Forum: World Health Assembly

Issue: Addressing the development and spread of treatment resistant strains of pathogens

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Introduction

Pathogens that are exposed to antimicrobials mostly die, but the ones that survive the drugs designed to kill them are often difficult to treat. Surviving pathogens are often the result of genetic mutations, Darwin's natural selection, and horizontal gene transfer in which bacteria transfers its pathogen resistant genetic information to other bacterial cells. Self-medication is also a way in which pathogen resistance occurs. This means that a previously effective treatment could very quickly lose its ability to counter pathogens leading to the need for stronger and more effective treatments, which often cost more money, harms the human body, and resources for research. If pathogens ever reach a point in which there are no adequate antimicrobials that can successfully kill them, it could raise a serious concern as diseases can no longer be treated. Antimicrobials include antifungi, antiviral, antiparasitic, antibiotics, and antiseptics.

Pathogens such as viruses often mutate millions of times faster than its host, and with the sheer number of them, a mutation that could survive the host is not rare. Most pathogens are often large in numbers and mutate extremely quickly, allowing at least a small percentage of pathogens to survive even with treatment. On the contrary, medical progress takes years if not decades to produce, and new and stronger medicine takes high resources to invent. With the rapid rate of growth in pathogens and the comparatively slow production of stronger treatments shows that the solution is not developing more antimicrobials, but figuring out ways to impede the growth rate of pathogens.

This issue has its real world implications. 700 thousand people die each year from antimicrobial resistant diseases. Further resistance development without any attempt to stop it would cause more and more of these issues and raise treatment costs.

Definition of Key Terms

Pathogens:

An organism that has the potential to spread and produce diseases, with the 5 main types being: bacteria, viruses, fungi, protozoa and worms.

Antimicrobials:

A medicine that disallows the growth of or destroys microorganisms.

Genetic Mutation:

An altercation in the genetic material of a cell of a living organism or virus that is mostly permanent.

Superbug:

Microbes with enhanced abilities to survive pathogens as well as enhanced mortality.

Gram-Positive:

Bacteria testing positive in the gram stain test, meaning it possesses a thick peptidoglycan cell wall.

Background

The Discovery of Antimicrobials

Before antimicrobials were discovered and widely used, many diseases spread across nations and killed millions of people. One of the most infamous diseases,the Black Death, happened between 1347 to 1351, in which roughly 25 million Europeans died, around 30-50% of the population at the time. This is widely believed to have been caused by the bacterium Yersinia petis, transferred by oriental rat fleas. The Europeans suffered heavily from these pathogens, which in the modern day could be solved easily with the help of antibiotics.

The discovery of antimicrobials originated from the discovery of the cell, a discovery made by Robert Hooke in 1665, using the technology of telescopes invented by Zacahrias Janssen in 1590. In 1676 Antione van Leeuwenhoek furthered this research by descrying microscopic living organisms. During the later parts of the 19th century, Robert Koch and Louis Pasteur discovered the correlation between bacteria and diseases by studying Bacillus anthracis and Mycobacterium tuberculosis. The research from these previous scientists opened a window of opportunity for scientists later on to create a pivotal discovery known today as antimicrobials.

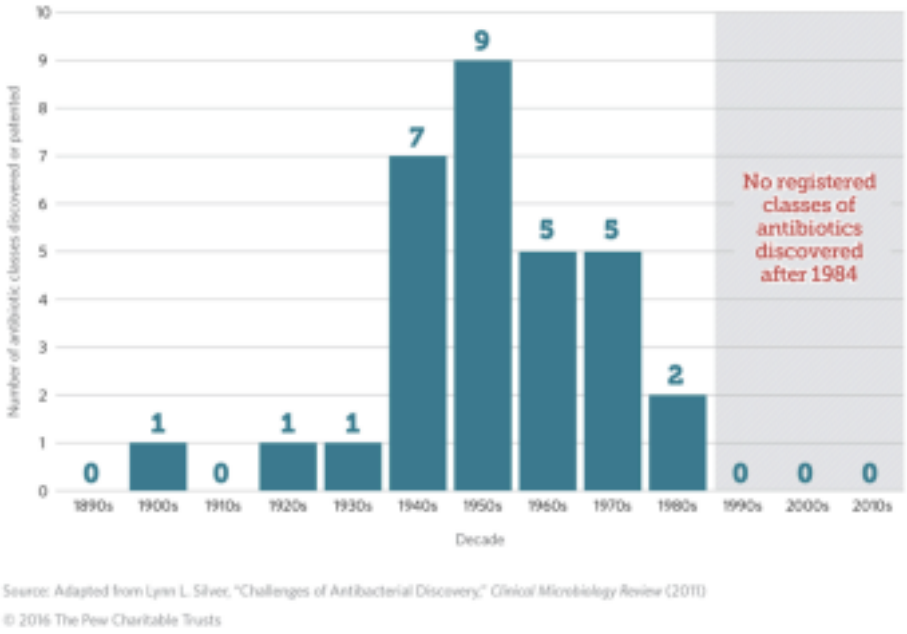

Figure 1: A bar chart illustrating the number of antibiotic discoveries since the 1890s

Struggle in the Discovery of Antimicrobials

The discovery of antibiotics in the present is too difficult and costly for pharmaceuticals to attempt upon. Since the easiest discoveries have already been made, it is now much more difficult to discover them. Pharmaceuticals now choose to improve upon medication rather than discovery. Ever since the 1990s, scientists have struggled to discover new antimicrobials, and 95% of pharmaceutical companies have moved onto improving medicine rather than discovering microbials.This means that pathogen resistance cannot be countered by using new pathogens due to the limited number of antimicrobials.

The History of Treatment Resistant Pathogens

The first instance of treatment resistant strains pathogens being confirmed was after the discovery of penicillin. In 1940, penicillinase was discovered in E. Coli, which was able to deactivate the effectiveness of penicillin. Since then, many other antibiotics such as streptomycin, which was used for tumor treatment in 1944, has pathogens that have developed resistances against them. Currently, the Gram-positive organism Staphylococcus aureus is the most infamous superbug. *S. aureus* is carried within 30% of the population as a nasal commensal, and is linked with skin infections. The reason for its fame is due to the difficulty in controlling it even through antibiotics. Antibiotics such as methicillin proved ineffective in as little as three years after its use to treat *S. aureus* due to antibiotic resistance being developed to fight against treatment

Superbugs and other types of antimicrobial resistant pathogens often make treatment more expensive and difficult, especially harming those who are unable to afford expensive treatment. As long as antimicrobials are used, it is only a matter of time before resistances are developed by pathogens. This proves a major issue in which many nations struggle to solve.

Acceleration in creating treatment resistant pathogens are created by many reasons including the following: overuse of medicine due to wrongful diagnostics, self-medication(prevalent in southeastern asian nations), poor sanitation, antimicrobial waste spills in the environment.

Major Parties Involved

Pharmaceutical companies

Pharmaceutical companies are the ones producing antimicrobials, and are therefore one of the biggest stakeholders on fighting against treatment resistant pathogens. Many pharmaceutical companies have taken steps to limit treatment resistant pathogens. Companies such as Pfizer, Aurobino, and GlaxoSmithKine have attempted to fix the issues through ways such as preventing antibacterial waste spills in the environment when disposing waste, creating more accurate labels of how much antimicrobials should be used in order to limit over use, and shunning volume-based production. Access to Medicine Foundation(AMF) has created a report to analyze companies' engagement in limiting treatment resistant pathogen strands. Despite many companies attempting to limit this development, many others still are driven based on profit and therefore do not attempt to fix these issues. Pharmaceutical companies are often profit driven so many companies are not incentivized to spend money on this, but rather potentially overprescribing to get more sales.

Governments

Governments have a major role in limiting misuse and creating regulations for pharmaceutical companies to follow. With the ability to regulate and look over hospitals and antimicrobials used, governments often attempt to limit antimicrobial development in many mediums such as policies and surveillance. Relevant policies that have been used include limiting overuse of antibiotics. Governments have done things such as spreading information on how to not misuse antibiotics, and to get a doctor if possible. Governments can also create projects to discover more antimicrobials and utilize government funds to discover better methods to prevent treatment resistant pathogens. This can help discover what pharmaceutical companies are unwilling to discover.

Antimicrobial Users

Antimicrobial users can affect pathogen's development of treatment resistant strains by overusing treatment. When treatment is overused, pathogens evolve quicker because the treatment is stronger than needed. When treatment is stronger than needed, the pathogen grows even stronger than when the treatment is enough but not too much. This is often caused by self-medication which is extremely prominent in South-East Asian countries. Not using adequate treatment could allow faster development of pathogens, and users play a big role in limiting these issues.

Doctors

Doctors are the ones that decide the amount of medicine to be prescribed. If the doctor is unprofessional it could lead to overuse of antibiotics, creating more antimicrobial resistance. Many countries have untrained or

doctors who haven't received enough resources, this means that there is a lot of potential for pathogens to grow

further resistance

Previous Attempts to Resolve the Issue

UNEP, WHO, UNFAO, and WOAH has created the One Health Response as a framework to solve issues around health in general with treatment resistant pathogens as a big part of the framework. The One Health Response includes methods such as educating and raising awareness in hospitals and farms, in which a lot of antimicrobials are used against bacteria. This method ensures that antimicrobials don't grow in these places in which they could spread easily. Outbreaks such as drug resistant-Salmonella were caused by dairy cows in 2016, and this method ensures farmers are aware and will attempt to prevent such cases from happening. The One health movement also traces a lot of antimicrobial pathogens through better surveillance and reports from places that have experienced treatment resistant strains of pathogens. This method further ensures the spread of resistant pathogens are monitored and can therefore be swiftly treated.

The CDC has also worked on releasing specific bacteria targeting viruses in hospitals that can ensure the resistant bacterias don't escape from the hospitals and spread elsewhere. Many sewage systems cannot fully get rid of all bacteria and is often released to the wild, allowing the spread of resistant pathogens further into the environment. The CDC also improved sanitation within hospitals to ensure the initial discharge of water into sewage systems is clean, and that the hospitals are cleaner in general.

Possible Solutions

Currently, the focus for many organizations and governmental bodies is on preventing pathogen resistance to be developed further. However, in order to address the already existent treatment resistant strains, methods need to be utilized to limit these as well.

Genetically modified microorganisms could potentially be used to combat antibiotic research, although this method requires further testing. Research has shown potentially for genetically modified microorganisms to be used to create a vulnerability in bacteria to antibiotics that would be otherwise ineffective against lung infections. This has the potential to both limit treatment resistance in pathogens but also ensure that pathogens already resistant to treatment can be modified to be treated easily with antimicrobials.

Drug delivery systems are another way to manage already treatment resistant pathogens. Conventional drug delivery systems often are ineffective due to build up of defensive strategies within pathogens against it, and due to the uncontrollable nature of it could cause antibiotic resistance. Nanoparticle delivery systems can be designed to release antibiotics in a more controlled manner, which would create less antibiotic resistance buildup. Additionally, modifying the drug delivery system in a way called the "Trojan Horse" strategy could also potentially be implemented. This strategy is when antimicrobials are covered by many layers of carriers such as liposomes and exosomes to push through the cell wall of treatment resistance pathogens. This could allow a smoother and better delivery of drugs against previously resistant pathogens, disallowing blockage and failure to deliver drugs. However, this method is also still in its testing phase and is therefore requiring further research and resources.

Because the solutions stated above are currently in the testing phase, the best solution is to engage in more research on these topics. With more funding there can be more discoveries made and used in order to create better strategies to counter antimicrobial resistance. Many other discoveries can be made on ways to ensure antimicrobial

effectiveness against resistance. In order to gain resources and funding, NGOs and governments can collaborate internationally in order to raise funding and gather worldwide researchers to work on antimicrobial resistance, creating a higher chance for the aforementioned strategies to be further refined and used.

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