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ANTIBIOTICS CLASSIFICATION AND RESISTANCE: A REVIEW

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ABSTRACT

Antibiotics are the substances that inhibits the growth of or destroys microorganisms. Antibiotics can be classified based on their action, mechanism of action, chemical nature, based on nature of source and based on spectrum of activity. One major problem with the use of antibiotics is development of resistance. Overuse of antibiotics has lead to antibiotic resistance. To overcome the antimicrobial resistance, unnecessary overuse of antibiotics should be avoided and research should be focused on alternate therapies to treat infection.

KEYWORDS: Antibiotics, Resistance, Classification, Mechanism.

1. INTRODUCTION

The term antibiotic was coined from the word antibiosis which literally means “against life”. In the past, antibiotics were considered to be organic compounds produced by one microorganism which are toxic to other microorganisms. However, this definition has been modified in modern times, to include antimicrobials that are also produced partly or wholly through synthetic means.[1]

Antibiotics either are cytotoxic or cytostatic to the micro-organisms, allowing the body’s natural defenses, such as the immune system, to eliminate them. They often act by inhibiting the synthesis of a bacterial cell, synthesis of proteins, deoxyribonucleic acid (DNA), ribonucleic acid (RNA), by a membrane disorganizing agent, or other specific actions. Antibiotics may also enter the cell wall of the bacteria by binding to them, using the energy-dependent transport mechanisms in ribosomal sites, which subsequently leads to the inhibition of the protein synthesis.[2]

2. TYPES OF ANTIMICROBIAL AGENTS

2.I) Bacteriostatic and bacteriocidal

Whilst some antibiotics are able to completely kill other bacteria, some are only able to inhibit their growth. Those that kill bacteria are termed bactericidal while those that inhibit bacterial growth are termed bacteriostatic.[1]

Bacteriostatic

- Glycylcyclines: Tigecycline.
- Tetracyclines: Doxycycline, minocycline.
- Lincosamides: Clindamycin.
- Macrolides: Azithromycin, clarithromycin, erythromycin.
- Oxazolidinones: Linezolid.
- Sulfonamides: Sulfamethoxazole.

Bactericidal

- Aminoglycosides: Tobramycin, gentamicin, amikacin.
- Beta-lactams (penicillins, cephalosporins, carbapenems): Amoxicillin, cefazolin, meropenem.
- Fluoroquinolones: Ciprofloxacin, levofloxacin, moxifloxacin.
- Glycopeptides: Vancomycin.
- Cyclic Lipopeptides: Daptomycin.
- Nitroimidazoles: Metronidazole.[3]

2.2) Based on chemical or molecular structures

- Beta-lactams.
- Macrolides.
- Tetracyclines.
- Quinolones.
- Aminoglycosides.
- Sulphonamides.
- Glycopeptides.
- Oxazolidinones.

2.3) Based o mode of action

- Inhibition of cell wall synthesis.
- Breakdown of cell membrane structure or function.
- Inhibition of the structure and function of nucleic acids.
- Inhibition of protein synthesis.
- Blockage of key metabolic pathways.

2.4) Based on the nature of the source

- natural compounds obtained from microorganisms example- benzylpenicillin.
- semi-synthetic members that are structurally modified natural products example- ampicillin.
- synthetic products example –norfloxacin.

2.5) Classification Based on the Spectrum of Activity

- narrow-spectrum antibiotics.
- broad-spectrum compounds.[4]

3. ANTIBIOTIC RESISTANCE

Antibiotic resistance occurs when bacteria change in response to the use of these medicines. The increased use of antimicrobial agents in clinical practice and other industries such as livestock farming has led to bacterial resistance to antibiotic agents. Bacteria have developed mechanisms to promote this resistance to survive.[3]

However, indiscriminate use of antibiotics and organism evolution have led to the emergence of multidrug resistant organism (MDRO), and at times resistant to most or even all currently available antibiotic classes, extensively drug resistant or pan-resistant organisms (XDRO, PDRO). Antibiotic resistance is a serious emerging global health threat and certain geographic areas might be affected more than others due to the pattern of antibiotic usage.[5]

3.1 Mechanism of antimicrobial resistance

3.1.1. Prevention of accumulation of antimicrobials

This is either by decreasing uptake or increasing efflux of the antimicrobial from the cell i.e Changes in outer membrane permeability.

a) By decreasing uptake

Uptake is decreased by decreasing proin channels. Porin channels are present in the outer membrane of gram negative bacteria through which certain drugs diffuse to enter into the bacteria. Eg- beta lactum antibiotics.[6]

b) By increasing efflux

Efflux pumps - Membrane proteins that export antibiotics from the cell and maintain their low-intracellular concentrations are called efflux pumps. At the same speed, where these antimicrobials are entering the cell, efflux mechanisms are pumping them out again, before they reach their target. These pumps are present in the cytoplasmic membrane.

3.1.2 Modification of target molecule

Natural variations or acquired changes in the target sites of antimicrobials that prevent drug binding is a common mechanism of resistance. This may be due to spontaneous mutation.

- ✓ Alteration in the 30S subunit or 50S subunit.
- ✓ Alteration in PBP.
- ✓ Altered cell wall precursors.
- ✓ Mutated-DNA gyrase and topoisomerase IV leads to FQ resistance.
- ✓ Ribosomal protection mechanisms imparting resistance to tetracyclines.
- ✓ RNA polymerase mutations conferring resistance to rifampicin.

3.1.3) Antibiotic inactivation

There are three main enzymes that inactivate antibiotics such as

- ✓ β-lactamases.
- ✓ aminoglycoside-modifying enzymes.
- ✓ chloramphenicol acetyltransferases.[6]

3.2 Methods to prevent antimicrobial resistance

- overuse of antibiotics should be avoided.
- The course of prescribed antibiotics should be completed even if after feeling better, otherwise, those bacteria are more likely to become drug-resistant.
- Immunization can protect oneself against some diseases (tetanus, whooping cough, etc.) that are treated with antibiotics. So, one should be vaccinated.

- The antibiotic-resistant bacteria are commonly found in hospitals, so cleanliness and proper sterilization must be performed, and surgical wounds must be free from infection.[7]
- Nanoparticles can be utilized for the therapeutic management of infections in different ways.
- the colloidal forms of zinc, silver, copper, and titanium can itself be used as antimicrobial agents.
- encourage researchers to adopt novel strategies to control bacterial infection with the following criteria: discovery of novel antibiotics, anticipation and prevention of antibiotic resistance, and protection of host microbiota.[8]

3.3 Causes of antimicrobial resistance

- overuse of antibiotics.
- nadequate regulations and usage imprecisions.
- awareness deficiency.
- online marketing.
- use of antibiotics as a poultry and livestock growth promoter rather than to control infection.[8]
- Inappropriate Prescribing.
- Availability of Few New Antibiotics.
- Regulatory Barriers.[9]

3.5 Antimicrobial resistance in India

The resistance spectrum of pathogens varies in different regions. There are some hospital based data which showed that antibiotic resistance is increasing and will be a greater problem if not tackled properly according to present needs as in other developed countries. In India studies reveal an increasing trend of development of resistance to commonly used antimicrobials in pathogens like *Salmonella, Shigella, Vibrio cholerae, Staphylococcus aureus, Neisseria gonorrhoeae, N. meningitidis, Klebsiella, Mycobacterium tuberculosis*, HIV, plasmodium and others. Multi-resistant enterobacteriaceae due to the production of extended spectrum β-lactamases (ESBL) have become very common in India. Presently there is no national program for prevention of drug resistance and there is inadequacy of quality assured laboratories, insufficient data analysis and dissemination, absence of national

guidelines on antimicrobial usage, no control on sale of these drugs for public consumption.[10]

CONCLUSION

This review analyses antibiotics, their classification, and mechanism of resistance, causes and methods to prevent resistance. Antimicrobial resistance scenario in India is also included in this article. Development of resistance is a major serious concern and need to be addressed.

REFERENCE

1. Etebu E, Arikekpar I. Antibiotics: Classification and mechanisms of action with emphasis on molecular perspectives. Int. J. Appl. Microbiol. Biotechnol. Res, 2016; 4: 90-101.
2. Zaman SB, Hussain MA, Nye R, Mehta V, Mamun KT, Hossain N. A Review on Antibiotic Resistance: Alarm Bells are Ringing. Cureus, 2017 Jun 28; 9(6).
3. Patel P, Wermuth HR, Calhoun C, et al. Antibiotics. [Updated 2023 May 26]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2023 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK535443/
4. Panchu DF, Scurtu A, Macasoi IG. Antibiotics: Conventional Therapy and Natural Compounds with Antibacterial Activity—A Pharmaco-Toxicological Screening. *Antibiotics*, 2021; *10*(4): 401.
5. Al-Tawfiq, J.A., Momattin, H., Al-Ali, A.Y. *et al.* Antibiotics in the pipeline: a literature review, (2017–2020). *Infection*, 2022; 50: 553–564.
6. apoor G, Saigal S, Elongavan A. Action and resistance mechanisms of antibiotics: A guide for clinicians. J Anaesthesiol Clin Pharmacol, 2017 Jul-Sep; 33(3): 300-305.
7. Begum S, Begum T, Rahman N, Khan RA. A review on antibiotic resistance and way of combating antimicrobial resistance. GSC Biological and Pharmaceutical Sciences, 2021; 14(02): 087–097.
8. Aslam B, Wang W, Arshad MI, Khurshid M, Muzammil S, Rasool MH, Nisar MA, Alvi RF, Aslam MA, Qamar MU, Salamat MKF, Baloch Z. Antibiotic resistance: a rundown of a global crisis. Infect Drug Resist, 2018 Oct 10; 11: 1645-1658.
9. Ventola CL. The antibiotic resistance crisis: part 1: causes and threats. P T, 2015 Apr; 40(4): 277-83.
10. Kumar SG, Adithan C, Harish BN, Sujatha S, Roy G, Malini A. Antimicrobial resistance in India: A review. J Nat Sci Biol Med, 2013 Jul; 4(2): 286-91.