**[Antibiotic Resistance Crisis]**

Author: Ashlyn Nossaman
Major: Microbiology/ Cell and Molecular
Department of Microbiology and Molecular Genetics, Oklahoma State University, Stillwater, OK 74078, USA

**Key Words:**

Antibiotics, Antibiotic resistance, Antibacterial, Antimicrobial

Antibiotics has been a game changer to the scientific and medical world since the 19th century. Antibiotics has been a “life changer” for millions of people with diseases and infections. Saving lives is not the only thing that antibiotics can do, they play a huge role with the advances in medicine and in the operating room during surgeries. The relevance of antibiotics is vital to the world; it has been how we have extended life spans and overcome many infectious diseases. Daily, the antibiotic resistance is increasing throughout the world, and the antibiotics are losing that “power” they once had to cure infections. However, researchers are at a tipping point with the research on how to stop the resistance among antibiotics. Antibiotics play a very pivotal role in medicine and life, and if antibiotics are continuing to become more resistance and there is not a stop then what is to combat diseases and infections in the future?

**Introduction**

In 1940, the first antibiotic resistance case was identified, Penicillin-R-Staphylococcus. This resistance was found not too long after antibiotics came around. (*Ventola 2015)* In today’s world, the developing world, antibiotic resistance is more common than most think. Antibiotic resistance is not a topic that is brought about in most conservations, and not a large population knows about this resistance, and the effect it could have among the world. More antibiotics are becoming resistance than the foundation of a new antibiotic being introduced. In the *Towards a Global Definition of Responsible Antibiotic Use: Results of an International Multidisciplinary Consensus Procedure* article that was published in 2018 discusses the importance of this medication to everyday life. In the article, it mentioned “human health, animal health, and the environment are closely interrelated, a One Health approach is of paramount importance. Antibiotic resistance has been recognized as the quintessential One Health issue, illustrating its principles better than any other public health threat" (*Monnier, Eisenstein, Hulscher, & Gyssens, 2018*). The Center for Disease Control (CDC) and Prevention discusses that the antibiotic/antimicrobial resistance is the largest public health challenge that has occurred. Over 23,000 people die from their immune system being resistance to antibiotics, and there are 2 million antibiotic resistant infections reported annually. (*Center for Disease Control and Prevention, 2018*)

Antibiotics are a way of life in the developed world and in the developing world. We must have antibiotics to survive, they are a powerful medication that healthcare world needs. This very imperative medication has a lot of benefits that is behind it. The medication can help patients with complex surgeries that have been performed (joint replacements, cardiac surgery, or organ transplants), chronic diseases (diabetes, rheumatoid arthritis, end-stage renal disease) and chemotherapy treatments. (*Ventola 2015)* On a simpler level they help those with common illnesses that have bacteria such as; urinary tract infections, pneumonia, and strep throat are a few.Not only do they help cure diseases and illnesses studies have shown that they have increased lifespan among individuals. In other countries around the world antibiotics help with the poor sanitations issues.

How are antibiotics the way that they are today? What caused the resistance to occur? By individuals overusing and misusing these particular medications had been the primary cause of the antibiotics resistance. The number of antibiotics that are prescribed yearly is far too high and it would take extensive work to reduce these numbers. (*Ventola 2015*) The overuse of antibiotics has evidently been the reason of the start of the evolution of the resistance crisis. Within the United States a medical professional has to prescribe medications, as antibiotics, to a patient. However, in other countries globally they are not regulated and anyone can get them over the counter with easy access. The lack of regulation rules allow people with plentiful and inexpensive medications causes overuse. Random mutation has also been a big factor within the antibiotic resistance crisis. A random mutation is a spontaneously change in a gene.

Not only is overuse and mutations a cause of the antibiotics resistance but also inappropriate prescribing to people all across the world. Inappropriate prescribing is more common than you think, “treatment indication, choice of agent, or duration of antibiotic therapy is incorrect in 30% to 50% of the cases” (*Ventola 2015*).

There also has been the lack of new drugs available to the medicine world. Stated in The Antibiotic Resistance Crisis article “as a lack of new drug development by the pharmaceutical industry due to reduced economic incentives and challenging regulatory requirements”. (*Ventola 2015*) Most pharmaceutical agencies that do provide new antibiotics they have a stronger interest in working with gram-negative bacteria rather than gram-positive. A big issue within the pharmaceutical industry on developing that new antibiotic is the lack of funding.There has been a tremendous funding cut due to the economy. There are 18 large pharmaceutical companies and 15 of those had dropped the antibiotic field due to the funding. (*Monnier, Eisenstein, Hulscher, & Gyssens, 2018)*

Antibiotics are not a long-term medication; they are short term. With that being said, a lot of pharmaceutical industries do not make as much profit off of it like medication for gastroesophageal reflux, asthma, psychiatric diseases, or diabetes which are relatively long-term (i.e. more money). The investment of new medications goes to those that will make more profit rather than an antibiotic that the net profit will roughly be around $50 million instead of 1 billion. Not only do investors choose the better investment but with a new antibiotic it does not reach the market for all financial levels. With a new antibiotic it can cost between $1,000-$3,000 per coarse of the medication. (*Monnier, Eisenstein, Hulscher, & Gyssens, 2018)* In developing countries such as India and China a large portion of the population cannot afford the expensive new medications. With developed countries that have well-funded health care systems more patients are applicable to purchase those new medications. Individuals purchase the generic drugs due to cheap price and they are effective. However, with people used to paying less for medications most individuals have this assumption new antibiotics will be just as cheap. This has had a very low percentage of users to consume that new medication.

Physicians are also weary about a new antibiotic. Physicians typically do not prescribe this new antibiotic immediately to patients, they typically will prescribe an older medication over a newer one. Which results in the antibiotic being used less frequently. (*Monnier, Eisenstein, Hulscher, & Gyssens, 2018)* From the pharmaceutical companies that do produce new antibiotics they do not get approved. The amount of antibiotics that are developed and are approved by the FDA Center for Drug Evaluation and Research is decreasing each year which leaves once again fewer strategies to treat resistant bacteria.

Not only is antibiotic essential to medicine and saving lives but it is a key ingredient to the agricultural world. They are used in agricultural to help promote the growth of livestock, and also helps the livestock with infections. Agriculture uses an estimated amount of 80% of antibiotics sold within the United States. With that fact the livestock consume the antibiotics and must the antibiotics that is consume is then released from the body via urine or feces. With the antibiotics being released in that way this allows to be dispersed through groundwater, and fertilizer.

**Recent Progress**

Within recent years’ researchers have been searching for that point to get them over the edge of how to stop this antibiotics resistance. In the pharmaceutical industry there has been developmental work of new antibiotics. When a new antibiotic is released and used frequently the resistance of that new antibiotic is ineluctable. The uncertainty of how long a new antibiotic will be resistance is the problematic part. Researchers do not when or how long that antibiotic will work due to the uncertainty of bacterial evolution. Another item to add to the list is everything must have boundaries, and the regulatory boundaries for new antibiotics is a very tight. It is very challenging to receive approval to even start testing for a new antibiotic. The CDC is a big advocate for finding that push to help the antibiotic resistance crisis. Within the last two years the program has made investments in all 50 states in the US, which included 6 large cities and even Puerto Rico to intensify the laboratories and increase the skill for epidemiology. (*Center for Disease Control and Prevention, 2018*) They also invested to grow the public’s health concerns to push the antibiotic resistance across healthcare settings, communities, and in food. Since 2016 the CDC has given $144 million to Puerto Rico and 56 different state and local health departments worldwide to help this issue. Not only have they given $144 million but the CDC has also invested roughly $76 million into 60 universities and health care programs globally. (*Center for Disease Control and Prevention, 2018*) Another progress that is getting pushed within the past year is to help the over prescribing numbers decrease. The push is to educate individuals within the United States to know when to take an antibiotic for a bacterial infection rather than a viral infection. Scientists are asking patients to say “no” to antibiotics for viruses.

**Discussion**

To get the antibiotic resistance crisis under control implementation of new rules needs to be addressed. Some ideas of recommended steps include the following: tracking and prescribing practices, optimizing therapeutic regimens, preventing infection transmission, and improving diagnosis are some of the few to a start of the crisis. The government and new agents help advocate and implement those policies. This topic is an unanswered and open ended topic. There is no for sure answer as to when there will be new antibiotic resistance medications or how effectively it will be. There is not an answer for what happens if researchers do not find that antibiotic resistance medication. There is no right or certain answer. What we do know is that researchers are continuing to conduct new studies and experimenting to find new antibiotics to help void the gap of the this worsening antibiotic crisis. There have been multiple new efforts all across the globe to apply new policies, new opportunities to have research efforts, and new innovative ideas to manage the crisis issue within the antibiotic resistance.

**References**

Centers for Disease Control and Prevention. “Fighting Antibiotic resistance: CDC tool maps progress in evert state, but still more to be done”.

Monnier, Annelie A. Eisenstein, Barry I., Gyseens, Inge C., Hulscher, Marlies E. “Towards a Global Definition of Responsible Antibiotic Use: Results of an International Multidisciplinary Consensus Procedure”. Journal of Antimicrobial Chemotherapy. 2018: vi3-vi11.

Ventola, Lee C. “The Antibiotic Resistance Crisis”. Part 1: Causes and Threats. 4 (2015): 277-282.

Ventola, Lee C. “The Antibiotic Resistance Crisis”. Part 2: Management Strategies and New Agents. 5(2015): 344-351.