



## A Review on Anti-Biotics Resistance

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### ABSTRACT

Global public health officials are very concerned about antimicrobial resistance. However, recent hospital and community-based data indicated an increase in the prevalence of antibiotic resistance in emerging nations like India. It is very difficult to do research on the use of antibiotics, the causes and progression of antibiotic resistance, regional differences, and interventional approaches based on the current state of healthcare in each nation. The situational analysis of antimicrobial resistance is covered in this study along with its issues, causes, and future obstacles, as well as the tactics that will be needed to lessen the burden in India. The authors evaluated and analysed recent data that was gathered from Medline, Google searches, and other sources. There are few community-based studies at the national level, whereas hospital-based studies revealed a greater and more variable spectrum of resistance in various locations. Regarding the measurement of the issue and the several determinants associated with antimicrobial resistance, there are gaps in the design and operation of the public health care delivery system. In India, there is a pressing need to create and improve antimicrobial policies, standard treatment guidelines, a national plan for containing antibiotic resistance, and research on the public health implications of antimicrobial resistance at the community and hospital levels.

**Keywords:** Anti-microbial resistance, challenges, determinants, problem burden, strategies.

### INTRODUCTION

Bacterial infections' resistance to antibiotics is a global problem linked to elevated rates of morbidity and mortality. Gram-positive and -negative bacteria's multidrug resistance patterns have led to infections that are challenging or even impossible to cure with traditional antimicrobials. Broad range antibiotics are widely and often needlessly utilized in healthcare settings due to the absence of early identification of pathogenic bacteria and their patterns of antimicrobial sensitivity in patients with bacteraemia and other serious infections. When combined with inadequate infection control procedures, there are sharp rises in developing resistance, which makes it simple for resistant germs to spread to other patients and the environment [1].

When bacteria develop several ways to avoid the effects of antibiotics, antibiotic resistance results. An ecological and public health problem is the spread of antibiotic resistance genes. By changing an antibiotic's

component, some bacteria can neutralize it and make it ineffective. Some bacteria can change their exterior structure and receptors to prevent antibiotics from attaching to them, while others may be able to export the antibiotics from the bacteria. Because of these mechanisms, some bacteria may be able to withstand the treatment of a particular antibiotic and acquire resistance that can spread to other germs as they proliferate. Additionally, bacteria can develop resistance by genetic material mutation [2].

## Mechanism of antibiotic resistance

### 1. Intrinsic Resistance

Through evolution, bacteria may develop intrinsic resistance to antibiotics by altering their components or structure. For instance, bacteria without a cell wall are immune to antibiotics like penicillin that interfere with the bacteria's ability to form walls.

Because they are inherently resistant to antibiotics, certain types of bacteria can occasionally withstand treatment and proliferate. For instance, whereas many bacterial species have cell walls, some do not. A bacterium that doesn't produce a cell wall in the first place cannot be harmed by an antibiotic like penicillin that inhibits the formation of cell walls.



Fig 1. Intrinsic Resistance

### 2. Acquired Resistance

Bacteria can develop resistance by either obtaining DNA from an already resistant bacterium or by developing a new genetic mutation that aids in the bacterium's survival. Rifamycin-resistant *Mycobacterium tuberculosis* is one example. There are two ways that bacteria can develop resistance: either by acquiring DNA from an already resistant bacterium or by developing a new genetic alteration that aids in the bacterium's survival [3].

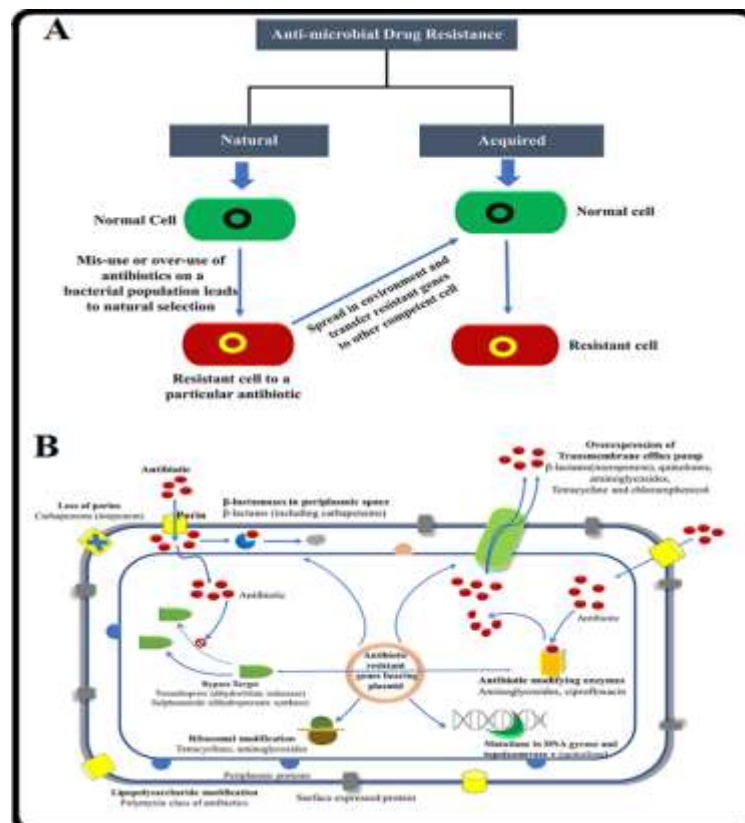


Fig 2. Acquired Resistance

### 3. Genetic Change

The creation of proteins may be altered by bacterial DNA, resulting in distinct bacterial components and receptors that prevent the antibiotic from identifying the bacteria. The genomics of bacteria that share an environment may be changed by intrinsic genetic factors of resistance. Haemophilus influenza and Escherichia coli (E. coli) resistance to trimethoprim are two examples.

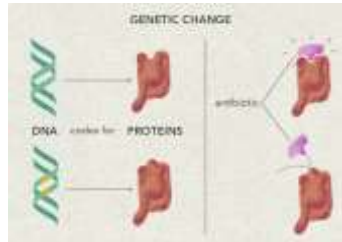


Fig 3. Genetic Change

### 4. DNA Transfer

Through a horizontal gene transfer, bacteria can exchange genetic components with one another and spread the resistant DNA. Bacteria typically go through three main stages to acquire exogenous genetic material:

- Transformation (through naked DNA incorporation)
- Transduction (through the process of phagocytosis).
- It witnessed a bacteria with an antibiotic resistance gene transfer a copy of that gene to another bacterium if you studied Agent Antibiotic. Lateral gene transfer is the term for this mechanism [4].



Fig 4. DNA Transfer

### Mechanism of Antibiotic Resistance

Antibiotics primarily target the microbial cells' biology and physiology in an effort to slow or stop their growth. While some antibiotics target the protein synthesizing machinery by interacting with ribosomal units, which limits the antibacterial activity of certain germs, others break down the  $\beta$ -lactam and glycopeptide components of bacterial cells to destroy their cell walls or cell membranes. These antibiotics that target the cell wall include macrolides, tetracycline, linezolid, aminoglycosides, and chloramphenicol. Rifampin and fluoroquinolones (FQ) are two more antibiotics that target cell machinery and interfere with nucleic acid production [5].

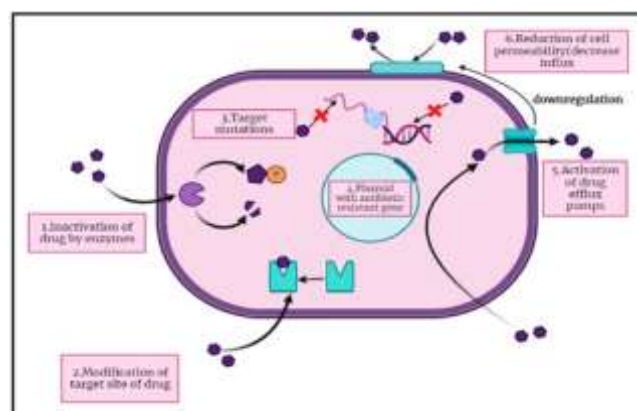


Fig 5. Different pathways of antibiotic resistance

## Causes of Anti-biotics resistance

overuse of antibiotics. Antibiotic resistance is a result of taking antibiotics when unnecessary. For example, the majority of sore throats are caused by viruses. Antibiotics are ineffective. It is vital to use antibiotics just as prescribed by your healthcare provider [6].

## Adverse Effects of Antibiotic Resistance

Because bacteria are becoming more resistant to conventional antibiotics, antibiotic resistance has become a global public health concern that necessitates the development of new medications. Resistance to new antibiotics is thought to be likely to develop and may shorten the time that these drugs are effective [7]. Humanity as a whole is impacted by antibiotic resistance, which affects all facets of health, including wildlife, humans, and the environment [8].

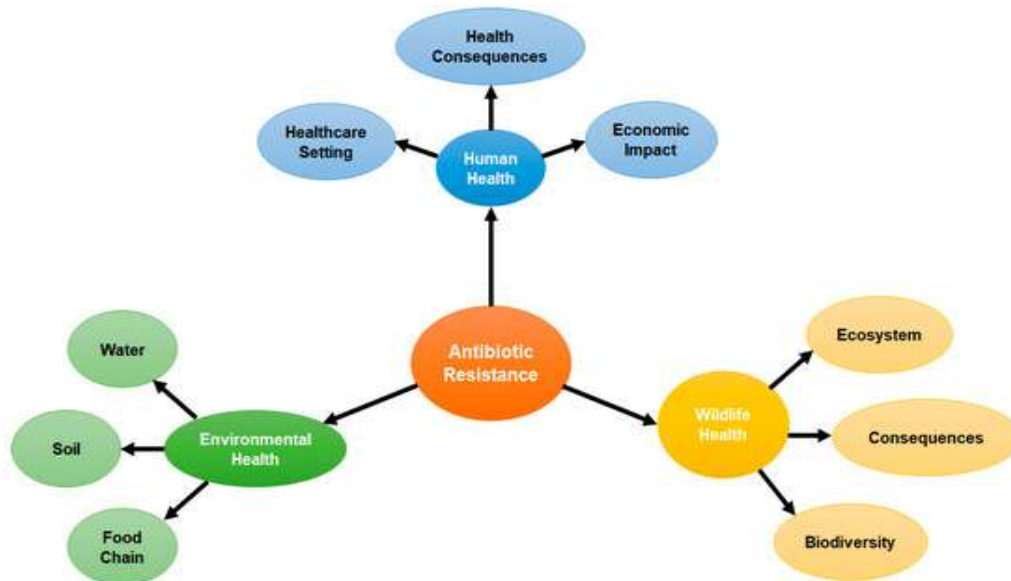


Fig 6. Impact and adverse effect of antibiotic resistance

## Future Perspectives of Anti Biotic Resistance

### 1. Novel Drug Discovery / New Antibiotics

- There's a strong emphasis on discovering new classes of antibiotics to address bacteria that have become resistant to existing ones.
- Drug discovery is increasingly leveraging natural products, especially plant-derived molecules (like polyphenols) that have antimicrobial activity.
- Combinatorial therapies and multi-target drugs are being considered to reduce the risk of resistance

### 2. Alternative Therapies Beyond Traditional Antibiotics

- Phage therapy (bacteriophages) is being explored to kill bacteria specifically and reduce collateral damage.
- CRISPR-Cas systems: Using CRISPR to specifically knock out resistance genes in bacteria is a promising direction.
- Antimicrobial peptides (AMPs) and immunomodulators are being studied as adjuncts or alternatives.

### 3. Better Diagnostics and Surveillance

- Advances in sequencing (like next-generation sequencing, metagenomics) help detect resistance more quickly and precisely.
- Data-driven approaches, including machine learning and AI, are being used to predict trends of AMR and guide stewardship.

- Global surveillance networks are needed to share data on resistance patterns across countries [9].

#### 4. Antibiotic Stewardship and Usage Policies

- Stewardship programs are vital: optimizing how antibiotics are prescribed, reducing unnecessary use, and ensuring correct doses.
- Regulation on antibiotic use in agriculture and veterinary settings is a major policy lever.
- Standardizing prescribing guidelines globally could reduce misuse; there is a lot of variation now across countries.

#### 5. Prevention of Infections

- Increasing vaccination coverage to prevent bacterial infections can reduce reliance on antibiotics.
- Improving hygiene, sanitation, and infection control (in hospitals and communities) to cut down transmission of resistant bacteria.
- Biosecurity and environmental measures (e.g., reducing antibiotic residues in the environment) are becoming more important.

#### 6. Use of Natural and Biotechnological Solutions

- Research on natural compounds (e.g., plant-derived polyphenols) that can act as antimicrobials or resistance modulators.
- Nanotechnology: nano-drug delivery systems to improve the delivery of antibiotics or reduce toxicity.
- Quorum sensing inhibitors: blocking bacterial communication (quorum sensing) to reduce virulence and resistance.

#### 7. Policy, Global Collaboration, and Public Awareness

- Stronger global policy frameworks for AMR: international coordination to enforce stewardship, invest in R&D, and monitor usage.
- Public education campaigns about antibiotic misuse, hygiene, and vaccination.
- Funding incentives for pharmaceutical companies to invest in antibiotic research: public-private partnerships are key [10].

### Applications of Antibiotic Resistance

Antibiotic resistance, although a serious global health concern, has several important applications in biotechnology, microbiology, and genetic engineering. One of the major applications is its use as a **selectable marker** in molecular cloning, where antibiotic-resistant genes are inserted into plasmids to identify and select only those bacterial cells that have successfully taken up the recombinant DNA [11]. These resistance markers also help maintain plasmids during **recombinant protein production**, such as insulin, enzymes, and vaccines. In research, antibiotic-resistance genes are widely used to study **gene expression, promoter activity, gene regulation, mutation patterns, and mechanisms of bacterial evolution**. They are also helpful in tracking or differentiating bacterial strains during ecological and microbial competition studies. In industrial microbiology, resistant strains of bacteria ensure stable and contamination-free fermentation processes. Additionally, antibiotic resistance markers play a role in **vaccine development, CRISPR gene editing, synthetic biology**, and environmental microbiology, where they help scientists understand how resistance genes spread through soil, water, and microbial communities. Thus, antibiotic resistance, despite its challenges, provides essential tools for scientific innovation and biotechnology [12].

### CONCLUSION

Effective antimicrobial treatments, a cornerstone of contemporary medicine, are at danger due to bacteria's and other microorganisms' ability to quickly evolve resistance. Due to the massive selective evolutionary pressure caused by humanity's widespread abuse of antibiotics in agriculture and healthcare, pathogenic bacteria have been able to develop a variety of mechanisms that undermine previously effective antimicrobials. We have entered a perilous post-antibiotic era since antibiotic discovery has not kept up with

the global spread of multidrug resistance. Additional delays run the risk of reversing the pre-antibiotic susceptibility patterns that have historically supported the dominance of infectious disease mortality, which could jeopardize both the security of world health and current medical capabilities.

## CONFLICT OF INTEREST

Authors declare for none conflict of interest.

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