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An Overview on antibiotics and their sensitivity

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ABSTRACT

Antibiotics have transformed healthcare by delivering effective treatments for bacterial infections, lowering the death and morbidity rates associated with these diseases. This abstract investigates the crucial functions antibiotics play in a variety of medical scenarios, including infection treatment, surgical operations, cancer treatments, and chronic disease management. Antibiotics used prophylactically in surgery have significantly improved postoperative results, and their function in cancer treatment helps control infections in immunocompromised patients. Antibiotics are also important in suppressing bacterial outbreaks, which pose a public health risk. Despite their relevance, the rise of antibiotic-resistant bacteria as a result of overuse and abuse poses a significant global health risk. Addressing this issue necessitates careful antibiotic usage and ongoing investment in the discovery of novel medicines.

Introduction

An antibiotic is a kind of antimicrobial chemical that works against bacteria. It is the most significant form of antibacterial agent for combating bacterial infections, and antibiotics are commonly used to treat and prevent such diseases. They can either kill or hinder the development of bacteria.Antibiotics are medications used to treat bacterial infections in humans and animals. They function by either killing or inhibiting the growth and multiplication of bacteria.(Lietman and Paul 1984,Bentley et al.,2003) Antibiotic molecules produced by microbes have been around for a long time, but only on a micro-scale within the immediate vicinity of the producing organisms. In the 20th century, antibiotics were mass-produced, primarily synthetic derivatives.Over the last 20 years, advances in mass spectrometry have enabled detailed analysis of antibiotic residues in complicated matrices. Man-made antibiotics can infiltrate the environment through several means, including the manufacture of active pharmaceutical components, excretion of residues after use, and disposing unneeded medications.(Sarmah et al.,2006,Kümmerer and Klaus ,2009)

History of anitibiotics

Ancient Egyptians, Greeks, and Chinese employed molds and plant extracts to heal diseases long before scientists could grasp germs. For example, Egyptians employed moldy bread to treat wounds, while Chinese herbalists used a range of antibacterial herbs. In the late 1800s, Louis Pasteur and Robert Koch proposed the germ theories of disease, which established that germs cause diseases. This key breakthrough paved the way for antibiotic development. Arsphenamine (Salvarsan), the first synthetic antibiotic used to treat syphilis, was developed by Paul Ehrlich in 1909. Ehrlich's work pioneered the notion of a "magic bullet"—a chemical capable of targeting disease-causing microorganisms without injuring the host.(Strebhardt et al.,2008,Durand et al.,2019)Streptomycin, discovered in 1943 by Selman Waksman and his colleagues, was the first antibiotic

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to be successful against TB, ushering in the antibiotic golden era.During the 1940s and 1960s, various antibiotics were discovered, including tetracycline, erythromycin, and vancomycin. These findings changed medical practice, resulting in viable therapies for formerly incurable bacterial illnesses. Overuse and abuse of antibiotics have resulted in the rise of antibiotic-resistant bacteria, posing a serious danger to world health. Notable examples include multidrug-resistant TB and methicillin-resistant Staphylococcus aureus (MRSA). Researchers are still looking for novel antibiotics and other therapies, such as bacteriophages and antimicrobial peptides. Advances in genetics and biotechnology are facilitating the identification of new drugs and tactics for combating resistant microorganisms.(Schatz et al.,2005, Aminov and Rustam, 2010, Dougherty et al.,2011, Zaffiri et al.,2012, Mohr and Kathrin,2016, Chin et al.,2023)

Applications of Antibiotics

Antibiotics are essential in contemporary medicine, serving a variety of purposes including the treatment, prevention, and control of bacterial infections. Here are some of the main uses of antibiotics:

1.Treatment for Bacterial Infections:-
Antibiotics are prescribed to treat acute bacterial illnesses such as pneumonia, urinary tract infections, strep throat, and skin infections. Prompt antibiotic medication can help to avoid problems and accelerate recovery.Severe infections, such as sepsis, meningitis, and endocarditis, require antibiotics for survival. Antibiotics must often be administered intravenously to be successful in these life-threatening diseases.(Runyon et al.,1991, Zaffiri et al.,2012)

2.Prophylactic Usage:-
Antibiotics are given before, during, and occasionally after surgery to help avoid postoperative infections. This is especially crucial for surgery on the gastrointestinal tract, heart, joints, and other infection-prone sites.Antibiotics may be administered to patients with specific heart diseases or prosthetic joints prior to dental treatments in order to avoid bacterial endocarditis or joint infections. (Gutiérrez et al.,2006)

3.Chronic Disease Management:-

Antibiotics can help control recurring bacterial infections in chronic obstructive pulmonary disease (COPD) and cystic fibrosis, lowering exacerbations and enhancing quality of life.
Diabetes: People with diabetes are more susceptible to skin and soft tissue infections, which can be adequately treated with antibiotics. (Wachtel et al.,2018)

4.Public Health and Outbreak Control:-

Antibiotics help reduce bacterial breakouts during epidemics and pandemics. Antibiotics, for example, are critical in the management of secondary bacterial infections during influenza pandemic.Antibiotics are used to treat bacterial STIs such as gonorrhea, syphilis, and chlamydia, hence reducing transmission. (Majumder et al.,2020)

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Fundamental discoveries

Fundamental discoveries in antibiotics have profoundly impacted medicine and public health. Here are some of the key milestones:

1. **Discovery of Penicillin (1928)**: Alexander Fleming discovered the first antibiotic, penicillin, from the mold *Penicillium notatum*. This discovery revolutionized the treatment of bacterial infections and laid the foundation for modern antibiotics.(Gaynes and Robert,2017)
2. **Sulfa Drugs (1930s)**: Gerhard Domagk discovered sulfa drugs, the first class of antibiotics. Prontosil, a sulfa drug, was effective against a wide range of bacterial infections and marked the beginning of the antibacterial era before penicillin became widely available.(Lesch andJohn ,2007)
3. **Streptomycin (1943)**: Discovered by Selman Waksman and his team, streptomycin was the first antibiotic effective against tuberculosis and other gram-negative bacterial infections. This discovery highlighted the importance of soil bacteria in antibiotic production.(Waksman amd selman,1951)
4. **Broad-Spectrum Antibiotics (1950s-1960s)**: The development of broad-spectrum antibiotics like tetracyclines and macrolides, which can treat a wide range of bacterial infections, significantly enhanced the capability to treat various infections with a single antibiotic.(Singh and Sheo,2016)
5. **Beta-Lactam Antibiotics**: The discovery and development of various beta-lactam antibiotics, including cephalosporins and carbapenems, expanded the arsenal against a broader range of bacteria, particularly those resistant to penicillin.(Birnbaum et al.,1985)
6. **Glycopeptide Antibiotics**: Vancomycin, discovered in the 1950s, became a critical antibiotic for treating severe infections caused by gram-positive bacteria, including those resistant to other antibiotics like methicillin-resistant *Staphylococcus aureus* (MRSA).(Butler et al.,2014).

These discoveries have been instrumental in the ongoing battle against bacterial infections and antibiotic resistance, continuously shaping the landscape of infectious disease treatment.

Antibiotic sensitivity

Antibiotic sensitivity, also known as antibiotic susceptibility, describes bacteria's vulnerability to certain antibiotics. It is an important part of microbiology and medical diagnostics that determines the most effective antibiotic for treating a bacterial illness. The process consists of numerous critical phasesandconcepts:

1.A sample is taken from the site of infection (such as blood, urine, sputum, or a wound swab).

2.Bacterial Isolation and Identification: The sample is cultivated to isolate the bacteria that caused the illness. The bacteria are then identified to identify their species.

3.Antibiotic susceptibility testing (AST): This is done to determine how effective various antibiotics are against the isolated bacteria. Common ways include:The Disk Diffusion Method (Kirby-Bauer

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Test) involves placing antibiotic-impregnated paper disks on an agar plate inoculated with bacteria. The size of the zones of inhibition (areas where bacteria do not grow) around the disks indicates the bacteria's sensitivity to antibiotics. The Broth Dilution Method involves growing bacteria in liquid media containing different antibiotic concentrations. The minimum concentration that suppresses observable bacterial growth (minimum inhibitory concentration, or MIC) is calculated. The E-test (Epsilometer Test) involves placing a strip impregnated with an antibiotic gradient on an infected agar plate. The MIC is determined where bacterial growth overlaps the strip.Automated Systems: Instruments such as VITEK and Phoenix automate bacterial identification and susceptibility testing.

4.Interpretation of results: Bacteria are classed as follows according to the measured zones of inhibition or MIC values:
Susceptible (S): The antibiotic works at regular dosages.
Intermediate (I): The antibiotic may be useful at higher dosages or when concentrated at the infection site.
Resistant (R): The antibiotic is ineffective.

5.Clinical Decision Making: The findings help physicians choose the best antibiotic medication for their patients, taking into account criteria such as the place of infection, the patient's state, and possible adverse effects. (Smith et al.,2014, Behera et al.,2019, Maugeri et al., 2019, Gajic et al.,2022)

Conclusion

In conclusion, antibiotic and antibiotic sensitivity studies are indispensable tools in clinical practice and public health. They ensure effective and safe treatment, guide policy-making, and foster ongoing research, all of which are crucial in combating antibiotic resistance and safeguarding global health.Antibiotic and antibiotic sensitivity studies are critical in the fight against bacterial infections and antibiotic resistance. These studies play a vital role in guiding effective treatment, ensuring patient safety, and informing public health strategies. Antibiotic sensitivity testing determines which antibiotics are most effective against specific bacterial strains. This ensures that patients receive the most appropriate and effective treatment, reducing the duration of illness and preventing complications. By identifying resistant strains, clinicians can avoid ineffective treatments and choose alternatives, improving patient outcomes.

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