Resistance: Causes, Consequences, and Global Management Strategies

Prepared by: Ehab Tawfiq Ragab

Student Number: 1129

Date: December 2025

•Introduction

•Antibiotics have been one of the greatest medical discoveries of the 20th century, transforming healthcare by making once-lethal infections treatable. Since the introduction of penicillin in the 1940s, antibiotics have saved millions of lives and enabled complex medical procedures such as organ transplantation, chemotherapy, and major surgeries. However, the misuse and overuse of antibiotics in humans, animals, and agriculture have accelerated the emergence of antibiotic-resistant bacteria. According to the World Health Organization (WHO), antimicrobial resistance (AMR) is among the top ten global public health threats. The article by Michael et al. (2014) emphasizes that we are entering a post-antibiotic era, where common infections and minor injuries may once again become fatal.

●Causes of Antibiotic Resistance

Several factors contribute to the rapid rise of antibiotic resistance:

Overuse in Clinical Practice

•Physicians often prescribe antibiotics empirically without diagnostic confirmation. In many cases, antibiotics are given for viral infections such as influenza, where they are ineffective.

•Incomplete Treatment Courses

Patients frequently stop taking antibiotics once symptoms improve, leaving partially resistant bacteria alive to multiply.

•Agricultural Misuse

Antibiotics are widely used in livestock and crops to promote growth and prevent disease. This creates strong selective pressure in the environment, allowing resistant strains to emerge and spread to humans through food chains.

•Self-Medication and OTC Sales

In many countries, antibiotics are available without prescription, leading to uncontrolled use.

•Globalization and Travel

Resistant strains spread rapidly across borders due to international travel and trade, making AMR a truly global issue.

●Mechanisms of Resistance

Bacteria employ several mechanisms to resist antibiotics:

•Genetic Mutation: Random DNA changes can confer survival advantages under antibiotic pressure.

•Horizontal Gene Transfer (HGT): Resistance genes spread via plasmids, transposons, and integrons, allowing rapid dissemination across species.

•Biofilm Formation: Bacteria in biofilms are up to 1,000 times more resistant to antibiotics.

•Efflux Pumps: Specialized proteins expel antibiotics from bacterial cells, reducing drug efficacy.

•These mechanisms highlight the adaptability of microbes and the evolutionary nature of resistance.

•Consequences of Resistance

The consequences of antibiotic resistance are profound:

•Clinical Impact: Resistant infections lead to longer hospital stays, higher mortality, and limited treatment options.

•Economic Burden: The global cost of AMR is projected to reach $100 trillion by 2050 if no action is taken.

•Examples of Resistant Pathogens:

▪MRSA (Methicillin-resistant Staphylococcus aureus).

•MDR-TB (Multidrug-resistant tuberculosis).

▪CRE (Carbapenem-resistant Enterobacteriaceae).

▪These pathogens represent major challenges in modern medicine, threatening the effectiveness of routine treatments.

•Management Strategies

▪Addressing antibiotic resistance requires a multifaceted approach:

▪Antibiotic Stewardship Programs: Rational prescribing, limiting use to confirmed bacterial infections.

▪Rapid Diagnostics: Point-of-care tests to identify pathogens and sensitivities quickly.

•Public Education: Campaigns to shift perception of antibiotics from “first-line” to “last-resort” therapy.

•Legislation: Restricting agricultural use and over-the-counter sales.

•Research and Innovation: Development of new antimicrobials, vaccines, and alternative therapies such as bacteriophage therapy.

Michael et al. (2014) argue that no single solution will suffice; instead, continuous management and global cooperation are essential.

•Future Perspectives

•Pharmacogenomics: Tailoring antibiotic therapy to individual genetic profiles.

•Artificial Intelligence: Predicting resistance patterns and guiding treatment.

•Global Cooperation: Coordinated international surveillance and response systems.

•Conclusion

Antibiotic resistance is not a temporary problem but a permanent global challenge. It is a dynamic evolutionary process driven by human behavior and microbial adaptation. Combating it requires a multidisciplinary approach involving medicine, public health, agriculture, and policy. Without urgent action, the gains of modern medicine could be reversed, leading to a future where routine infections are once again deadly.

•References

Michael CA, Dominey-Howes D, Labbate M. The Antimicrobial Resistance Crisis: Causes, Consequences, and Management. Front Public Health. 2014;2:145. PMC article

World Health Organization (WHO). Antimicrobial Resistance: Global Report on Surveillance. 2014.

Centers for Disease Control and Prevention (CDC). Antibiotic Resistance Threats in the United States. 2019.

O'Neill J. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. Review on Antimicrobial Resistance. 2016.

Dondorp AM, Fairhurst RM, Slutsker L, et al. The threat of artemisinin-resistant malaria. N Engl J Med. 2011