Chapter 5
Antibiotic Resistance:
A Global Threat to Humanity

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ABSTRACT

Antibiotics are certainly miracle drugs and have comprehensive usages in humans and livestock for the treatment of various bacterial diseases. However, inappropriate or misuse of antibiotics can lead to the development of antimicrobial-resistant bacteria. Antibiotic resistance happens when bacteria change in responding to the usage of these medicines. These bacteria can also be disposed of from animals to humans via contact between humans and animals directly, or through the food chain and the environment. Antibiotic resistance is a great threat to global humanity as it can prolong treatment in hospitals, increase medical costs, increase mortality, and burden the family. Residual antibiotics above the maximum residue limit (MRL) are harmful to human health and animals and need to be monitored. By increasing national policies, international declarations, agreements for enough chemical and analytical instrumental facilities, and above all, creating awareness about the harmful effect of resistance, the situation of antibiotics resistance can be improved.

INTRODUCTION

Antibiotics are synthetic, semi-synthetic, or naturally occurring compounds with antimicrobial activity to treat and prevent diseases. Antimicrobial agents are chemotherapeutic, prophylactic, synthetic, and therapeutic agents used to prevent and treat infections in humans, animals, and plants (Patel, et al., 2020). They include antibiotics, antiviral, antifungal, and anti-parasites. In general, antibiotics are used to treat

bacterial infections. Antifungals are used to kill or prevent the growth of fungi. Viral infections are treated by antiviral drugs. Anti-parasites are used for the treatment of infectious diseases caused by parasites.

Usually, antibiotics possess sensitive strains which selectively inhibit the growth rate of target bacteria and stop multiplying the cell wall developing, destroying, or attacking the surrounding bacteria. Antibiotics are effective against the suspected infections caused by bacteria, fungi, or protozoa but not against viral diseases like the common cold, influenza, flu, etc. according to the World Health Organization (WHO, 2020).

HISTORY OF ANTIBIOTICS

Antonie van Leeuwenhoek, a Dutch microbiologist identified the first single-cell microorganism bacteria in the 1670s. Later, Louis Pasteur and Robert Koch worked on *tuberculosis mycobacteria* in 1882. Rudolph Emmerich and Oscar Low discovered the antimicrobial drug for cholera and typhus in 1890 and Paul Ehrlich introduced the bacteria responsible for syphilis in 1909 (Lambrin et al., 2018). However, the first natural antibiotic known as Penicillin which was derived from *Penicillium notatum* in 1928 by Alexander Fleming was effective against gram-positive and gram-negative bacterial infections (Patrick, 2013) (Table1). Within 14 years of discovery, in 1942 penicillin saved the life of Anne Sheafe Miller who was suffering from a streptococcal infection. The discovery of penicillin saved many more lives and inspired scientists to work on the discovery and development of new antibiotics. Later, many new and useful antibiotics of different classes were discovered from natural sources and synthesized in laboratories to save human lives. It has been an ongoing process of discovery until now.

CLASSIFICATION OF ANTIBIOTICS

Antibiotics can also be classified based on their chemical structure, the basis of origin, mechanism of action, the spectrum of action effects on their activity and route of administration (Singh, 2020; Kebede et al., 2014) as described in Table 2-7:

SELECTED ANTIBIOTICS

Antibiotics are regularly used in humans and livestock to treat various bacterial diseases. Their improper usage results in residues in animal tissues that cause antibiotic resistance via the food chain and environment. So, it is essential to investigate residual amounts of those familiar antibiotics used in humans and food-producing animals to make awareness of using antibiotics and stopping antibiotic resistance.

Amoxicillin

Amoxicillin ($C_{16}H_{19}N_3O_5S$; α-amino-p-hydroxybenzyl penicillin) is an antibiotic of the beta-lactam class. It is used for the treatment of bacterial infections (nose, ears, throat, lung, skin, and urinary tract), stomach ulcers by *Escherichia coli*, *Haemophilus influenzae, H. pylori*, *Neisseria gonorrhea,* pneumococci, streptococci, *Salmonella spp*, *Proteus mirabilis*, and certain strains of staphylococci (El-Sayed et

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