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Research Article

# Antimicrobial Resistance: The Secret Killer

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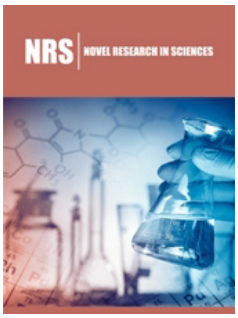
**Abstract**

Antimicrobials are medications used to fight common bacteria-caused infections in the body that can range from minor to severe. Bacteria can mutate and alter its genetic coding to fight the antimicrobials and ultimately build up resistance making the antibiotic ineffective. Antimicrobial resistance is a problem faced across the globe and especially in lower income countries. Excessive prescribing, over usage, incomplete treatment, and lower dosing all contribute to antimicrobial resistance. It is detrimental because it causes infections that cannot be treated by present antibiotics and it can often be fatal. In the age of COVID-19, antimicrobial prescribing has increased as an attempt to combat the virus as proper treatment has not yet been discovered. Various methods can be taken to decrease antimicrobial resistance and prevent it from becoming highly common in society, but action should be taken soon so long-term consequences are limited.

**Keywords:** Antimicrobial resistance; Antibiotics; Bacteria; COVID-19; Prescribing; Vaccines

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## Introduction

How far can science go until it fights back? It is no doubt that modern innovations have taken society into unimagined levels of capability. Over merely a few centuries, knowledge turned letters into instant electronic messages and wooden ships into powerful yachts. Science is constantly being researched, developed, and built upon, and that is unlikely to stop anytime soon. Many of these inventions have dramatically impacted the world. The telephone, for example, allowed for communication between people hundreds of miles away. As experimentation continued, telephones became mobile phones which then became smart phones. Smart phones grant access to nearly anything at the touch of one's fingertips. It was not too long ago when a quick Google search was instead a short trip to the local library. Additionally, the creation of trains and cars paved way for expansion across countries. Without such high-speed travel, the population would likely be more concentrated and much smaller, not to mention the intense impact on culture. With a world so focused on mass media, the technology that allows for them has interchangeably altered societal values. The radio, television, and film all have an extreme significance on the perception and morals of life. Inventions have and continue to change virtually every aspect of people's lives.

Modern medicine is the prime evidence of the vast progress that has been made throughout history. In the past, simple infections were fatal, and most illnesses went untreated. With continuous research, antibiotics, vaccines, and medicines have brought cures and methods to alleviate pain and prolong life. Machines in hospitals can produce x-ray imaging of an entire person in a number of minutes. Advancements such as these have produced a longer life expectancy and numerous means to battle disease and pain. It is a simple task to run to a grocery store for cough medicine, heating packs, or vitamins, but having such easy access to simple pain relief is in itself an impressive feat. There is much to be thankful for in the contemporary world, but many often question when innovation has gone too far.

People often think of a robot takeover or a zombie apocalypse as the "impending doom" facing society, but rather the threat may be already here, and on a microscopic level instead. Antibiotics are immensely useful for the treatment of bacterial infections that often result in pain and discomfort in some way. An abundance of antibiotics exists for the purpose of treating such a large variety of infections. As great as they are, the threat of antimicrobial resistance looms above. Antimicrobial resistance is when bacteria grow to become insusceptible to the

antibiotics, leaving an infection that medicine is no longer effective in fighting. This causes a number of problems and questions left to be asked: What happens as a result of antimicrobial resistance? How can it be prevented? Since the late twentieth century, this topic has been increasingly researched and observed in bacterial infections. The struggle becomes this: as more research is conducted, antimicrobial resistance becomes a larger problem.

Diseases are constantly evolving and arising, an idea that has clearly been evident in the past few years. Flu season and the advertisement of flu vaccines is often seen as strains of the flu continue to emanate. Most recently, the outbreak of COVID-19 has stirred up new questions about everything from public health to its impact on antimicrobial resistance. With a new virus, only so much knowledge can be obtained in such a short period of time, making it much more troubling to attempt to understand the short-term and long-term effects of the sickness on the body, society, and developing research. Experimental antimicrobial use is practiced in an attempt to combat the unknown, but it leaves further observations to be carried out. Antimicrobial resistance has left society with extensive research and new developments to be done, and it must be done soon.

## How it develops?

In order to understand the problems and find solutions, it is necessary to understand how antimicrobial resistance develops. Medicine in present times has been established with a foundation of treating infections using antimicrobials [1]. As a result of this understanding, much of the past century has focused on creating those antibiotics to transform infections from fatal to easily treatable. Antimicrobials are created with the intent to fight an infecting pathogen by producing as much bacterial killing microbes as necessary [2]. By attacking the infecting pathogen, it can be destroyed from the inside until it is no longer affecting the body negatively. Unfortunately, the bacteria that is being fought off can become resistant to the antimicrobials in a number of ways. Through mutation, selection, and obtaining other genetic coding, bacteria are able to become resistant [3]. Bacteria can essentially alter itself in these methods to create bacteria that the antimicrobial was not made to fend against. Bacteria were, however, able to possess resistant properties even before the introduction of antimicrobials. This may be a result of certain bacteria, often used in antibiotics, discovering techniques to defend them against their own bactericidal properties [4]. The ability of bacteria to do become protective is troublesome because when antibiotics are introduced, the bacteria to do not to modify in any way as they are already resistive. Another complicated nature of bacteria is their ability to generate rapidly in whatever direction is most advantageous [5]. So, if bacteria mutate to fight an antimicrobial, the microbes will quickly reproduce their resistant bacteria until the antibiotic is no longer effective. Since it can happen so quickly, it becomes hard to diagnose and properly treat as a result. Resistant bacteria are not a rare species, but rather can be spread through human contacts, animals, or environment contaminations [6]. Due to the fact that they can be spread in multiple ways, it is not probable to attempt to contain the resistant strains or track their source as a sole solution. Additionally, as the use of antibiotics increases, so does the number of resistant bacteria, expanding their overall population [7]. With more antibiotics available to the population and easier access to obtain them, antimicrobial resistance continues to intensify as a problem in the world.

## Impact on daily life

For some reason or another, most people have likely been prescribed or used antibiotics at some point in their lifetime. As common as they are, nearly half of prescribed antimicrobials may not actually be needed [8]. Antimicrobials may be prescribed as precautionary or for trivial purposes, yet many fail to realize this has a larger impact than simply taking a medication. Some consider this readiness to supply antibiotics for mild cases “lax” and “irresponsible” [9]. While it is up to medical professionals on a proper course of action to take towards combatting an illness, the general population should understand the issue at large. Society encourages such medications, leading people to understand that antibiotics are always the best course of action. As important as antibiotics are for severe infections, they may do more harm than good for cases where they are unnecessarily prescribed. The question that can then be asked is: Why are antibiotics being prescribed when they are not needed? A strong factor to answer this question is the existence of sepsis and other infections that can be fatal, resulting in antibiotics being prescribed out of fear [10]. The saying “better safe than sorry” is commonly thrown around, but there comes a line where more long-term consequences arise out of such a minor action. Another question is behind the motives for prescribing and discovering antibiotics, and whether or not they are warranted. It is argued that economic intentions and conflicts have become a driving force in the medical field, overtaking the incentive of scientific benefits [11]. Moreover, a struggle that influences tough decision making is the difficulty of diagnosing bacteria that is resistant to antibiotics [12]. When prescribing medication, it is easy to think about the well-known benefits, but when it does go south and bacteria becomes resistant, the challenging diagnosis can lead to further complications. Antibiotic usage may seem individualized, when it is in fact not. It can be compared to the concept of majority of people getting vaccines to achieve herd immunity, as more antibiotic usage will increase the resistant microbes present and impact those not on antibiotics [13]. If antibiotic usage increases, naturally the number of resistant bacteria will as well, but they can spread among populations and expand the number of people affected by resistant bacteria. Human actions can and have been shown to influence agriculture, in this case with antimicrobial resistance [14]. The bigger picture goes beyond one person and has an impact on the global population of humans and animals.

## Global impact

With a problem such as antimicrobial resistance, it has consistent data worldwide, but inconsistent means of tackling the problem [15]. When each country implements policies to counteract antimicrobial resistance, it may be effective for an amount of time within that country, but the resistant bacteria can still be found in high volumes and transferred from other regions.

Within the United States, it is estimated that over two million people develop antimicrobial resistant infections a year resulting in a minimum of 23,000 deaths [16]. In the whole world, it is reported that more than 700,000 deaths each year can be attributed to antimicrobial resistance [17]. The problem is not a small one and it is not concentrated in just one area. The entire globe sees the consequences of antimicrobial resistance, yet it is not widespread in media coverage. In developing countries, a greater problem is seen because antibiotics are widely used in uncontrolled environments, so people may take incorrect dosage or not finish a treatment if costs do not permit [18]. Disorderly antibiotic use is worse for antimicrobial resistance because bacteria can develop resistance more easily when the medication is weaker or not used to completion. Antimicrobial resistance destroys global, decade long struggles against diseases such as tuberculosis, HIV, and malaria by increasing the threat that had been majorly resolved [19]. If bacteria become excessively resistant, an extensive trouble of recreating treatment do these infectious diseases that have killed so many on their own. This goes back to the idea that health care provides prescribing antibiotics has medical effects on a grander scale [20]. Society must be analyzed and understood on the need for antibiotics. People see a medication kill deadly infections, so the demand for antimicrobials increases. There is a widespread pressure placed on global health systems to produce more antimicrobials to create quick fixes for people [21]. However, the quick fixes are undesirable. Similar to climate change, people can gain short term benefits from their use of antibiotics (and carbon), but in consuming these things, the world faces the threat of global warming and deadly, antimicrobial resistant infections [22]. It is hard to convey the idea that the benefits provided briefly do not outweigh the negative consequences that may happen down the road because people see the present and short-term results right in front of them.

## COVID-19

In the present day, thousands of issues are being researched and observed, but the introduction of the COVID-19 pandemic has drastically impacted life around the world. With a new disease, so much is unknown and only so much knowledge can be determined. The long-term effects of a disease, medication, or a vaccine can only be predicted when being used suddenly. In this pandemic, the problem arises of finding ways to treat extremely ill patients, with no prior experience with the virus. As a result, antibiotics and antifungals have been disbursed in large amounts in only a few months [23]. They are being used due to the fact that symptoms of COVID-19 can present similarly to bacterial pneumonia and because patients could potentially get bacterial infections as a result of the virus [24]. Additionally, the uncertainty alone is probable in pushing antibiotic usage as physicians attempt any treatment [25]. Moreover, studies have shown that of the 72% of patients that were given antibiotics, a mere 8% of them had infections that required antimicrobials [26]. Antimicrobials are being used in lieu of specific treatments because there is not enough research conducted to discover what the best course of action is [27]. Using antimicrobials as a last resort or a preventative measure will increase future exacerbation of antimicrobial resistance [28]. Just as with the virus itself, long term consequences can only be guessed, but it is likely that antimicrobial resistance will change based on its location in the hospital or within different countries [29]. At home, people are using excessive amounts of disinfectants, however, these too can experience bacteria that mutates and becomes resistant to the disinfectant properties when used in large amounts [30]. Emerging from this pandemic and moving forward, it is important to discover the amounts of antimicrobial usage and attempt to discover resistant bacteria.

## Possible solutions

Recognition of the influence of antimicrobial resistance is only the beginning and now action must be taken to combat the global issue. First and foremost, surveillance is necessary to obtain an understanding of antimicrobial usage and resulting resistance [31]. By gaining this knowledge, it will be easier to tackle the problem once there is a consensus on where the problems arise most, what prescriptions are unnecessary, and how to eliminate unwarranted usage. This is especially important in lower income countries where the threat of antimicrobial resistance is intense and based on improper antibiotic usage [32]. Second, improved diagnosing methods is essential to provide for more accurate treatment rather than precautionary prescribing [33]. If conditions are diagnosed more accurately, only the necessary medications can be given to the patient. Additionally, improved diagnosing will grant the ability to detect antimicrobial resistance before it becomes a threat. Thirdly, antibiotic prescription and usage should be decreased. If antibiotics were prescribed for more advanced infections, it may be possible for 60 to 70% of prescribing to be reduced [34]. Reducing prescribing would decrease antimicrobial usage, therefore decreasing the volume of resistant bacteria. Keeping antibiotics to limited usage would make them more effective when they are required because resistance is not as prevalent. Fourthly, alternatives to antibiotics should be researched and considered. New antimicrobials have the potential to fight resistant bacteria, but the introduction of more microbial may perpetuate the issue even further [35]. Another alternative is the usage of natural medicine in the form of plants. Biologically, plants have survived against microbes for centuries while human medicine has fallen short [36]. Microbes can still become resistant to plants, but the rate of resistance is lower, and strength of plants may be more powerful in fighting bacteria. The preferred alternative to antimicrobials is the production of vaccines. Vaccines prevent infections from occurring by destroying resistant bacteria, decreasing symptoms of infection, and lowering the bacterium ability to rapidly produce [37]. Having vaccines to fulfill these duties is favored because it reduces the demand for antibiotics while protecting people against infections and resistant bacteria. Finally, the last action that should be taken is boosting information to the public about antimicrobial resistance [38]. In doing so, people may become less susceptible to take antibiotics for minor reasons which would help limit the overall usage [39-45]. Also, by expanding public knowledge, more concern will be focused on antimicrobial resistance, further encouraging more research and governmental policies to be enforced [46-50]. Similar to bacteria,

there is power in numbers and a greater population fighting will have a stronger impact.

## Conclusion

Modern innovations bring modern challenges, and at the heart of them is antimicrobial resistance. Within the past century alone, thousands of advantageous advancements have made life easier and safer. There is much to be grateful for from modern medicine, but it is important to exercise caution, so the adverse effects are limited. Antimicrobial resistance is a lesser focused on but equally important epidemic to face. If it goes without attention now, the future may face consequences of resistant bacteria and a lack of effective antimicrobials. Antimicrobial resistance on an even wider spread scale would mean an immense increase in infections with the likelihood of fatality in them increasing as well. Additionally, it would be much harder to manage if the resistant bacteria have reproduced and become more common than the original bacteria. Fortunately, there are multiple steps that can be taken to prevent the problems that arise as a result of antimicrobial resistance. Surveillance, improved diagnosing, limited antibiotic prescribing, establishing alternatives to antibiotics, and educating the public are some of the primary methods that can benefit communities globally. It is also important that efforts are made universally and not just in one region in order to assist all people and better combat antimicrobial resistance.

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