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Title: Antibiotics: A Double-Edged Sword

Antibiotics: A Double-Edged Sword

Today, antibiotics plays an essential role in healthcare and medicine. But even though these powerful drugs have been used to treat bacterial infections, antibiotic resistance has weakened the effectiveness of antibiotics. In this essay, we will discuss the origin of antibiotics and their antibacterial qualities, as well as the problems related to overuse of antibiotics (e.g. antibiotic resistance).

Roots of Antibiotics

Antibiotics have a long, rich history. In 1896, the French medical student Ernest Duchesne investigated that Penicillin affected the virulence of the bacteria in guinea pigs, removing their lethal effects. Unfortunately, since Duchesne could not establish the relationship between Penicillin and an agent with antibacterial properties, his finding was left unrecognised until Fleming's rediscovery. In September 1928, *Penicillium notatum* fungi was discovered to inhibit the growth of *Staphylococcu*bacteria by Doctor Alexander Fleming.

Since then, antibiotics have been widely used in healthcare and have saved many lives. In World War II, the death rate from bacterial pneumonia fell drastically to less than one per cent and saved 12 to 15 per cent of Allied forces' lives. Furthermore, antibiotics are still preventing an estimated 200 million people from death across the globe today.

Effects of Antibiotics

Antibiotics are medicines that can inhibit the growth of or destroy batteries. Bacteria are microorganisms that were first observed in 1676, by a Dutch businessman *Antoni van Leeuwenhoek.* Although most bacteria are harmless, some potentially cause diseases by extracting nutrients like proteins and minerals. The antibiotics can perform mechanisms on bacteria such as the following:

1. Interfering with cell wall synthesis or maintenance
2. Inhibition of nucleic acid synthesis
3. Interfering with protein synthesis

As such, bacterial infections can be cured efficiently.

Antibiotic Resistance

Are antibiotics still at the top of the game? The answer is no. Bacteria have developed strong resistance against many types of antibiotics, deteriorating the use and effectiveness of antibiotics. For example, tuberculosis (TB)-causing mycobacterium has developed resistance and TB has re-emerged as a "serious infectious disease" from 1990 and 1992 in the US. More than 140 patients treated with three different antibiotics were discovered to have had strains of TB-resistant bacteria. The Centers for Disease Control and Prevention (CDC) had called the problem a "catastrophic threat" as more than two million of people each year in the US, are infected with resistant bacteria—

microorganisms with strengthened immunities against future doses of antibiotics. Around 23,000 people die each year as a direct result of such infections.

In 2008, it was first discovered that bacteria found in soil was not only resistant to antibiotics, but also are used as a food source. Furthermore, high occurrence of antimicrobial resistant genes (ARGs) was found in wastewater and urban surface water environments in Singapore.

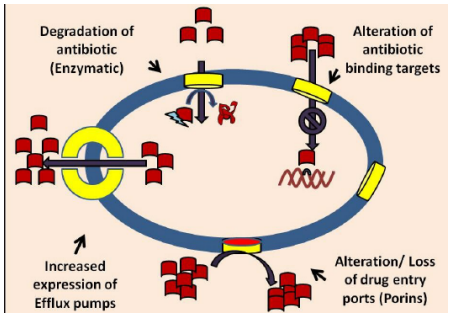
Thus, antibiotics resistance is an alarming issue and it could be contributed by bacterial and human factors.

1. Bacterial factors

Bacteria have found ways by evolving and adapting in response to the increasing prescription of antibiotics. When antibiotics are overly-prescribed, bacteria tend to adapt and evolve accordingly. Bacteria must first obtain the resistant genes via two means

- Spontaneous mutation—DNA is altered to become antibiotic-resistant. Some mutants are capable of producing enzymes disabling antibiotics, allowing them to thrive with less interference from antibiotics.
- Transfer of resistant genetic material from other bacteria via R plasmids (a cellular structure that replicates independently of chromosomes)

Both processes take place via exchanges involving transduction and transformation, and conjugation. Through gathering a multitude of resistance genes over a long period of time, bacteria would build resistance to numerous antibiotic types. Some of the manners in which bacteria resist antibiotics are illustrated in the dDiagram below.



Diagram

2. Human factors

There are many human factors contribute towards antibiotic-resistance, such as the antibiotic overuse in medicine or livestock and the high concentration of antibiotics in hospitals.

The overuse of antibiotics in medicine for the past 40-50 years has resulted in a significant increase of antibiotic-resistant bacteria, since pathogenic bacteria have undergone genetic changes, enabling them to survive antibiotic treatment. Many physicians prescribe antibiotics for conditions that don't warrant their use just for the ease of treating the illness, building up the resistance of bacteria too. This leads to the growth of superbugs like Methicillin-resistant Staphylococcus aureus (MRSA), which results in skin infections that are more challenging to treat than the common *Staphylococcus aureus*, and increased outbreaks of antibiotic-resistant infections.

Furthermore, many patients cling to the myth that antibiotics will remove their cold and flu symptoms and pressure their doctors to prescribe antibiotics for themselves or their family. Also, some patients fail to take the full dosage of the antibiotic recommended to them. Once their

illnesses have appeared to have subsided, patients may think that the antibiotics have ridded the bacteria. Sadly, that is not true. In fact, the remaining bacteria still surviving after the dosage of antibiotics is prescribed usually holds the *strongest* resistance. Hence, it would possibly grow rapidly and transfer its genes to other cells.

A medical institution like the hospital may also be a source of resistant microorganisms. Patients going for treatment occasionally carry resistant strains of bacteria from infections into the hospital. The high concentration of antibiotics can cause resistant bacteria to reproduce rapidly while the remainder are killed by antibiotics. Thus, resistant genetic information contained inside the plasmids can spread in hospital

Recently, the overuse of antibiotics has spread to agricultural sectors. In 2001, the Union of Concerned Scientist found nearly 90% of the total antimicrobial use in the US was for non-therapeutic purposes in farming. Livestock producers have been feeding or injecting into their animals antibiotics to increase their rate of growth or survival in the congested spaces of factory farming. This, in turn, results in the increased development of antibiotic-resistant bacteria in human consumers upon ingesting meat—a much more severe issue. Would this be worth it then—the exchange of economic benefit for human health?

In addition to antibiotic resistance, based on the latest US findings (2018), women who take antibiotics for a longer duration succumb to greater risk of death from heart disease and other causes. The study among 37,510 women aged 60 years and older observed that women who took antibiotics for two months or more in late adulthood had a 27 per cent greater death risk than those who did not.

Possible Solutions

In order to reduce antibiotic resistance and health issues, I believe that public education and research advancement are some of the possible approaches to take.

Firstly, for audiences ranging from healthcare professionals (especially doctors), patients, to farmers, public education is the key to tackling this complicated issue. More seminars and forums on antibiotic resistance should be conducted and medical professionals would be more mindful about antibiotic overuse, and similarly educate patients on it. From a local study, more than two-thirds of patients visiting GP clinics have the misconception that antibiotics can cure viral illnesses. The same number think antibiotics cure URTIs more quickly. Through media like the internet or television, we can teach patients never to save antibiotics for the next time they fall sick and encourage them to take the full dose of antibiotics prescribed by the clinician. We can also raise farmers' awareness by making livestock companies aware of the consequences of drug overuse. This can encourage the prudent usage of antibiotics.

Second, innovative research regarding drug resistance is also ongoing. Based on scientific findings, Vitamin C may remove resistance from bacteria without killing it, which is essential as it disallows the selection of resisting the Vitamin C treatment. An article on the Journal of Current Research in Scientific Medicine found Vitamin C may also have potential use in topical antibacterial applications, or urinary bladder irrigation fluid for catheterized patients with urinary tract infections or during bladder instrumentation.

Plasmid researchers are also finding methods of eliminating R plasmids from bacteria as well as preventing the expression of resistance genes contained in the plasmids. The search for new medicines is still ongoing, creating antibiotics is definitely insufficient to fight the growing resistance.

Resistance multiplies with the instant combination of mutations and gene transfers from different species.

Conclusion

Antibiotics is truly a double-edged sword. No doubt it has saved millions of lives—from WWII up till today, however, its effectiveness has greatly deteriorated over the years due to the growing medicine resistance. Then, is it a “catastrophic threat”, as labelled by the CDC, that puts many people’s lives at stake? Or should it retain its status, as a miracle that averted the deaths of 200 million people?

I guess it largely depends on how antibiotics are used. Thus, each and every one of us must think twice before using antibiotics, exercising prudence while holding this double-edged sword.

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