International Journal of Healthcare Sciences ISSN 2348-5728 (Online)
Vol. 10, Issue 1, pp: (187-190), Month: April 2022 - September 2022, Available at: www.researchpublish.com

An Overview on Antibiotic Resistance Effects and Preventions

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DOI: https://doi.org/10.5281/zenodo.6952003

Published Date: 02-August-2022

Abstract: **Discovered in the year 1928, the first natural antibiotic "Penicillin" by Alexander Flemming. He was then later awarded the Nobel prize in physiology or medicine in 1945, alongside Ernst Boris Chain and Sir Howard Walter Florey. Since then, antibiotics have turned into one of the key agents in dealing with bacterial infections. Because of their effectiveness, antibiotics became so widely used among doctors. Not understanding how antimicrobials work, over-prescription is now the leading cause of antibiotic resistance.**

Antibiotic resistance has become increasingly common over the few present years. It is important to be able to identify the danger, and causes and understand means of prevention in order to combat the spread. This study describes the hazard of antimicrobial resistance, It's effects on humans lives in different aspects, causes, preventions and aims to address the general problems surrounding antibiotic resistance. By gathering information from various websites and researches published by trusted publishers around said topic, we concluded that antimicrobial resistance related issues are still getting overlooked and finding a new way to determine antibiotic profits must be implemented. Additionally, new rules surrounding the use for antibiotics might also be needed.

Keywords: **Antibiotics, Antimicrobial resistance, Antibiotic resistance.**

1. INTRODUCTION

Bacteria, single cells and microorganisms are one of the most abundant living beings on the planet. It can be found virtually everywhere and all over your body, inside and out. Some are beneficial but some are more harmful than others. In the past humans were extremely vulnerable to these harmful bacteria, getting a small cut could mean death to some. We were desperate for a cure until 1928 when "penicillin", the first antibiotic was discovered by Sir Alexander Flemming. [3] Since then people are beginning to see bacteria-related diseases to be less and less of a threat because of how effective these antibiotics are. Pharmacies started prescribing and handing out more and more antibiotics even to those with non-bacterial related illnesses such as viral infections. This could lead to even more resistant bacteria by killing those non-resistant and increasing the chance for those that are to thrive. Because of how bacteria can evolve to develop resistance and pass on that genetic information [5], Drug-resistant bacteria are becoming more common to the point where some are immune to most of our current available drugs, such as the MRSA superbug which evolved from Staphylococcus aureus with antibiotics resistance that can cause painful skin infection. [15] These are reasons why prescribing antibiotics must be maintained and ways that promote antibiotic resistance must be kept to a minimum.

2. DAMAGES CAUSED BY ANTIBIOTIC-RESISTANT STATISTICS

It was reported in 2019 by the Centers for Disease Control and Prevention (CDC) that there were more than 2.8 million antibiotic-resistant infection cases that occurred in the U.S. each year, and more than 35,000 of the cases resulted in death. [3] If the cases related to *Clostridioides difficile*, a bacterium that is not generally resistant but is the cause of some deadly diarrhea and is related to antibiotic use were to be added, The total number of cases in the U.S. would surely reach further than 3 million cases and 48,000 deaths. Some other urgent threats determined by the CDC include *Carbapenem-resistant Acinetobacter baumannii* (CRAB), which is responsible for pneumonia and wound, bloodstream and urinary tract infections which hospitalized around 8500 patients with an estimated 700 deaths in 2017 . [1]

Clostridioides difficile, a bacterium that is a source of infection of the large intestine (colon), infected approximately 223,900 patients and about 12,800 deaths per year. Erythromycin-resistant Group A *Streptococcus* (GAS), is a bacterium that can cause from a mild and uncomplicated infection to serious and deadly diseases including strep throat, pneumonia, flesh-eating infections and sepsis. It is estimated to be the cause of 5,400 drug-resistant related infections and 450 deaths in 2017.

Research published by the Multidisciplinary Digital Publishing Institute (MDPI) done about antibiotics' use in Thailand also states that antimicrobial resistance infections caused 3.24 million additional hospitalization days and 38,481 fatalities in Thailand annually.[8] This comes up to around 84.6- 202.8 million USD a year on antibiotics and is also suffering from productivity loss as a result of morbidity and mortality of at least 1.3 billion USD. The Thai National Statistics Office (NSO) disclosed that households spent 0.9% of their expenses on self-medication which accounts for antimicrobials in 2013, which later increased to 1.4% in 2016 .[8] This is the result of how communities may lack sufficient knowledge on antimicrobials and how patients can easily obtain these antimicrobials without any prescription from pharmacies.

HARMS FROM ANTIBIOTIC-RESISTANT

When a bacteria that gains antibiotic resistance infects humans and animals, It results in harder to cure infections than those caused by non-resistant bacteria. This could lead to higher medical bills, causing a great economic and emotional burden on families and the healthcare system, extended hospital stays and a higher risk of increased mortality. A resistant infection can also be passed on when resistant bacteria are spread to the environment and food through water contaminated by faeces or even through wildlife.[1] The passed out illness could then lead to serious disability or in some extreme cases, even death.

On a larger scale, antibiotic resistance is also threatening our progress in healthcare, food production and ultimately life expectancy of many nations worldwide. Common infections such as pneumonia, gonorrhoea, salmonellosis and tuberculosis are becoming more difficult to cure with the use of current antibiotics that have become less effective. Recent research done by the World Bank additionally shows that antimicrobial-resistant related issues would elevate **t**he rate of poverty and greatly impact low-income countries compared to the rest of the world. Studies also suggest that annual global GDP could decline by approximately 1.1% and there would be a 5–7% loss in developing countries by 2050. [4]

CAUSE FOR ANTIBIOTIC RESISTANCE

The main cause for antibiotic resistance unsurprisingly is antibiotic usage, and even though AMR can happen naturally whether it would be through random mutations, bacteria turning on certain resistance processes or receiving protective genes from other bacteria, the misuse of antibiotics is still the number one source of the problem.

When a patient uses antibiotics, it removes some bacteria that can cause infections but at the same time leaves those resistant to thrive, multiply and quickly become the dominant type throughout the microbial population. Because how most microbes reproduce by the means of dividing every few hours, it allows them to evolve and adapt to the environment at a rapid rate. [6] During the replication process, some mutations may occur including those that could potentially help them survive when being exposed to antibiotics. Those mutated genes can then also be transferred to non-resistant bacteria making them resistant. Other causes for antibiotic resistance could additionally consist of inadequate diagnosis, oftentimes healthcare providers are forced to use incomplete or imperfect information to diagnose an infection and thus have to prescribe a broader spectrum of antimicrobials. Hospital use, where critically ill patients are more susceptible to infections and, thus, often require the aid of antimicrobials which could result in creating a fertile environment for the spread of antimicrobial-resistant germs. [8]

Scientists also suspect that agricultural use could also be one of the leading causes, considering how widespread the problem has become.

ANTIBIOTIC USE IN AGRICULTURE

More than half of the antibiotics produced in the United States are used for agricultural purposes. They are used mostly to increase crop productivity, in animal husbandry and livestock to treat sick animals and as growth promoters in animal feed at controlled concentrations. [11] There are at least 30 different antibiotics that are often used in agriculture and livestock, among which macrolides, penicillins and tetracyclines are the major ones. Complete absorption, however, does not happen to these antibiotics once entered these animals, They are instead excreted out of the body in the form of faeces and urine which ultimately ends up in the form of manure. Although rich in organic matter, and nutrients and help improve the fertility of the soil, this manure also plays a role in transferring traces of antibiotics from the animal kingdom to the soil ecosystem and ultimately to the plants.

Streptomycin, an aminoglycoside, has also been reported to be most commonly used in plant agriculture as a way to cure diseases such as fire blight from the early 1940s till the late 1940s as a result of not having effective alternatives. [16] This decade-long dependence on streptomycin caused an emergence of resistant strains against the antibiotic and impeded the control of many diseases that could potentially lead back to humans in several ways.

When animals are slaughtered and processed for food, resistant bacteria can contaminate the meat or other animal products and can cause human infections when coming in contact. Antibiotics-resistant bacteria could also spread through faeces contaminated water being used for human necessity.

A field-based research made in 2016 evidently showed a level of copper contamination in two contrasting agricultural soil. By using PCR array to detect the responses of broad spectrum of antibiotic resistance genes (ARGs) per 4-5 year copper contamination (0-800 mg/kg). It resulted in 157 and 149 individually different ARGs in red and fluvo-aquic soil, respectively, with the two most dominant ones being multidrug and β-lactam. The research aimed to provide field base evidence on how copper contamination can significantly change the diversity, abundance and mobility potential of antibiotic resistance after prolonged periods of time.[18]

Even though it is yet not understood how metallic copper can kill bacteria on a molecular level, previous studies exhibit a wide array of microbes turning inactive after a few hours of contact. Examples are *Escherichia coli*, *Staphylococcus aureus*, and *Clostridium difficile.* It is also proven that bacteria kept from exposure to copper alloy coins contain strains that are more resistant to negative properties exerted by dry metallic copper surfaces. [19]

COMPARING DRI RATES

A study carried out by a team of researchers from the USA's Johns Hopkins School of Medicine about the use of different types of antibiotics across 41 countries shows that antibiotic use and antibiotic-resistant greatly vary between countries, with high-income countries like Sweden, Canada, Norway, Finland and Denmark having the lowest Drug-Resistant Index (DRI) rate compared to low and middle-income countries such as Thailand.[12] The researchers attribute this to the fact that the higher-income countries had higher usage of narrow-spectrum penicillins along with access to more effective and expensive antibiotics while people in Thailand are lacking. So by

increasing and focusing more on investment in the research and development of vaccines, newer and more effective drugs, and improving living conditions like sanitation and hygiene, this together could curb the current trends of AMR in Thailand.

3. PREVENTION AND CONTROL

For individuals, to best combat the spread of antibiotic resistance, only using antibiotics when prescribed by a certified health professional may be your best bet. Never share or use leftover antibiotics and prevent infections from happening in the first place by regularly maintaining your hygiene. Wash your hands frequently, prepare and eat clean food, avoid close contact with sick patients, practice safe sex, and keep vaccinations up to date.[10]

The Healthcare industry should also invest more in research and development of new antibiotics, vaccines, more efficient diagnostics and other tools. Supporting health professionals to fend off infections by ensuring their hands, instruments, and environment are clean. Only prescribe and dispense antibiotics when they are needed and report any signs of antibiotic-resistant infections to surveillance teams.

In the agriculture sector, it is important to only give antibiotics to animals under veterinary supervision and not use them to solely promote growth or production. It is also advised to vaccinate animals to reduce the need for antibiotics and keep a certain standard in hygiene and animal welfare.

4. CONCLUSION

Even though the use of antibiotics itself could lead to antibiotic resistance which further can result in a detrimental effect on the user, it remains a fact that antibiotics are one of the if not the most revolutionary drugs to ever be invented. If used correctly, it can render some of the most feared bacteria and infections in the past to be non-threat to humans. So in order to prevent antibiotics from becoming less effective, it is important that we must learn how to use and take advantage of this incredible drug correctly. Some changes may also be needed, such as shifting profits of antibiotics away from the volume being sold to better promote and fund further research on antibiotics or other solutions in the future.

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