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Antibiotic Resistance

The recent outbreaks of MRSA or staph infections are prime examples of the issues facing our society within the medical field. The issue facing scientists, doctors, and patients today is the increasing rate of drug resistant diseases and cases in which first-choice antibiotics fail to cure infections. The continued emergence of antibiotic resistance remains a global public health concern and simply reflects the adaptability of bacteria. After an analysis of this widespread issue, it becomes evident that the use of antibiotics must be reduced in both clinical and community settings, which requires educational awareness regarding antibiotic resistance for the general public. The need for an alternative therapy that is not resistant to any bacteria also becomes urgent in the medical field.

Scottish bacteriologist, Alexander Fleming, conducted several experiments and devoted much of his time to the study of bacterial infections and the development of antibiotics. Fleming created the first string of penicillin in 1941, and by 1944, the mass production of the antibiotic was saving the lives of many people. Fleming's discovery of Penicillin commenced the antibiotic era. For the first time, fatal infectious diseases had treatment options with antibiotics, causing death rates to drop significantly. Success with treatment led to an explosion of antimicrobial products (Crawford 192). The next twenty years of antibiotic production led to a time period spanning nearly fifty years when antibiotics slowly became overused and abused. This led to many of the resistance trends seen today.

Antibiotics and antimicrobial products, either synthetic or natural, act as powerful drugs that limit or kill the growth and life of harmful bacteria in the body (Kowalski 20). Bacteria are the most numerous living things on this Earth, with over tens of thousands of species identified to date. These microscopic organisms exist as single cell microbes that live, grow, and divide independently. When a harmful bacterium multiplies, it invades and interferes with normal bodily processes, which leads to bacterial infections. Essentially, antibiotics are used to treat infection by destroying microorganisms that cause the infection, as well as killing harmful bacteria to keep them from reproducing (Hooton 1). Antibiotics are selected according to the unique structure of each cell wall and the proteins that compose it, which in theory will leave all other cells unharmed (Crawford 193). Antibiotics kill bacterium by attacking the cell wall and binding to the specifically targeted bacterium.

In understanding how antibiotics fight bacterial infections through the invasion of cell walls, it is important to note that viruses are not cells. Viruses are not alive and therefore non-existent on their own, until they invade another living cell. Viruses are particles outside of cells and when they infect the cell, they essentially become one with the cell, using human body cells as its host. It is important to understand that, unlike bacterial infections, viral infections do not respond to antibiotics. Therefore, viral infections such as common colds, strains of the flu, chickenpox, and AIDS will not respond with antibiotic treatment. Both viruses and bacteria are responsible for illnesses and diseases prevailing today; however, each infection must be treated differently. The unnecessary use of antibiotics for the treatment of viral infections is one of many issues that have led to the resistance trends seen today.

In theory, antibiotics are prescribed to kill all of the invading bacteria causing an infection. However, since the development of antibiotics, bacteria have slowly fought back with resistance to the drugs. These resistant strains of bacteria are known globally as *superbugs*. The term *superbug* still refers to bacteria; however, these strains of bacteria have altered their genetic composition, which prevents antimicrobials from accessing and killing the targeted bacteria. Through chromosomal mutations in DNA that change the composition of the cell wall, or acquisition of new genetic materials from other bacteria, bacteria becomes resistant (Mulvey 408). Bacteria mutates at an extremely fast rate, therefore stronger drugs are required to treat resistant strains; yet the cycle continues, creating more superbugs and requiring stronger doses of antibiotics, which technology cannot produce quickly enough. Drug companies have made over a million pounds of antibiotics, but when the targeted bacterium is not susceptible to the drugs, new antibiotics are continuously required for treatment, which makes the development costly and rarely substantial to solve the problem (Kowalski 7).

In understanding antibiotic resistance, it is important to note that the discovery and production of antibiotics have not caused resistance; rather it has expanded the amount of naturally occurring resistance. The human body naturally operates and functions on a system of checks and balances. In the same way that antibiotics are natural, so too is antibiotic resistance – antibiotic producing microorganisms need to have a system in place that enables them to resist their own agent of destruction (Moore 72). Generations of the 1940s witnessed the explosion and production of mass quantities of antibiotics and other microbial products, such as penicillin, which allowed for an increase of production that shifted the balance of power in nature. This power shift altered the environmental conditions, to one which fosters the growth and development of bacteria; this is known as selective pressure (Mulvey 411). Selective pressure gives rise to resistant forms of bacteria that have competitive advantage over other strains of bacteria (Kowalski 26). Mathematical models show that with a more balanced use of the different antibiotics available, physicians will be more successful in reducing the selection pressure, which leads to antibiotic resistance (Sandiumenge 1197). Antibiotics have worked medical miracles for over seventy years, and they have routinely cured fatal diseases; but what people have failed to recognize is that yesterdays 'wonder drugs' are no longer the 'magic bullets' that can cure almost anything (12).

The human body is capable of recognizing 100,000,000 different types of bugs. As a function of the body, the immune system creates specific antibodies to attack infectious bacteria. It can take 10 – 14 days for the immune system to create an antibody; once created, an antibody stays in the body for the remainder of one's life (Magee 630). When a germ invades the body, the antibody takes action to protect the immune system. Every time a patient fights off infection without the aid of antibiotics, his or her immune system becomes stronger (Abelson 3). With the development of these antibodies, it would be easy to think that the body contains an army of antibodies; therefore, people should never get sick. However, the mechanism in the body that recognizes and matches the invading bug fails to perform its function as the human body ages. Resistance in response to most pathogens and antibiotics tends to decrease in adolescents due to a more developed immune system, plateau with age, and then increase in risk beyond the age of 65 (Magee 630). Through the study of the immune system, doctors grasp a better understanding on the resistance trends seen in their patients.

Due to the rapidly growing amount of resistant bacteria, individual patient risk is amplified initially after treatment of antibiotics. Pneumonia, skin infections, tuberculosis and several other infections have become more and more difficult to treat due to the increased amount of resistance. Traditional antibiotics have lost their effectiveness in the battle against infectious diseases, illnesses last longer and risks of complications or death have increased dramatically. Antibiotic-resistant organisms have become a global concern and a threat to the society due to the fact that they are capable of causing serious, life-threatening infections with limited treatment options (Mulvey 408). Carren Bersch, author of *Molecular Dx vs. Superbugs & Superdrugs*, writes in the Medical Laboratory Observer, “HAI’s (Hospital Acquired infections) afflict two million Americans each year and prove fatal to over 100,000” (10). In the past ten years the number of resistant bacteria has increased significantly, in correlation with the increasing number of deaths from resistant infections. It is imperative that the issue of resistance in hospitals is addressed not only for the sake of the mortality and morbidity of patients, but also for the expenses of the hospital. Costs in managing antimicrobial resistance have skyrocketed for many reasons. Some costs are attributed to longer hospital stays, lost revenue from private isolation rooms, the development of new antibiotics, the increased amount of testing in labs, and extreme implements of intervention for infection control (Mulvey 414). With increasing costs and a falling economy, hospitals are looking for the most affordable and effective solution to the superbug crisis.

New supplies of antibiotics offer the most obvious way to overcome the superbugs attacking the population today. However, there are many different angles from which to view the situation, and the public society has a far different view compared to the pharmaceutical producers, in terms of creating new antimicrobial products. Lack of education in the public community leads the average person to be in favor of developing new antibiotics, mainly due to the false assumption that antibiotics will prevent future epidemics. The public also associates mortality and morbidity with a lack of effective treatment, which leads people to support the development of antibiotics; however, the average person remains unaware about the pressing issue of resistance. Contrary to this view, producers in the pharmaceutical industry are hesitant to continue their research and development of new drugs. Technology is extremely expensive and projected studies suggest that new antimicrobials will become resistant in a short amount of time (Aiello 1912). In fact, new antibiotics have already been introduced and physicians have witnessed only a limited virginity before resistance emerges (Woodford 259). Although new technology can offer new antibiotics, they show potential for rapid obsolescence, which continues the cycle of creating more resistant strains of bacteria that require a continuous need for new drugs in treatment. Therefore, due to both the learned and projected failure of investing money in new antibiotics, it becomes evident that it would be more beneficial to seek a solution with another approach.

The overuse and abuse of antibiotics is related to the development of antibiotics and, as stated before, has contributed to the resistance trends seen today. This progression suggests that rationalizing the total use of antibiotics and reducing the amount of prescriptions doctors give, would bring down the amount of resistance. The amount of prescriptions written by doctors continues to climb in the United States, reaching nearly 190 million prescriptions per year – about 110 million in outpatient settings and 35 million in emergency departments (Hooton 3). The issue of over-using antibiotics lies not only with the doctors, but also with the patients. Most doctors succumb to the pressure of their patients by prescribing unnecessary antibiotics while treating the patient. Nearly 20 – 50 percent of antibiotic used in community settings have been deemed unnecessary, and nearly 25 – 45 percent of antibiotics use in hospital settings have also been deemed inappropriate (Hooton 3). Doctors overprescribe antibiotics for several factors. One factor being the demand from the patient; and another, more significant factor, is the concern doctors have for misdiagnosing bacterial infections, cases in which antibiotics are not appropriate for viral infections. Doctors often fear the liability of misdiagnosing patients (Lord).

However, in spite of this, Thomas Hooton, a professor of medicine at the university level says, "The physicians in private practice estimated that they could reduce their own prescribing of antibiotics by 10 to 30 percent without negatively affecting patient care" (3). Many patients fail to understand that antibiotics are not needed to treat all infections. Therefore, it is imperative to know that antibiotics are nonessential when treating a viral infection and it is important for patients to understand the risk of developing antibiotic superbugs when taking unnecessary antibiotics (Hausler 23).

In spite of actions taken to rationalize the amount of prescriptions written for non-bacterial infections, the amount of antibiotics used in industrial farming cannot be dismissed. Over 40 percent of antibiotics in the United States are used in animals on industrial farms (Hooton 4). Antibiotics are given in low doses, over long periods of time not only to prevent bacterial infections in animals, but also to enhance the growth of cattle and poultry. Author Thomas Hooton cannot deny obvious evidence of the resistance this leads to in saying, "Long-term exposure to low concentrations of antibiotics creates the environment for the development of resistant strains of bacteria that can be passed to a broad human population" (4). The application of antimicrobial agents in farm products allows resistant bacteria to colonize and grow during the food processing. The use of antibiotics in farming translates into the everyday food that today's society consumes, yet the average person remains unaware of this. The Pew's Charitable trusts on Human health and Industrial Farming argues that the use of these antibiotics provides the ideal situation for food-borne illnesses to spread, causing danger with the increasing difficulty in treatment for antibiotic-resistant strains of bacteria (Human Health and Industrial Farming 1). "Each year 300,000 hospitalizations and 5,000 deaths are caused by food contaminated with dangerous pathogens and bacteria such as Salmonella and E.Coli, which are increasingly becoming resistant” (1). Non-organic or dairy products provide the consumer with unnecessary doses of antibiotics and steroids. These antibiotics weaken the immune system, while also providing greater opportunities for resistance. Due to these facts it is important that doctors encourage healthy eating habits, and diets of organic food (Abelson 3).

Antibiotics and steroids in food are not the only things that have been overlooked in the contribution factors of resistance seen today. Antibacterial agents, such as disinfectants and antiseptics, have been incorporated into nearly all household products, and contrary to popular belief these items are not always beneficial. Often times the public views the ‘antibacterial’ aspect of cleaning agents as a positive angle, in that the products help fight off infection as well as sterilize homes. However, what consumers fail to understand is that these agents produce changes in the flora of the bacteria, which fosters resistant strains of bacteria (Hooton 4). Alcohol-based products claim to kill bacteria, yet often times they fail to recognize harmful bacteria versus beneficial bacteria; therefore, they wipe out all strains of bacteria minus the resistant superbugs. It is also important to note that these products are only effective for twenty minutes (Chapman, Biocence vs. Alcohol 1). Recent studies show that the excessive hygiene habits of today are not as beneficial as most people believe, mainly because they prevent the body’s immune system from the learning process it relies on to fight infection (Dossey 85). Studies show that exposing the body to dirt and other pathogens as a child allows the immune system to become stronger; however, many argue that the recent overload of antibacterial products have inhibited the immune system and created resistance (85). With the extreme cases of resistant infections seen today, the best option to protect oneself from hospital acquired infections and superbugs in community settings is to learn proper hand washing techniques and take healthy precautions when using antibacterial agents. Still, some believe that the superbugs today are too big for the immune system to handle, and a better solution must be discovered quickly in order to solve this antibiotic resistance crisis (Lord).

With recent advancements in technology, microbiologists have developed an alternative to alcohol-based antibacterial products. This product has been introduced as *Biocence* to hospital, school, and community settings. Many biologists and researchers, including Allan Lord who has worked scientifically in this field since 1995, hypothesize that the Biocence product offers a solution to the antibiotic resistance crisis evident today for several reasons, but most importantly because it has never shown resistance to bacterium or viruses as it kills the vegetative form of pathogenic bacteria (Lord). Unlike most alcohol-based products that are synthetically made, Biocence is all-natural and organic. The product is not toxic and safe enough that it could be taken internally, however not suggested by the FDA (Chapman 1). Biocence is the only over-the-counter, topical antiseptic that has been proven to successfully kill all organisms, including resistant strains, on contact (Chapman, Biocence vs. Alcohol 1). After testing this product in a lab, Senior microbiologist, Karine Aylozyan, at Micro Quality Labs says, “Not only does it destroy the five commonly tested pathogens (Staph aureus, E. Coli, Aspergillus niger, Canadia albicans, and Pseudomonas aueroginosa) it also is able to destroy several pathogens in less than 30 seconds of time!” (Aylozyan).

Biocence has several advantages over the leading alcohol-based hand sanitizers. First, being that it kills all disease causing bacteria, even resistant bugs, on contact within seconds with no harm to healthy cells. In doing this, the product destroys the pathogen in both the spore and vegetative form. However, the most significant advantage of the Biocence product is that the product identifies between the ‘friend and foe’ bacteria of the body, leaving the beneficial bacteria of the body unharmed (Lord). Biocence is unique in the world of antiseptics in that it immediately kills all pathogens and disease causing microbes, yet it serves as a ‘pre-biotic’ to feed beneficial bacteria (Chapman, Biocence vs. Alcohol 1). Unlike any other alcohol-based product, Biocence has been named an antiseptic by the FDA, as well as a disinfectant by the EPA (Environmental Protection Agency) – antiseptics being agents that kill growth on living tissue, and disinfectants being agents that kill growth on applied surfaces (Chapman, Biocence vs. Alcohol 2). If hospitals and clinical settings can afford to use this product line, there will finally be preventative treatment for more than fifteen different pathogenic bacteria, which have previously been resistant.

In analysis of this issue, it becomes most evident that today’s society must approach this problem with a variety of steps in order to decrease the amount of resistance and prevent resistant infections. In understanding how resistance is developed, it becomes obvious that the top priority in fighting against superbugs should be reducing the total number of prescriptions written by doctors. Secondly, it is important that the use of antibiotics in farming decreases and diet plans of organic foods are implemented, in order that resistant strains of bacteria have a smaller window to break through. Finally, if people are properly educated about the disadvantages of alcohol-based products when used in excess, and introduced to more effective products, such as Biocence, individuals will have a better chance of preventing resistant infections that often prove to be fatal. In raising awareness about the issues of resistance facing the medical world today, along with rationalizing antibiotics and taking action to prevent bacterial infections, superbugs will begin to retreat in the battle of resistance.

The sudden emergence of antibiotic resistance remains a global public health concern and simply reflects the adaptability of bacteria. Have no doubt that antibiotics are still greatly needed and effective in the treatment of many infections, but the current use and abuse of these drugs has insinuated a great battle between the infectious disease and the antibiotic. The acts of rationalization and prevention will move the antimicrobial world in a step towards a healthier and safer direction. In possessing both knowledge and technology, it is imperative that both physicians and their patients exercise caution with the use of antibiotics. Traditional antibiotics will remain in battle with infectious diseases until we rise up and take action.

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