

The Impact of Antibiotic Misuse in Adult Patients: A Review of Contributing Factors, Consequences, and Strategies for Mitigation

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ABSTRACT

Antibiotic misuse, characterized by inappropriate use, over-prescription, and self-medication, is a severe threat to health in that it increases the rate at which antibiotic-resistant bacteria develop. This paper provides a review of antibiotic misuse concerning adult patients, an outline of factors that perpetuate it, the consequences, and the possible mitigation strategies. We discuss patient-related issues, such as lack of knowledge and non-compliance, problems with healthcare providers in terms of over-subscription and poor training, and system problems like poor stewardship programs and lack of regulatory efforts. In addition, the authors debate the environmental consequences of poor antibiotic stewardship coming from agriculture use and contamination. The consequences of misuse include the development of antibiotic-resistant pathogens and deleterious drug reactions, but also imply significant costs to the health system. The review calls for increased antibiotic stewardship, improved patient education, the development of new antimicrobial agents, and good policy infection control. This review is essence, a call to multifaceted efforts in the fight against the misuse of antibiotics and stresses that continuous research works are required to change policies. Antibiotic misuse is emerging as a global problem because addressing this problem not only ensures sustainability in the existing antibiotics but also assures that public health is protected.

Keywords: Antibiotic, Antibiotic resistance, Stewardship program.

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INTRODUCTION

One of the greatest global health threats is the abuse of antibiotics, which continues to propagate the problem of antibiotic resistance. The abuses involved are several: over-prescription by health professionals and incorrect self-medication by patients in inappropriate ways in a number of settings. According to the Centers for Disease Control and Prevention (CDC), at least 30% of antibiotics prescribed in outpatient settings are unnecessary¹. It is estimated that antibiotic resistance adds up to an annual cost of up to \$100 billion in the United States alone, resulting from increased healthcare costs and lost productivity². This includes, upon occurrence of public health impact, the following: Increased resistant infections, enhanced morbidity, and extended hospitalizations. Effective strategies are needed to address this issue and mitigate its far-reaching consequences.

Importance of the Topic

Unless swiftly checked, the continued misuse of antibiotics in many parts of the world could mean that, in the near future, common infections become un-treatable, with consequent

increased mortality and an enormous burden to the healthcare system.³ Effective measures to counter misuse, on the other hand, improve patient outcomes, reduce healthcare costs, and improve health for all.

Thesis Statement

This review sheds light on causes, effects, and mitigation techniques concerning antibiotic misuse in adults. Highlighted here is the need to find solutions for such a significant public health problem by multidisciplinary efforts

Contributing Factors to Antibiotic Misuse

Patient-related factors

One of the central drivers of antibiotic overuse is the lack of knowledge about the drugs and how to properly use them. Antibiotics have no effect on viral infections, yet most patients do not know this and generate unnecessary demand⁴. Patients also often fail to complete their courses of antibiotics before their symptoms improve, and in many cases, patients simply do not follow through on prescribed antibiotic courses. Age and socioeconomic status are two other demographic factors that

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influence usage patterns. For instance, the elderly and those of a lower socioeconomic class are more likely to abuse antibiotics because of their restricted access to healthcare resources and education^{4,5}. The related factors are depicted in Table 1.

Healthcare provider-related factors

Over-prescription of antibiotics is a major issue driven by patient demand and diagnostic uncertainty. Many physicians prescribe antibiotics as precautionary measures or due to time constraints that prevent them from properly carrying out a diagnosis. Moreover, sub-optimal prescribing practices are attributed to a lack of training in antibiotic stewardship. Inadequate training of health providers concerning the principles of antibiotic stewardship exacerbates the problem of misuse of antibiotics.⁶ The related factors are depicted in Table 1.

System-related factors

Inadequate antibiotic stewardship programs and limited access to diagnostic tools are systemic issues that contribute to antibiotic misuse. In any healthcare setup, a stewardship program becomes very crucial for the monitoring and optimization of the use of antibiotics; however, it is missing in most of these institutions. The problem is further compounded

at the level of the pharmaceutical industry through aggressive marketing and financial incentives for prescribing particular antibiotics. It could also be that control policies and legislation are archaic or poorly implemented and hence incapable of addressing the level of complexity of abuse of antibiotics. The related factors are depicted in Table 1.⁷

Environmental factors

Antibiotic overuse affects not only human health but also the ecosystem. Administration of antibiotics, mainly in agriculture, enables the formation of resistant bacteria to spread among the people through the food chain.⁷ The antibiotic-resistant bacteria that contaminate soils and water pose a greater threat to public health in that they foster an environment that encourages resistance to grow. The related factors are depicted in Table 1.

Consequences of Antibiotic Misuse

Antibiotic resistance

Antibiotic misuse leads to the development of resistant bacteria, which are more challenging to treat with existing antibiotics. The ability of bacteria to persist in the presence of antibiotic treatment lies in mechanisms of resistance that include horizontal gene transfer and genetic changes.

Table 1: Contributing factors to antibiotic misuse

<i>Factor type</i>	<i>Contributing factors</i>	<i>Description</i>
Patient-related	Lack of knowledge about antibiotics and their proper use	Patients often do not realize that antibiotics are useless against viruses and misuse them as such. ⁸
	Expectations for antibiotic treatment for viral infections	Patients often request antibiotics for illnesses such as the common cold, for which they are not recommended ⁹ .
	Non-adherence to treatment regimens	Patients often do not complete antibiotics, where treatment is not optimally finished, and resistance may have developed ¹⁰ .
	Demographic factors (e.g., age, socioeconomic status)	There are, though age and socioeconomic status influences patterns of antibiotic misuse, where some groups are more likely to misuse antibiotics than others ¹¹ .
Healthcare provider-related	Over-prescription of antibiotics	Antibiotics are often prescribed without an indication, and diagnostic uncertainty or patient pressure is common reasons.
	Lack of training on antibiotic stewardship	Poor training of healthcare providers regarding antibiotic stewardship principles is a reason for inappropriate prescribing ¹² .
	Time constraints and workload	Blocked times for consultations may mean superficial evaluations and over-prescription.
System-related	Diagnostic uncertainty	Providers are more likely to prescribe antibiotics on a precautionary basis when they suffer from uncertainty with a diagnosis.
	Inadequate antibiotic stewardship programs	A lot of healthcare systems do not develop effective stewardship programs that would monitor and eventually optimize use of antibiotics.
	Limited access to diagnostic tools	Poor diagnostic resources lead to the injudicious use of antibiotics.
	Pharmaceutical industry influence	Marketing strategies and incentives by the pharmaceutical industry also encourage inappropriate prescribing.
Environmental	Regulatory policies and guidelines	Outdated or otherwise deficient legislation can carry out ineffective prevention in the misuse of antibiotics.
	Agricultural use of antibiotics	Use of antibiotics in agriculture drives the development of resistant bacteria.
	Contamination of water and soil with antibiotic-resistant bacteria	Antibiotics' and resistant bacteria's environmental contamination affects people's health.

The spread of resistant bacteria may mean poorer clinical outcomes for patients, resulting in serious infections that are very hard to treat.¹²⁻¹⁴ The following Figure 1 shows a mechanism of antibiotic resistance by several routes like genetic mutation, efflux pump, enzymatic inactivation and others.

After showing the mechanisms of antibiotic resistance the following Table 2 Consequences of antibiotic misuse shows few consequences and its description as well as its impact.

Adverse reactions

There are several ways through which antibiotic misuse can manifest some side effects. Allergies induced by antibiotics can result in minor rashes or lethal anaphylaxis. Besides, *Clostridium difficile*, which causes fatal and serious gastrointestinal infections, is a result of antibiotic abuse. Inappropriate use of antibiotics will disturb gut flora and lead to long-term health complications; it may also make a person more susceptible to further infections.¹²⁻¹⁴

Economic burden

The abuse of antibiotics is costly, as depicted in Figure 2. At the very least, indirect costs involve lost productivity and challenges of caring for dependents, while direct costs include extended hospitalization and more expensive treatment for resistant diseases. This poses a significant economic burden to health systems and economies across the world, necessitating effective interventions to reduce overuse and related expenditures.¹²⁻¹⁴

Case studies

Case studies from various settings, such as hospitals and long-term care facilities, illustrate the real-life consequences

of antibiotic misuse. For example, the outbreaks of resistant diseases in the healthcare setting underscore the need for improvement in practices of infection control and stewardship.^{10,12} These cases highlight the importance of addressing antibiotic misuse through targeted interventions and education.

Strategies for Mitigation

Improving antibiotic stewardship

It is thus important to have comprehensive stewardship programs in place, which will limit the misuse of antibiotics. Such programs should be structured around improved surveillance, development of guidelines for antibiotic use with adherence to them, and periodic review of the trends in prescribing practices. Successful stewardship programs can reduce antibiotic resistance to a minimum and optimize antibiotic practice.

Enhancing patient education

There can be a reduction in the overuse of antibiotics by educating patients on how to use them appropriately. Health promoters in public health could sensitize patients on when to use antibiotics and how to adhere to the treatment as recommended. This kind of awareness in promoting appropriate usage reduces demand and abuse.

Developing new antibiotics

Research into new classes of antibiotics and complementary therapies will also go a long way in fighting this resistance. New developments like antimicrobial peptides and phage therapy are feasible alternatives to conventional antibiotics and may solve some of the problems caused by resistant bacteria.

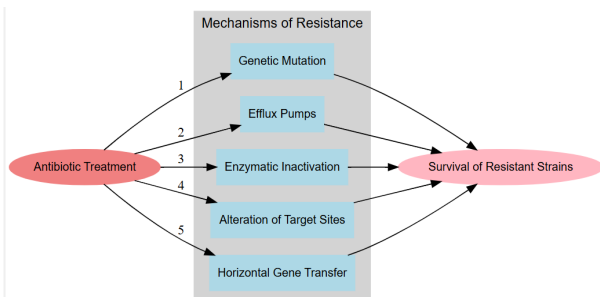


Figure 1: Mechanism of antibiotic resistance

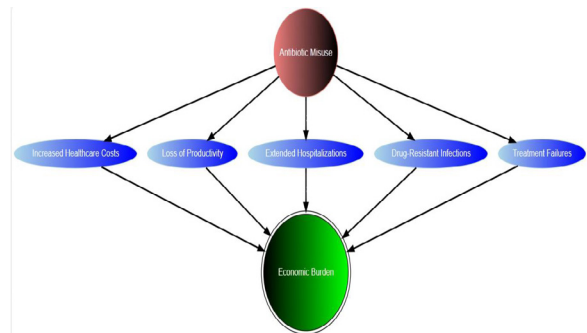


Figure 2: Economic impact of antibiotic misuse

Table 2: Consequences of antibiotic misuse

Consequence	Description	Impact
Antibiotic resistance	Development of resistance in bacteria to the present antibiotics through various mechanisms, including genetic mutation and gene transfer.	Eventually, it leads to more difficult-to-treat infections and poor clinical outcomes.
Adverse reactions	This includes allergic reactions, <i>Clostridioides difficile</i> infection, and gut microbiome disruption.	This leads to serious health complications and secondary infections that complicate treatment for the patients.
Economic burden	This includes direct costs; thereby hospitalization, as well as indirect costs like lost productivity and caregiver burden.	Enormous burden on health systems and economies through mounting treatment costs and lost work.

Infection prevention and control

Infection control measures, like environmental cleaning and hand hygiene, need to be strengthened in order to help halt the spread of resistant germs. Second, enhanced immunization campaigns would lead to lower illness rates, hence lowering the demand for drugs.

Policy and regulatory changes

Policy measures to limit the use of antibiotics in agriculture and increased funding for research will also be required. Rigorous guidelines in health care, if enacted and monitored properly, may reduce misuse and improve prescribing practices.^{8,12,15,16}

CONCLUSION

Antibiotic misuse in adult patients is very complex in nature and has major health and economic consequences. The prevention of facilitators that go on to sustain this emerging problem, and formulation of effective strategies against it are equally important. In essence, combating misuse will call for a comprehensive package of improved stewardship, patient education, and policy changes toward safeguarding public health.

Future Directions

It calls for future research into the exploration of novel diagnostic tools, assessment of the impact of misuse in certain patient populations, and development of new treatment approaches. Further investment in research and policy development will be required if the complexities of antibiotic misuse and resistance are to be understood.

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REFERENCES

1. Baur D, Gladstone BP, Burkert F. Antibiotic Stewardship: A Review and Practical Guide. *Journal of Clinical Medicine*. 2017; 6(2), 53. DOI: 10.3390/jcm6020053
2. Brown ED, Wright GD. Antibiotics: Challenges, Mechanisms, Opportunities. *Cell*. 2016; 164(6), 1223-1234. DOI: 10.1016/j.cell.2016.02.021.
3. CDC. Antibiotic Use in the U.S.: Progress and Opportunities. Centers for Disease Control and Prevention. Retrieved from CDC Website, 2019
4. Goff DA, Kullar R, Goldstein EJC. Antibiotic Stewardship in Adult Patients: Guidelines and Recommendations. *Clinical Infectious Diseases*. 2018; 66(9), 1515-1522. DOI: 10.1093/cid/cix958.
5. Kamada N, Seo SU, Chen GY. Role of the Gut Microbiota in Immunity and Inflammation. *Nature Reviews Immunology*. 2013; 13(5), 321-335. DOI: 10.1038/nri3431.
6. Lipsitch M, Samore MH. Antibiotic Use in the Community: A Review of Its Role in Antibiotic Resistance. *The Journal of Antimicrobial Chemotherapy*. 2022; 50(1), 27-35. DOI: 10.1093/jac/dkaf007.
7. Martinez JL. The Role of Natural Environments in the Evolution of Antibiotic Resistance. *Trends in Microbiology*. 2009; 17(6), 274-277. DOI: 10.1016/j.tim.2009.03.003.
8. Micallef SA, Sweeney JC, Hoxworth JM. & Regulatory Policies and Their Impact on Antibiotic Misuse. *Infection Control & Hospital Epidemiology*. 2020; 41(7), 823-830. DOI: 10.1017/ice.2020.136.
9. Nicolau DP. The Global Challenge of Antibiotic Resistance. *Critical Care Clinics*. 2018; 34(3), 425-438. DOI: 10.1016/j.ccc.2018.03.001.
10. Patel R, Baddour LM, Popham DL. Case Studies of Antibiotic Misuse in Healthcare Settings. *Clinical Microbiology Reviews*. 2020; 33(1), e00031-19. DOI:10.1128/CMR.00031-19.
11. Shapiro DJ, Hicks LA, Hicks LA. Antibiotic Prescribing for Acute Respiratory Infections: An Update for 2019. *Clinical Infectious Diseases*. 2019; 68(10), 1554-1561. DOI: 10.1093/cid/ciy1127.
12. Smith RD, Coast J, Millar M. The Economic Impact of Antimicrobial Resistance: A Review of the Evidence. *Global Health Action*. 2017; 10(1), 1351660. DOI:10.1080/16549716.2017.1351660.
13. Abed AR, Khudhair AM, Hussein IM. Effects of Misuse of antibiotics on the resistance of Escherichia coli isolated from the intestines of broiler chickens. *International Journal of Drug Delivery Technology*. 2020;10(2):190-194. DOI: 10.25258/ijddt.10.2.1
14. Ingale MH, Shinde V, Jharandikar A, Tayade M, Mahajan GD. Practice on Antibiotic Use: Analysis of Overall Practice Score in Indian Set-up. *International Journal of Pharmaceutical Quality Assurance*. 2023;14(4):1206-1210. DOI: 10.25258/ijpqa.14.4.59
15. Jakhar A, Dahiya N, Patil A, Jaiswal H, Mali S, Sharma D. Assessment of Prescription Patterns and Appropriateness of Antibiotics for Prophylaxis in Dental Procedures: A Retrospective Study. *International Journal of Pharmaceutical Quality Assurance*. 2023;14(3):730-733. DOI: 10.25258/ijpqa.14.3.45
16. Kazem EM, Jarallah EM. Antibiotic Resistance Profile of Staphylococcus aureus isolated from Imported and Domestic Meat Samples. *International Journal of Drug Delivery Technology*. 2022;12(4):1797-1801. DOI: 10.25258/ijddt.12.4.51