VANCOUVER YOUTH MODEL UNITED NATIONS 2020

WORLD HEALTH ORGANIZATION

Background Guide

World Health Organization
Director: Catherlin Lu
Chair: Pierre Collet
Assistant Director: Tony Zhang
Assistant Chair: Talia Pimstone

Dear delegates,

My name is Catherlin Lu and it is my pleasure to be your director of the World Health Organization for VYMUN 2020. I hope to make this year's online conference an enjoyable, rewarding and truly memorable experience that allows you to grow and understand the world of Model United Nations. For this conference, WHO will focus on two urgent topics: Antimicrobial Drug Resistance and Vaccine Development and Distribution.

Our first topic, Antimicrobial Drug Resistance, is of pressing concern to our global health and mortality rate. In the past few decades, resistance to antimicrobial drugs has intensified, leading many patients vulnerable to pathogens that cannot be cured by the current antimicrobial drug market. This topic is rooted in the importance of protecting the current antimicrobial drugs from failure while developing solutions to ensure that future generations have the benefits that these drugs bring to human health. There are nuanced situations surrounding antimicrobial drugs in each country and it is essential that WHO takes all of these perspectives into account. With antimicrobial drug resistance on the rise across the world, it is paramount that WHO implements solutions to halt the spread of antimicrobial resistance.

Our second topic, Vaccine Development and Distribution, is a broad one. It involves many areas regarding vaccination including vaccine coverage rates, distribution to hard-to-reach areas and efficient development. As seen in the worldwide pandemic in 2020, developing vaccines is of utmost importance to protecting human health across the world. To ensure global health, WHO has a responsibility to discuss strategies in order to vaccination benefits across the world. In certain circumstances, this involves stopping the rising spread of information regarding vaccines—namely anti-vaccination groups. Vaccines have played a significant role in public health; therefore, it is essential that delegates understand and reflect the importance of this topic in committee sessions.

If you have any questions about either topic or anything related to the structure and guidelines of a Model UN conference, please don't hesitate to contact me at *who@vymun.com*. I am beyond excited to be your director and I am sincerely looking forward to meeting all of you in October.

Kindly,

Catherlin Lu
Director of WHO | VYMUN 2020

TABLE OF CONTENTS

Antimicrobial Drug Resistance

Questions to Consider

1. How are antimicrobial drugs regulated in your country? In what sectors and areas are antimicrobial drug resistance most prominent? How are antimicrobial drugs depicted in your country?
2. How do antimicrobial drugs work in the body? Why do pathogens develop antimicrobial resistance?
3. What are the main causes that accelerate antimicrobial drug resistance around the world? How can WHO address these issues?
4. How should WHO help countries with poor healthcare systems regulate the use of antimicrobial drugs?
5. In what ways can WHO work with other U.N. committees to regulate antimicrobial drug use in various different sectors?
6. What strategies can be employed to ensure antimicrobial resistance awareness?

Overview

Antimicrobial drug resistance is a global health issue in which microorganisms develop resistance to existing antibiotics. Since the discovery of penicillin in 1928, the use of antibiotics has been widespread and extremely helpful in treating diseases. Antibiotics are intended to treat types of bacterial infections, ranging from reducing the prevention of bacterial reproduction to killing bacteria in the human body. However, due to the misuse of antimicrobials in the health and agriculture industry, the world is facing a crisis in which bacteria have become “superbugs” and are causing a major issue to the safety and health of millions around the world. By 2050, experts predict that death caused by antimicrobial resistance will rise to 10 million[1]. Diseases that have become antibiotic resistance are a strain on healthcare systems as they are significantly harder to cure and cause more stress on a patient’s body. [2]

One of the leading causes of antibiotic drug resistance is the overprescription and overuse of antibiotics in healthcare systems. After the introduction of antibiotics, doctors began to overprescribe antibiotics without the knowledge that it could cause detrimental effects. As patients are overly exposed to these drugs, there is a higher possibility of bacteria developing resistance and thus, can cause the spread of antibiotic resistance. This issue is especially prevalent in developing countries due to unstable healthcare systems, resulting in the use of antimicrobial drugs often being unregulated, allowing massive misuse in such countries.

Another major factor is the overuse of antibiotics in agriculture. Research has found that a majority of animal farms in low-middle income countries feed antimicrobial drugs to animals for commercial reasons. This has caused a rise in antibiotic resistance in farm animals around the world and scientists believe that resistance genes in farm animals could pass on to human pathogens. In addition, there is a severe lack of new antibiotic drugs that are being tested and found in these recent years. This severely undermines the efforts to fight drug-resistant pathogens.

[1] https://www.who.int/news-room/detail/29-04-2019-new-report-calls-for-urgent-action-to-avert-antimicrobial-resistance-crisis
[2] Ibid.

Currently, there are many diseases that show signs of developing antimicrobial resistance which causes concerns all over the world. These include Klebsiella pneumoniae and E.Coli which have both caused millions of deaths across the world. Emerging resistance is expanding in HIV, tuberculosis and others[3]. Without the effectiveness of antimicrobial drugs, numerous treatments for cancer and any major surgeries would be impossible.

WHO aims to reduce antimicrobial resistance by educating the public on the proper use of these drugs—by reducing the amount of unnecessary antimicrobial use there is a lessened chance of resistance developing. In addition, much research needs to be conducted to aid the discovery of new and effective antimicrobial drugs. At the moment, antimicrobial drug resistance is on the rise and present in every country around the world.

Timeline

1600s: The existence of microorganisms is discovered through the invention of the microscope, allowing scientists to observe organisms invisible to the human eye. Antonie van Leeuwenhoek was the first to document this type of finding[4].

1928: Alexander Fleming discovers the first antimicrobial substance known: penicillin, an antimicrobial that prevents the growth of staphylococci[5].

1942: The first patient is successfully treated with penicillin. The drug then played an important role in World War 2 as it was commercialized for use[6].

April 1948: The World Health Organization is formed in Geneva, Switzerland.

1947: First bacterium resistant to penicillin was found—a mere four years after the drug was mass-produced.

1950: Researcher E.S. Anderson reports widespread transfer of antimicrobial-resistant bacteria from animals to humans due to the common use of antimicrobials in agriculture[7].

1969: Great Britain generated the Swann Report which urged the ban of therapeutic antibiotics, such as penicillin and tetracyclines, for agricultural use. However, little action became of the reports.

1981: Stuart Levy, a Tufts University scientist, gathered 147 scientists from 27 countries to form a conference in Santo Domingo regarding the “Molecular Biology, Pathogenicity, and Ecology of Bacterial Plasmids.” Levy was one of the first advocates for antibiotic awareness and successfully spearheaded the movement to frame antimicrobial resistance as a global issue. Later that year,

[3] https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
[4] https://www.britannica.com/science/microbiology
[5] https://www.sciencedaily.com/terms/antibiotic_resistance.htm
[6] https://www.nature.com/articles/s41599-018-0181-x
[7] Ibid.

Levy founded the Alliance for the Prudent Use of Antibiotics—an organization that raised awareness about antibiotic usage.[8]

2001: A culmination of WHO organized consultative groups and expert workshops in the 1990s and 2000s about the growing health issues concerning antimicrobial resistance. These events led to the WHO Global Strategy for Containment of Antimicrobial Resistance, which addresses said issues through a "framework of interventions to slow the emergence and reduce the spread of antimicrobial-resistant microorganisms."[9]

July 2004: The Infectious Diseases Society of America championed the movement to bring attention to the pharmaceutical industry's need to focus on the fight against antimicrobial resistance instead of new profitable drugs for chronic illnesses. This is emphasized in the 2004 report "Bad Bugs, No Drugs: As Antibiotic Discovery Stagnates … A Public Health Crisis Brews"[10].

May 2015: WHO creates its first Global Action Plan on Antimicrobial Resistance. This report includes new aspects of prevention primarily highlighting the importance of education in the role of preventing antibiotic and antimicrobial misuse. [11]

September 2016: The United Nations convenes a high-level General Assembly meeting with the sole purpose of discussing antimicrobial resistance. It was only the fourth time that such a meeting had been dedicated to a health issue[12].

Historical Analysis

While the term 'antimicrobial' was not coined until the late 1800s, antimicrobial treatments have been a part of the medical community for centuries, though early doctors were not aware of their real repercussions until later. There has been evidence of antimicrobial use in early Chinese and Egyptian civilizations. However, the modern age of antibiotics came during the 1900s when scientist Alexander Flemming discovered penicillin—the first antibiotic to be widely used in medicine. The following section explores cases of antimicrobial resistance in a variety of contexts and where they arose.

Case Study 1: Penicillin Resistance

The 1940s was revolutionary for the development of antimicrobial treatment. In 1942, the first patient was successfully treated with penicillin and in 1945, penicillin was mass-produced and distributed to medical professionals around the world. During this time, penicillin played a major role in saving the lives of soldiers in World War 2. However, heavy use, a result of its wide success, of the drug led to its unexpected failure in the 1950s. As Flemming himself predicted, the "public will demand [the drug and] then will begin an era … of abuses,"[13] referring to the eventual failure of the drug as a result of heavy demand from the public. By the 1950s, resistance to penicillin had become increasingly prominent across the world and its existence could nearly derail the medical

[8] Ibid.
[9] https://www.ncbi.nlm.nih.gov/books/NBK97127
[10] https://www.nature.com/articles/s41599-018-0181-x
[11] https://www.who.int/antimicrobial-resistance/publications/global-action-plan/en/
[12] https://www.who.int/antimicrobial-resistance/events/UNGA-meeting-amr-sept2016/en/
[13] Ibid.

advancements of the previous decades; the drug began to fail in clinical settings and led to the need for another antimicrobial drug in its place[14]. This pattern repeated itself throughout the 20th century; new drugs were discovered and rendered 'useless' within years of commercialization—a pattern that may continue to repeat if diligent action is not given to the seriousness of this issue.

Case Study 2: Colistin in Chinese Livestock

Colistin was an antibiotic discovered in 1949[15]. Initially too taxing on the human body, it was rarely used in hospital settings; however, as bacteria developed alarming multidrug-resistance, colistin was brought back into use as a last resort for multidrug-resistant bacteria in countries such as the UK and US. In China, colistin is not used to treat patients but instead used as growth enhancers and disease-prevention in livestock and agriculture—specifically in pig farms.

In 2015, there was a discovery of bacteria carrying the MCR-1 gene: a gene that makes bacteria resistant to colistin. This caused alarm around the world as colistin is seen as a final defence against multidrug-resistant bacteria. The bacteria became a global health concern as it causes an illness that is virtually impossible to treat with the existing antimicrobials available in the world; moreover, scientists were certain that the bacteria could eventually gain genes that made it impossible to cure with antimicrobials. Soon after, researchers discovered the gene in 16 out of 1322[16] human patient samples in China, clearly showing that the bacteria had moved from animal to human. As expected, the bacteria quickly worked its way around the world and had been identified in "50 countries across six continents"[17]. After these frightening developments, the Chinese government finally banned the use of colistin for non-medical purposes in April of 2017.

Researchers found the direct short-term effects of banning colistin in a 2020 study. Through looking at colistin residues and colistin-resistant bacteria in samples of pig feces, researchers found that the amount of bacteria resistant to colistin dropped substantially. Across 23 provinces in China, colistin-resistant bacteria was originally found in "34% of feces samples" in 2015-2016 as opposed to the 5.1% found from 2017-2018[18]. Clearly, there is a direct impact of banning antimicrobials from livestock on antimicrobial resistance.

Case Study 3: Drug-Resistant Tuberculosis

Tuberculosis (TB) remains a threat worldwide due to its drug resistance to first and second-line anti-TB drugs. In 2012, there were an estimated 450,000 cases of multidrug-resistant tuberculosis and 170,000[19] of those cases died as a result of tuberculosis. This disease disproportionally affects those with HIV and vulnerable children. It is caused by two strains that are at least resistant to one of the five main antibiotics for tuberculosis; strains of tuberculosis resistant to the second line of anti-TB drugs are known as extensively multidrug-resistant tuberculosis—this has been recorded in

[14] Ibid.
[15] https://academic.oup.com/cid/article/40/9/1333/371785
[16] https://www.theatlantic.com/health/archive/2017/01/colistin-resistance-spread/512705/
[17]https://www.cidrap.umn.edu/news-perspective/2020/06/study-finds-short-term-impact-chinas-ban-colistin-animals
[18] Ibid.
[19] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4790366/

117 countries[20]. More worrisome is that there has been the discovery of a strain of tuberculosis that has developed immunity to all anti-TB drugs and are impossible to cure without new antibiotics.

Managing the resistance in tuberculosis is quite difficult as curing TB requires a complete antibiotic treatment course over 6 months. For multidrug-resistant tuberculosis, this can range from 16-18 months. In developing countries and places where the securement of proper antibiotics is difficult, it is extremely hard to ensure that the full course is taken and TB is fully cured. An incomplete course of treatment will typically increase the chance of drug resistance. For many citizens, there is a lack of knowledge on the importance of finishing the full length of a treatment in order to effectively eliminate the bacteria from the body. Tuberculosis also easily spreads through crowds as it is transmitted through the air from person to person, meaning that spreading drug-resistance TB is rapid as well. Moreover, resistance to anti-TB drugs is a cause of a lack of new drugs emerging to replace ones that bacteria have developed resistance to. The lack of interest pharmaceutical companies possess in the procurement of new antibiotics only accelerates the rate at which tuberculosis resistant to all antibiotics will develop.

Past Action

Since the awareness of the severity of antimicrobial resistance has risen throughout the 20th to 21st century, WHO has taken considerable action to slow the spread of such diseases. The most impactful meetings and resolutions concerning the rise of antimicrobial resistance are the UN Interagency Coordination Group (ICGA) reports, the WHO Global Action Plan and the Worldwide Country Situation Report. Prerequisites to such reports are noted in WHA 67.25[21], a resolution precursor to the WHO Global Action Plan.

The earliest antimicrobial drug resistance centred report by the UN was the Global Strategy for Containment of Antimicrobial Resistance, published in 2001. This report mainly focuses on the findings and recommendations of expert workshops and consultative groups on regulating the use of antimicrobial drugs. It was not until 2010 and onwards that the UN and WHO began to severely focus on the detrimental effects of antimicrobial resistance. While there have been resolutions made in accordance with the issue, the WHO issued its first Worldwide Report regarding the status and action of antimicrobial resistance in 2014.

The Worldwide Country Situation Report consists of surveys in all six WHO regions with the goal of understanding “the extent to which effective practices and structures to address antimicrobial resistance have been put in place and where gaps remain”[22]. WHO hoped to use this report as a way to model upcoming action plans in order for such plans to be effective in multiple different areas of the world. Country authorities completed the surveys and subsequent interviews took place with the conductors of the report. A total of 133 out of 194 WHO member states participated in the survey. The findings found that few countries had national plans regarding the antimicrobial crises and none had implemented these plans for an adequate amount of time to create an effective report.

[20]https://www.who.int/news-room/q-a-detail/what-is-multidrug-resistant-tuberculosis-(mdr-tb)-and-how-do-we-control-it

[21] https://apps.who.int/gb/ebwha/pdf_files/WHA67/A67_R25-en.pdf?ua=1&ua=1

[22] https://apps.who.int/iris/bitstream/handle/10665/163473/WHO_HSE_PED_AIP_2015.1_eng.pdf?sequence=1

The WHO led a series of meetings and consulting sessions to curate the current action plan on antimicrobial drug resistance. Starting in September of 2013, WHO held several meetings with the Strategic and Technical Advisory Group on Antimicrobial Resistance (STAG-AMR) to advise WHO on the proper plan of action to combat the resistance. Ultimately, the meetings led to the creation of the Global Action Plan on Antimicrobial Resistance during the 68th WHO meeting with the goal of the draft being the "continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way, and accessible to all who need them"[23]. The action plan strongly emphasized five strategies: improving awareness, increased knowledge through research, reducing incidence of infection, optimizing the use of such agents, and investing in the needs of countries as well as new technologies and drugs. After this report, the WHO also created the World Antibiotic Awareness Week in November of each year to increase awareness surrounding antibiotics and subsequent resistance.

Most recently, the UN Interagency Coordination Group (IACG) generated a report on antimicrobial resistance in April of 2019. The IACG recognized the connection between WHO, Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OIE) in the fight against antimicrobial resistance and highlighted this in its report. Mainly, the report emphasized the place antimicrobial resistance holds in the United Nations' Sustainable Development Goals and the importance of a One Health response to the crisis: a collaborative approach across multiple sectors to ensure success[24].

Current Situation

Right now, antimicrobial drug resistance is seen as a global issue that affects citizens and healthcare systems around the world. Antimicrobial resistance is prevalent in every single country in the world and without urgent action, previously treatable diseases will once again be fatal to the human population. Although progress has been made in the past, there are still many facets of the issue to be addressed. Outlined below are some of the most prevalent matters that must be addressed in order to successfully combat the rise of "superbugs."

Increased Drug Resistance in Global Illnesses

Currently, the emergence of antimicrobial resistance in illnesses that have an impact on global health is of the most alarming concern. Tuberculosis (TB) is one of the ten leading causes of death and leading cause of death from a single infection around the world[25], the development of multidrug-resistant tuberculosis—a type of TB that is resistant to two of the strongest anti-TB drugs—is a worthy cause for alarm. There have been 480,000[26] new cases of such disease in 2014 and this number is expected only to increase in future years. This development causes patients to have a higher mortality rate and take significantly longer to treat—causing harm to both those infected and healthcare systems around the world.

[23] Ibid.
[24]https://www.who.int/antimicrobial-resistance/interagency-coordination-group/IACG_final_report_EN.pdf?ua=1
[25] https://www.who.int/news-room/fact-sheets/detail/tuberculosis
[26] https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

This is also the case for malaria, as resistance to the first line of treatment has been found in 5 Asian countries: Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand and Viet Nam. The possible spread of these resistant strains to other parts of the world could cause the derailment of progress made in nearly eradicating malaria from the modern world. Furthermore, drug-resistant HIV is quickly emerging in both developing and developed nations. For developing nations, 7% of those seeking treatment had drug-resistant HIV; in developed nations, the figure was much higher at 10-20%. As antiretroviral treatment becomes more widespread, resistance is expected to rise as well. This resistance can cause serious economic impacts for patients as second and third-line treatments are respectively 3% and 18% more expensive[27].

Incorrect Use of Antimicrobial Drugs

A major issue surrounding antimicrobial resistance is the incorrect use of antibiotics and antimicrobial drugs. This is extremely prevalent in developing countries. Due to underdeveloped infrastructure and poorly trained medical personnel, antimicrobial use is often unregulated. Doctors often overprescribe antibiotics to patients. A study showed that a doctor could see 350 patients a month and will prescribe over 60% of these patients with antimicrobial drugs based on symptoms alone.[28] In these cases, problems arose from the absence of proper testing before administering a course of antimicrobial drugs. Beyond this, these drugs are easily accessed in pharmacies, stores, and even market vendors without a doctor's prescription. Moreover, patients often do not finish a full course of treatment due to the inability to afford the high prices of the drugs and may stop after symptoms cease. This is problematic as the disappearance of symptoms does not always reflect the presence of pathogens in the body. In many cases, pathogens are still present in the body even though symptoms have stopped. Thus, antimicrobial resistance easily rises in such unregulated circumstances. It can be noted that due to poor medical systems, antimicrobial resistance is much harder to treat in developing countries as there is a lack of staff and equipment available and oftentimes, these hospitals are poorly equipped to deal with these situations.

This issue is also prevalent in developed countries through the emerging trend of self-medication. Through a Google and Yahoo search, researchers found a total of 138[29] websites in which citizens could find and purchase antibiotics without a prescription. Although governments have created laws forbidding the purchase and selling of such drugs without a prescription, websites often provide a prescription without an examination in order to evade these regulations.

Antimicrobial use for non-therapeutic purposes in agriculture

In the United States, 80% of all antimicrobial drugs sold are to the agriculture sector.[30] In other countries, 4 times the amount of antimicrobials sold to humans are often given to animals and farming industries.[31] The sheer volume of food-producing animals that receive antimicrobials is detrimental to the fight against antibiotic resistance. Antibiotics and antimicrobials are fed to farm-grown animals to decrease the chances of infection and can significantly affect growth rates; this practice is expected to grow over the next few decades. The drugs are often used for commercial purposes of growth and prevention rather than treating diseases in the animals. China

[27] Ibid.
[28] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2272287/
[29] Ibid.
[30] Ibid.
[31] Ibid.

and Brazil currently use the highest amount of antimicrobial drugs in farming. Thus, this constant use, no doubt, creates antimicrobial-resistant strains of bacteria that can be passed from human contact, the food chain and the environment to the human population.[32]
Not only is this an issue on land but antimicrobial resistance has been found in aquaculture. A result of the persistent use of antimicrobials in fish farming, researchers have detected antimicrobial resistance in waters around Latin America.

Possible Solutions

Development of New Antimicrobial Drugs

Currently, there is a severe lack of new antimicrobial drugs being introduced into the global market. There has not been a new class of antibiotic drugs discovered since the 1980s[33]. As antimicrobial resistance develops, there is an increasing need for new drugs to fill the 'pipeline' as drugs become ineffective towards resistance strains of bacteria and microbes. Due to the view of new drugs as the final line of defence, companies see little profit from research into new antimicrobial drugs and therefore there are few companies that actively search and experiment in this field. Thus, there must be joint public and private investment into these projects in order to ensure fruitful progress. One way companies can be incentivized to research this field is through 'market entry rewards': a system in which public institutions and governments pay developers a sum of money for developing a new antimicrobial drug.[34]This can encourage companies to continue to search for new and effective drugs in the fight against antimicrobial resistance.

Support for Universal Health Coverage (UHC)

At least half of the world's population do not have adequate access to essential healthcare services. For developing countries, this situation further aggravates antimicrobial resistance. As citizens of developing countries lack access to proper and adequate healthcare, many turn towards unmonitored use of antibiotics and treatment services that are harmful to human health as well as to the fight against antimicrobial resistance. By supporting and funding UHC, it ensures that citizens in developing countries are able to easily access properly trained medical professionals who are able to advise them on the proper course of treatment. This goal would also allow suffering patients to receive the full treatment course without suffering financial hardships. Similar to the EU, developed countries can be encouraged to fund efforts towards meeting the Sustainable Development Goal of achieving UHC in every country by 2030.[35]

Awareness and Education

Unawareness and lack of education on the effects of antimicrobial drugs and subsequent antimicrobial resistance is often the cause of drug misuse. This is especially prevalent in developing countries, where the education system is undeveloped and children and adults know little of the implications of antimicrobial misuse; without adequate knowledge, many living in these countries do not use antimicrobial drugs properly, causing a rise in resistance rates. Therefore, it can be essential to educate citizens on the importance of proper drug use with the help of NGOs and placing higher value upon WHO's Antimicrobial Resistance Awareness Week. Educating the general public is of great importance to lessen the amount of antimicrobial drug misuse. At the same time,

[32] https://www.who.int/foodsafety/areas_work/antimicrobial-resistance/amrfoodchain/en/
[33] https://wellcome.ac.uk/news/why-is-it-so-hard-develop-new-antibiotics
[34] https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf
[35] https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc)

awareness and education are important in developed countries in order for the eradication of self-medication with antibiotics. This can range from targeted education at the school-level to increased reliable and accessible online sources.

Joint United Nations Response

Through the collaboration of multiple United Nations committees in multiple different sectors, the issue of antimicrobial resistance will be addressed in multiple facets. As recognized previously, the WHO relies on collaboration with the FAO as well as the OIE in order to ensure success. The FAO has worked with WHO in the past to ensure that regulations have been put on antimicrobial drug use in agriculture and the OIE has similarly provided aid on regulations in relation to antimicrobial use on animals. In order to address this issue in areas other than direct human impacts, the WHO must work with other committees to ensure that the issue is being properly addressed in agriculture and aquaculture. Through this collaboration, WHO can encourage countries to strictly regulate the use of antimicrobial drugs in livestock and aquaculture so that resistance is less likely to be developed and passed from animals to humans.

As mentioned earlier, illegal sellings of antimicrobial drugs without a prescription also play a large role in the increase of antimicrobial resistance. To combat this, WHO must partner with other UN committees such as the United Nations Office on Drugs and Crime (UNODC) to eliminate the ability to buy and sell antimicrobial drugs without a prescription. This is an issue in both developed and undeveloped countries as it can range from selling drugs online to in-person pharmacies where antimicrobials can be easily bought. For example, it was found that out of 1106 pharmacies across the country, 95% of them sold customers antimicrobials without prescription[36]. By working with the UNODC, WHO can help and urge countries to strictly regulate illicit antimicrobial drugs.

Bloc Positions

EU and North American Countries

Across the European and North American regions, healthcare systems are already meeting the rising antimicrobial resistance crisis with education and awareness. As these countries have strong healthcare systems, unregulated use usually comes from self-medication rather than overprescription from doctors. However, the United States and other European countries currently have growing trends of anti vaccination[37] which may eventually impact the use of antimicrobials as without vaccinations, there is an increased demand for antimicrobial use. Many countries have also taken the step to ban important human-use antibiotics from non-therapeutic animal feeds including Switzerland and the United States. Yet, this does not exempt these countries from the effect of antimicrobial resistance. Henceforth, with a stable economy and healthcare system, this bloc holds a large amount of power in creating new antimicrobial drugs and researching alternative solutions to the antimicrobial drug resistance crisis. It is also responsible for reducing the amount of antimicrobial drug misuse in developing countries through support.

Africa and South Asia

African and South Asian nations all suffer from underdeveloped healthcare systems and subsequent lack of regulation and control over antimicrobial drug use. This enables many citizens

[36] https://aricjournal.biomedcentral.com/articles/10.1186/s13756-019-0655-7

[37]https://www.who.int/news-room/q-a-detail/why-is-vaccination-important-for-addressing-antibiotic-resistance

to be able to purchase various antibiotics without a prescription. Drug resistance is highest in the developing countries of this bloc. As healthcare systems struggle to cope with drug resistance, doctors continue to overprescribe to the general public. However, it is difficult for the government to track and monitor antimicrobial resistance as there is little data regarding the subject and even fewer resources available to do so. African and South Asian nations primarily focus on developing their healthcare system in order to combat antimicrobial resistance. By creating a stronger healthcare system with proper sanitation and health protocols, there is a lessened need for the prescription and use of antimicrobials. More importantly, in areas of poverty, there are unregulated stands and stalls that sell antibiotics that are counterfeit or contain a minimal amount of antimicrobial agents—this could help accelerate antibiotic resistance. Due to poverty, citizens of developing countries often turn to cheap stalls instead of doctors and often only buy a few tablets rather than the prescribed course in order to save money. These nations must rely on developed countries for aid to regulate antimicrobial use and develop their healthcare system.
It is worth noting that these countries do actively use antimicrobial drugs in livestock to promote growth and prevent disease. Many nations have shown reluctance to cease the use of antimicrobial drugs in these areas as their use can effectively feed a nation's population with higher productivity and lower costs.

China, India and Brazil

These three countries currently have the highest amount of antimicrobial resistance in their farming and livestock industries. As the population in China increases and the demand for meat surges, the industry has turned to multiple antibiotics in order to increase growth in animals. This same phenomenon is observed in Brazil and India. Plus, China has a much higher use of antimicrobials as opposed to other countries with similar economies. There have been government policies that attempt to reduce the amount of antimicrobial drugs used in the healthcare system. However, growing concerns around the world arise from the high volume of antimicrobial agents used in livestock as well as the growing rate at which antimicrobial resistance is developing in the farming industry of these countries. While the governments have banned important human medicines such as colistin, there are still little regulations regarding antimicrobial drugs in livestock practices. Farmers are still able to easily purchase illegal antimicrobials without a prescription and distribute them to livestock. For these countries, although regulations are in place for hospitals, a large majority of the population seeks medical aid in rural areas where antimicrobials are still often overprescribed.

South America

In South American countries, there is little data regarding antimicrobial resistance. Currently, there are no surveillance programs monitoring the spread and mechanisms of resistance. However, hospitals have reported a high level of antimicrobial resistance in hospital settings and according to a study, they can cause up to 50% of such infections in countries such as Bolivia and Peru. Another major concern from South America is the high level of antimicrobial use in aquaculture.[38] Especially in Chile, where an abundance of antibiotics are used for salmon fish farming. In many of these countries, there is not an official registration program for administering antimicrobials for aquaculture use and therefore, little data is known about the amount of antibiotics in Latin American waters. Many Latin American countries do not officially share this data with other

[38] https://www.paho.org/hq/dmdocuments/2015/CD54-12-s.pdf

countries as well, making it difficult to understand the level of antimicrobial resistance that exists. There have also been few studies about the status of antimicrobial resistance in Latin American waters.

Works Cited

Aminov, Rustam I. "A Brief History of the Antibiotic Era: Lessons Learned and Challenges for the Future." *Frontiers in Microbiology*, vol. 1, 2010, doi:10.3389/fmicb.2010.00134.

"Antimicrobial Resistance and Agriculture." *OECD*, www.oecd.org/agriculture/topics/antimicrobial-resistance-and-agriculture/#:~:text=The%20potential%20consequences%20of%20antimicrobial,and%20contamination%20of%20the%20environment.

"Antimicrobial Resistance in the Food Chain." *World Health Organization*, World Health Organization, 28 Nov. 2017, www.who.int/foodsafety/areas_work/antimicrobial-resistance/amrfoodchain/en/.

"Antimicrobial Resistance Is Drastically Rising." *ScienceDaily*, ScienceDaily, 19 Sept. 2019, www.sciencedaily.com/releases/2019/09/190919142211.htm.

"At UN, Global Leaders Commit to Act on Antimicrobial Resistance." *World Health Organization*, World Health Organization, www.who.int/en/news-room/detail/21-09-2016-at-un-global-leaders-commit-to-act-on-antimicrobial-resistance.

Chris Dall | News Reporter | CIDRAP News | Apr 29, 2019. "UN Report Calls for Urgent Action against Antimicrobial Resistance." *CIDRAP*, 29 Apr. 2019, www.cidrap.umn.edu/news-perspective/2019/04/un-report-calls-urgent-action-against-antimicrobial-resistance.

Cui, Dan, et al. "Use of and Microbial Resistance to Antibiotics in China: a Path to Reducing Antimicrobial Resistance." *Journal of International Medical Research*, vol. 45, no. 6, 2017, pp. 1768–1778., doi:10.1177/0300060516686230.

Davies, Julian, and Dorothy Davies. "Origins and Evolution of Antibiotic Resistance." *Microbiology and Molecular Biology Reviews*, vol. 74, no. 3, 2010, pp. 417–433., doi:10.1128/mmbr.00016-10.

"Development Process of the Global Action Plan on Antimicrobial Resistance." *World Health Organization*, World Health Organization, 22 Aug. 2016, www.who.int/antimicrobial-resistance/global-action-plan/development_process/en/.

"Development Process of the Global Action Plan on Antimicrobial Resistance." *World Health Organization*, World Health Organization, 22 Aug. 2016, www.who.int/antimicrobial-resistance/global-action-plan/development_process/en/.

Essack, S.y., et al. "Antimicrobial Resistance in the WHO African Region: Current Status and Roadmap for Action." *Journal of Public Health*, 2016, doi:10.1093/pubmed/fdw015.

"Global Action Plan on AMR." *World Health Organization*, World Health Organization, 19 Sept. 2016, www.who.int/antimicrobial-resistance/global-action-plan/en/.

Jacobs, Andrew, and Matt Richtel. "In a Poor Kenyan Community, Cheap Antibiotics Fuel Deadly Drug-Resistant Infections." *The New York Times*, The New York Times, 7 Apr. 2019, www.nytimes.com/2019/04/07/health/antibiotic-resistance-kenya-drugs.html.

"Lack of New Antibiotics Threatens Global Efforts to Contain Drug-Resistant Infections." *World Health Organization*, World Health Organization, www.who.int/news-room/detail/17-01-2020-lack-of-new-antibiotics-threatens-global-efforts-to-contain-drug-resistant-infections.

Mega, Emiliano Rodríguez. "Alarm as Antimicrobial Resistance Surges among Chickens, Pigs and Cattle." *Nature News*, Nature Publishing Group, 20 Sept. 2019, www.nature.com/articles/d41586-019-02861-5.

Miranda, Claudio D., et al. "Current Status of the Use of Antibiotics and the Antimicrobial Resistance in the Chilean Salmon Farms." *Frontiers in Microbiology*, vol. 9, 2018, doi:10.3389/fmicb.2018.01284.

Moreno-Switt, Andrea I., et al. "Antimicrobial Resistance in Water in Latin America and the Caribbean." *JBI Database of Systematic Reviews and Implementation Reports*, vol. 17, no. 10, 2019, pp. 2174–2186., doi:10.11124/jbisrir-2017-003919.

Qu, Junyan, et al. "Crisis of Antimicrobial Resistance in China: Now and the Future." *Frontiers in Microbiology*, vol. 10, 2019, doi:10.3389/fmicb.2019.02240.

Schoenmakers, Kevin. "China's Farms Are Petri Dishes of Antibiotic Resistance." *Foreign Policy*, 21 May 2020, foreignpolicy.com/2020/05/21/china-farms-antibiotic-resistance-antimicrobial-amr/.

"UN Interagency Coordination Group (IACG) on Antimicrobial Resistance." *World Health Organization*, World Health Organization, 10 Jan. 2020, www.who.int/antimicrobial-resistance/interagency-coordination-group/en/.

"WHO Global Strategy for Containment of Antimicrobial Resistance." *World Health Organization*, World Health Organization, 16 Aug. 2016, www.who.int/drugresistance/WHO_Global_Strategy.htm/en/.

"Worldwide Country Situation Analysis: Response to Antimicrobial Resistance." *World Health Organization*, World Health Organization, 22 Dec. 2015, www.who.int/drugresistance/documents/situationanalysis/en/.

Zimmer, Carl, et al. "The Surprising History of the War on Superbugs." *STAT*, 19 Sept. 2016, www.statnews.com/2016/09/12/superbug-antibiotic-resistance-history/.

Vaccine Development and Distribution

Questions to Consider

1. How do vaccines work? What role do vaccines play in the context of global health?
2. What are the policies regarding vaccination in your country? Is there a steady healthcare system that is able to distribute vaccines to all citizens? What are the reasons for vaccine coverage rates in your country?
3. How can WHO ensure equal access to necessary vaccines in both urban and rural areas? What strategies can be employed to aid countries that lack support for vaccination programs?
4. What can WHO do to address the rising rate of vaccine hesitancy in the developed world? What are the causes of misinformation surrounding vaccines and how can WHO prevent such transmission of information?
5. How can vaccines be more efficiently developed in the setting of a pandemic?

Overview

Vaccines have been an essential part of public health development and are widely known to be one of the greatest medical advancements in human history. First commonly used in the 1800s, vaccines have played a part in eliminating deadly diseases in history, most notably smallpox.[39] Vaccines provide protection for those vaccinated by using the body's immune system to build immunity to a certain disease. The method of vaccines works similarly to that of the human body which typically builds immunity to any viral illnesses that it has suffered and therefore in the future cannot be affected by it anymore. Vaccination occurs by injecting a vaccine which imitates a pathogen; this then creates an immune response where the body produces antibodies to 'fight off' the illness. While the vaccines will not cause the illness in the patient, it does give the patient immunity to the illness that they have been vaccinated against.

As vaccines have been identified as crucial to lowering child mortality rates and increasing global life span, WHO has declared vaccine coverage across the world of utmost importance. According to the United Nations Sustainable Development Goals, vaccination aids the completion of 14 out of 17 goals.[40] Due to its value in aiding global health, WHO aims to give full immunization benefits to all those living in the world by 2030. However, recent trends as well as long-standing issues may cause these goals and developments to derail. Most significantly, vaccine hesitancy has greatly impacted global vaccine coverage; moreover, several issues regarding the equitable distribution of vaccines have yet to be properly addressed. With the modern pandemic of COVID-19, access to vaccines has and could continue to worsen.

Due to regulations and proper precautions required to be met before distributing a vaccine, there is often a long period of time between research and when vaccines can be administered to those in need. In particular, trial periods are of utmost concern because of their length. For many rapidly spreading diseases, this causes concern as in the past, vaccines have often been distributed after the most urgent period is over and many have already contracted the illness. There is a need to

[39] Ibid.
[40] https://www.gavi.org/our-alliance/global-health-development/sustainable-development-goals

discuss how the WHO can aid companies to develop vaccines quicker in order to staunch spreading illnesses. Aside from development, the distribution of vaccines is often hindered as well. Although developed countries can easily reach those living in cities, those living in rural areas of both developed and developing countries do not always receive necessary immunizations. This is unfortunate as vaccines greatly benefit those who receive them and can increase the quality and duration of life for those living in both developed and undeveloped countries.

However, even in areas where vaccines are readily available, an increasing number of people are choosing to opt-out of vaccines. Vaccine hesitancy is on the rise in developing countries, especially in metropolitan areas. Stemming from misinformation and targeted anti-vaccination lobbyists, the movement has spread across North America and Europe as parents refuse to vaccinate their children. As these trends begin to derail previous vaccination efforts, the WHO has declared vaccine hesitancy one of the top ten concerns in 2019.[41] Without proper action, vaccine hesitancy could spread to other countries and cause serious issues regarding vaccine coverage.

Vaccination currently prevents millions of deaths around the world, and WHO is able to provide immunization for more than 20 illnesses through vaccination.[42] By improving vaccine coverage in countries through addressing distribution and development concerns, WHO can greatly prevent global death and illness from vaccine-preventable diseases.

Timeline

1500s: Earliest documentation of smallpox inoculation in China and India.

May 1796: Edward Jenner inoculates eight-year old boy James Phillips with the pus from a cowpox lesion on a cow maid's hand. Jenner later inoculates Phillips with a smallpox lesion to which the boy did not contract the deadly infection. This event is commonly known as the first vaccination.[43]

1800: Benjamin Waterhouse, a Harvard medical professor at the time, brings smallpox vaccinations to America by writing to the soon-to-be US President Thomas Jefferson of the benefits of using cowpox to protect against smallpox infections.[44]

1830s: The working class of Britain protests against new laws by the British government addressing mandatory vaccination for smallpox. Working-class citizens felt that it was a direct assault on their communities to implement such laws.[45]

July 6th, 1885: Louis Pasteur administrates 13 doses of a previously untested rabies vaccine on a boy who has been bitten by a rabid. The boy survives and is the first to be cured of rabies with Pasteur's vaccine.[46]

April 1948: The World Health Organization is formed in Geneva, Switzerland.

---

[41] Ibid.
[42] Ibid.
[43] https://www.healthaffairs.org/doi/full/10.1377/hlthaff.24.3.611
[44] https://www.historyofvaccines.org/timeline/al
[45] ibid.
[46] ibid.

1955: The success of the polio vaccine showed the public that it was possible to create vaccines without the aid of the government as the polio vaccine was mainly funded by philanthropic organizations related to the cause.[47]

January 1st, 1967: The WHO launches its Intensified Smallpox Eradication Programme. At the time, smallpox was endemic in multiple countries in the world. The plan consisted of mass vaccinations and a global surveillance system to track infections.[48]

May 8th, 1980: Smallpox is officially declared eradicated by WHO thanks to aggressive vaccination campaigns and a global surveillance system. It is the first and only disease that has been officially eradicated.[49]

1998: Researchers from England, including Andrew Wakefield, publish a study in The Lancet linking the vaccine for measles and mumps to autism. This cites the beginning of the modern age of anti-vaccination trends.[50]

2010: The Lancet pulls Wakefield's study after he lost his license due to conflict of interest in his study and the numerous counter-studies that have surfaced.[51]

May 2012: WHO launches the Global Vaccine Action Plan which aims to eliminate millions of preventable deaths by 2020 by providing "more equitable access to existing vaccines for people in all communities"[52].

2014: Health officials see a rise in vaccine opposition in major metropolitan areas throughout the developed countries and western world.[53]

January 2019: Measles outbreak in developed countries reaches emergency levels. These countries include Germany, the United States and Brazil.[54]

2020: The COVID-19 is declared a pandemic and at one time, 91% of the world lived in a country where borders were restricted to foreign nations to discourage disease transmission. Due to the rapid transmission rate and unknown long-term effects of the virus, researchers race to create and distribute a vaccine.[55]

[47] https://www.healthaffairs.org/doi/full/10.1377/hlthaff.24.3.622#_i14
[48] https://www.cdc.gov/smallpox/history/history.html
[49] https://www.who.int/health-topics/smallpox#tab=tab_1
[50] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6122668/
[51] https://www.nature.com/articles/ni1208-1317
[52] https://www.who.int/immunization/global_vaccine_action_plan/GVAP_doc_2011_2020/en/
[53] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6122668/
[54] ibid.
[55]https://www.pewresearch.org/fact-tank/2020/04/01/more-than-nine-in-ten-people-worldwide-live-in-countries-with-travel-restrictions-amid-covid-19/

Historical Analysis

Case Study 1: Smallpox Vaccine:
The eradication of smallpox is one of the greatest medical feats in human history. Before its elimination, smallpox killed 3 in 10 people infected and in the 20th century alone, killed around 300 million people.[56] Edward Jenner is widely credited as the first person to vaccinate a patient against a virus. During his studies, Jenner observed that milkmaids that had been infected with cowpox, a less deadly variant of the smallpox virus, were not infected by smallpox after exposure. To test his theory, he inoculated the pus from a cowpox sore into a young boy's arm in 1796. Afterwards, Jenner repeatedly exposed the boy to smallpox to which he received no reaction nor infection. This signified the success of Jenner's theory and proved the effectiveness of modern vaccination. The vaccine was heavily produced in the 1800s to be distributed to citizens.

Although the vaccine had been available for use for decades, smallpox was still an issue in the mid to late 1900s, especially in underdeveloped countries. Thus, WHO planned to rid the world of smallpox in 1959; however, the initiative was underfunded and lacked staff. This caused smallpox outbreaks to continue in developing countries at the time. Finally, in 1967, WHO launched its Intensified Smallpox Eradication Program dedicated to eliminating smallpox from the world. Mass vaccinations occurred in countries to reach 80% coverage in each country[57]. Afterwards, strategies called 'ring vaccinations' where any individual that could possibly have been infected through others were vaccinated as well in order to stop the spread of the disease. Smallpox was also relatively easy to track because of its traditional rashes and therefore, WHO began a global surveillance program to track any cases of smallpox. These efforts were a success as the last naturally occurring case of smallpox was reported in 1975 and in 1980, WHO officially declared smallpox eradicated. This triumph clearly demonstrated to the world the potential of vaccines in protecting human health. To date, there are no proven treatments for smallpox and the only way to prevent its effects are vaccinations.

Case Study 2: Ebola Vaccine:
The Ebola virus is an often fatal viral disease originating from Africa and transmitted through direct contact of blood, body fluid and infected tissue. Ebola was discovered by WHO in 1976 and was thought to be transmitted to humans through bats.[58] Without treatment, the virus has a fatality rate of up to 90%.[59] While Ebola is incredibly deadly, it has sporadic outbreaks which makes developing a vaccine difficult. Ebola is also mostly confined to developing countries in Africa where healthcare systems are poor and outbreaks often occur in rural areas where there is a lack of proper medical care.

In the early 2000s, Canada had already begun to develop an Ebola vaccine and tested it in mice; however, vaccines need an overwhelming amount of investment and because the vaccine was going to be distributed to developing countries, no companies were interested in it. At the time, only 1300 people had died in the 30 years that Ebola had been discovered.

---

[56] https://www.bbc.co.uk/history/british/empire_seapower/smallpox_01.shtml
[57] https://www.who.int/csr/disease/smallpox/vaccines/en/
[58] https://www.livescience.com/47946-where-did-ebola-come-from.html
[59]https://www.health.nsw.gov.au/Infectious/factsheets/Pages/ebola-virus-disease.aspx#:~:text=%E2%80%8BEbola%20virus%20disease%20(formerly,of%20infected%20animals%20or%20people.

With these challenges, an Ebola vaccine was not properly invested in and mass-produced until a major outbreak in West Africa in 2014. Starting in Guinea, the virus travelled to the borders of Liberia and Sierra Leone. A major difference between previous outbreaks was that this was the first outbreak to take hold in urban areas. By this time, possible Ebola vaccines were offered to the WHO, but were turned down due to concerns that countries containing the outbreak were ill-equipped to distribute the vaccine. It was only after WHO declared it a global health emergency that Canada donated its vaccine to the agency to aid the outbreak. This was controversial at the time because the vaccine had not been properly tested and it was commonly known to be unethical to distribute an untested vaccine. Eventually, the vaccine was declared to be 100% effective in certain trials.[60]

When an outbreak occurred in the Democratic Republic of Congo, WHO worked with Doctors without Borders to administer ring vaccinations (similar to that of the smallpox vaccine). However, given the rural areas that Ebola mainly affected, this was still difficult. In these rural areas, determining the number of medical professionals or natural healers was difficult as WHO did not know the exact number of rural hospitals and clinics in the area.[61] Overall, the Ebola outbreaks have served as a reminder of the importance for WHO to establish better vaccination strategies in rural areas where it is difficult to locate many ill patients.

Case Study 3: Measles Outbreak 2019:

In many developed countries, measles has been declared eliminated by WHO—which is defined as "the absence of endemic measles virus transmission in a defined geographical area (e.g. region or country) for at least 12 months"—due to vaccination efforts.[62] These efforts were derailed in 2019 however when measles outbreaks soared high in Western Europe and the United States. In Europe, measles cases in the first half of the year were double that of 2018, and in the United States, there were a total of 1282 cases—the highest since 1992.[63] For these countries, vaccine refusal is the major cause of rising cases; areas in certain cities are 'hotspots' for transmission due to the high number of unvaccinated children. These hotspots are the result of loopholes which allow children to attend school without the proper vaccinations; anti-vax parties typically use these areas to lobby and target cities that have a non-medical exemption for vaccinations.[64] The MMR vaccine, for mumps and measles, in particular, has been the target of false information due to a study linking autism and sudden infant death syndrome to the vaccine. Before the vaccine was developed, measles was one of the most infectious diseases in the world; droplets containing measles could be infectious hours after leaving the body.[65] For herd immunity to work, 85-90% of the population must be vaccinated.[66]

The major challenge that health providers face is the high volume of loopholes that parents are able to use to not their children, such as religious exemptions. In 2019, the UK officially lost its

[60] https://www.statnews.com/2020/01/07/inside-story-scientists-produced-world-first-ebola-vaccine/
[61] https://www.nature.com/articles/d41586-019-02879-9
[62] https://www.who.int/wer/2013/wer8809.pdf
[63] https://www.cdc.gov/measles/cases-outbreaks.html
[64] https://www.theguardian.com/cities/2019/mar/14/are-urban-anti-vaccine-hotspots-putting-children-at-risk
[65] https://www.vox.com/2019/4/15/18311377/measles-outbreak-2019
[66] https://www.nytimes.com/2019/08/29/world/europe/measles-uk-czech-greece-albania.html

'measles-free' status, defined as the absence of measles transmissions for a year, illustrating to the world the dangers of vaccine hesitancy and the potential for eliminated diseases to return to the developed world.

Past Action

Throughout the past decades, the World Health Organization has created some of the greatest public health advancements through its vaccination campaigns. As mentioned previously, WHO had great success in delivering its smallpox vaccination campaigns and in subsequent years, WHO has taken the same campaign and adapted it to suit other preventable diseases. Although WHO has been successful in its Expanded Programme on Immunization, there are still millions unvaccinated against preventable diseases. To address this fact, WHO has launched a Global Vaccine Action Plan along with a recent Global Vaccination Summit.

Before the last case of smallpox was announced, many saw the potential in the application of the Intensified Smallpox Eradication Programme to other diseases that were avoidable through vaccination. This caused the formation of the Expanded Programme on Immunization (EPI), a campaign dedicated to "its goal of universal access to all relevant vaccines for all at risk."[67] Initially having a slow start, the programme soon became effective when the United Nations Children's Fund (UNICEF) began funding efforts and urging country leaders to take part in the immunization initiative. While many countries were eager to deliver vaccination programmes to its citizens, a substantial number of them could not ensure quality vaccine delivery processes; UNICEF responded to this issue by supplying many countries with technologies to aid vaccine transportation, including refrigerators, needles and cold boxes. These efforts resulted in a dramatic rise in immunization rates across the world. Just 6 years after the program began, the diphtheria-tetanus-pertussis vaccine (DTP3) had a global coverage rate of 30% and in 1990, this rate had reached 88%.[68] Similarly, the polio vaccine has caused the infection rate of polio to fall 99% and prevented 5 million from paralysis.[69]

A more recent effort in 2010 marked the importance of private foundations in the combat against diseases. The Global Vaccine Action Plan (GVAP) is a collaboration between WHO and the Bill and Melinda Gates Foundation, along with UNICEF and the National Institute of Allergy and Infectious Diseases. Preceded by the Global Immunization Vision and Strategy, the GVAP is founded on the same principles: a world where all citizens are not encumbered by vaccine-preventable diseases. The GVAP aims to give people "the full benefit of immunization… regardless of where they are born, who they are or where they live,"[70]by 2020. The GVAP has six major strategic objectives: all countries must commit to the importance of immunization, individual rights and responsibility of vaccination, equitable access to immunization, the importance of vaccination in building a health system, access to immunization programs to necessary technology, and global research for vaccines. Along with this plan, WHO also developed the World Immunization Week to highlight the importance of vaccines and vaccine education in the world.

---

[67] https://www.who.int/immunization/programmes_systems/supply_chain/benefits_of_immunization/en/
[68] https://www.who.int/bulletin/volumes/92/5/14-020514/en/
[69]https://www.who.int/immunization/programmes_systems/supply_chain/benefits_of_immunization/en/
[70]https://www.who.int/immunization/global_vaccine_action_plan/GVAP_Introduction_and_Immunization_Landscape_Today.pdf?ua=1

In September of 2019, WHO held the first Global Summit on Vaccination. In the new age of vaccinations, the summit centred around vaccine access and the rising rates of vaccine hesitancy. Addressing the rise of measles cases across the globe in 2019, members of the summit discussed the importance of social media and education in the war on vaccines; similarly, members stressed the value of education in rural areas in order to increase immunization rates.

Current Situation

Length of Vaccine Trials

As seen in the 2020 COVID-19 pandemic, an efficient and rapid process to develop vaccines is increasingly important as new diseases continue to arise. Due to long periods of trial time for vaccines, many essential personnel affected by certain diseases do not receive vaccines until after the pandemic or endemic has already waned out; this can be problematic as new infectious zoonotic diseases emerge as a result of global warming and increased human-to-animal interactions. In order for a vaccine to be approved for public use, it must survive a lengthy clinical trial period consisting of three phases according to WHO. In Phase 1 and Phase 2, the vaccine is used on a small group of roughly 20-80 people to test the vaccine's functionality, if the vaccine passes Phase 1, it then goes on to a few hundred people. These phases are crucial in determining the efficacy and safety of vaccines in different groups of people from different demographics. These trial periods typically only last a few months to a year. In the case of Phase 3 trials, however, the period is significantly longer; this phase involves thousands of individuals spanning different ages and communities in order to gauge the potential side effects that may only occur in 1 out of 10,000 patients. Because of this, Phase 3 trials can take several years to complete. For diseases that are rapidly spreading across the world, the length that it takes for this specific phase of the clinical trial to be completed is a major obstacle.

Unequal distribution and access

Although vaccine access may be a norm for those living in urban areas, vaccine distribution is a major issue for citizens in rural areas in both developing and developed countries. The easiest way to decrease the mortality rate is to vaccinate children;[71] despite this, 20-30% of the causes of death in children were due to vaccine-preventable diseases in developing countries. First off, prices for a standard vaccine package has increased 68 fold over the past few years, and due to this, many governments of developing countries must choose which vaccines they are able to supply to their citizens.[72] In some cases, low to middle-income nations pay more for their vaccines in comparison to developed countries. In a study conducted in a rural area in Pakistan, researchers found that a severe lack of education of the mother could often be accounted as the cause of partially or completely unimmunized children. Only 58.8% of parents were able to produce an immunization card, citing the absence of importance placed around vaccination for their children.[73] Mothers often have to walk long distances to reach a vaccination centre and more problematically, do not always believe that vaccinators will be available for their children. Another issue comes from the vaccination centers themselves: oftentimes, vaccination centers provided by EPI do not have an adequate supply of measles vaccines—this results in the annual outbreak of measles in children in rural areas and developing countries.

[71] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6218029/
[72]https://qz.com/329851/vaccinating-a-child-in-a-poor-country-costs-nearly-70-times-more-than-it-did-in-2001/
[73] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6443532/

In the case of developed countries, fewer individuals in rural areas are still vaccinated than those living in urban areas. This is primarily due to less access to primary care due to physical and distance barriers as well as a lack of urgency to seek medical aid due to inconvenience. It was reported that in America, one-fourth of those needing care in rural areas chose not to receive it.[74] This can be particularly problematic as those living in rural areas are often more exposed to dangerous diseases; for example, rural citizens relying on agriculture and livestock are frequently exposed to zoonotic diseases.

Vaccine Hesitancy

Currently, there is a troubling rise in vaccine refusal or hesitancy. Throughout the past decade, vaccine hesitancy has been on the rise and an increasing number of citizens in developed countries view vaccines, medical professionals that administer them and vaccine researchers with skepticism and distrust. Starting with Andrew Wakefield's study on the correlation between the measles vaccine and autism, many parents protested and opted out of routine vaccination due to unfounded fears for their child. Although the study has been discredited multiple times, the 'anti-vaccination' movement continues to brew with little variation over time. The movement often credits their decisions against vaccination with terms such as human liberty, its 'unnatural' source, and safety. For many, there is also a heightened distrust of major vaccine producers and those who administer vaccines; this causes people to turn away from the advice of health experts and doctors. There was a 31% increase in distrust toward vaccines from 2001-2009.[75] Social media plays a major role in spreading the movement. There are two types of false information spread on these platforms: misinformation from false conclusions and deliberate misinformation from those pursuing an agenda. As social media caters search results to the user, those believing "anti-vax" views easily enter a spiral of misinformation due to curated posted and targeted advertisements. Due to this, platforms such as Facebook and Instagram have begun to censor anti-vaccination groups in an attempt to discourage misinformation. Anti-vaccination movements have caused a resurgence of previously declining diseases such as measles in developed countries. Vaccine hesitancy can potentially unravel the decades of progress made in preventing disease in humans and lead to dangers for those who cannot be protected with vaccines if not promptly addressed.

Possible Solutions

Challenge Trials

To combat lengthy vaccine trials, challenge trials have been introduced and contested around the world. In vaccine trials, it is necessary to test the vaccine's response against the virus in a natural setting; by contrast, challenge trials involve participants receiving the vaccine as well as its corresponding virus or pathogen. Participants of the trial will be willingly exposed to the virus in a lab setting and monitored by research professionals. This can severely lower the amount of time that is needed to test out the vaccine against the intended pathogen in a large number of people. Challenge trials have previously been conducted in malaria and H1N1. While previous challenge trials have typically yielded success and safe results, some have resulted in serious issues like myocarditis in participants. This is a possibility in many developed countries as individuals have previously volunteered for such trials in the past.

[74] https://media.npr.org/documents/2019/may/NPR-RWJF-HARVARD_Rural_Poll_Part_2.pdf
[75] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5597904/

However, in cases where a vaccine is being developed without adequate knowledge of the pathogen, this can lead to several ethical issues. In the case of Covid-19, challenge trials were a topic of debate; scientists did not know yet the implications and long-term effects of the virus and could therefore not supply a cure if the trials were to go array. An ethics debate arises when scientists could be intentionally exposing a healthy human being to potentially deadly pathogens without proper precautions for the safety of the participant. On the other hand, such trials conducted in developing countries are much more concerning. Even in the past with regular trials, underdeveloped countries typically lack regulations surrounding the safety of their trial participants as well as a history "of unethical research.[76] If developed countries were to fund challenge trials in developing countries, there would be little to no support from underdeveloped healthcare systems for the patients and vulnerable populations suffering from poverty could be incentivized to take part in trials that are not properly mandated by the government.

Education

Addressing vaccine hesitancy is of the utmost importance to WHO as it is listed as one of the items on the list of top ten priorities in 2019.[77] A solution to this issue would be to use social media as a way of educating the public in developed countries. As seen in the case of Ethan Lindenberger, a boy who vaccinated himself against his anti-vaccination mother, educating children about the benefits of vaccination can be incredibly beneficial to decrease anti-vaccination trends. Therefore, using social media as a way to give teenagers and children more exposure to vaccination benefits is effective as adolescents can spend an average of 4.5 hours per day on social media platforms.[78] Targeting younger children and teenagers gives those who have not formulated an opinion on vaccines yet to be positively influenced by accurate reports on vaccination; this allows them to make more informed decisions about vaccinations when they come of age. A way to implement this is to collaborate with national health providers to spread accurate research information on media platforms. More importantly, it is essential to educate healthcare professionals on ways to find middle ground with those who hold anti-vaccination views. It is possible to provide intentional education for healthcare providers on the subject of vaccine hesitancy and how to efficiently deal with such views.

On the contrary, there is still a severe lack of general education for those living in developing countries. In particular, maternal education is of concern when regarding vaccine coverage rates. Studies have shown that maternal education greatly impacts whether or not a child will be taken for routine immunizations.[79] Therefore, WHO needs to work with non-governmental organizations as well as the United Nations Girls' Education Initiative to provide quality and accessible education to girls. In the long term, raising education rates for girls will ensure higher rates of vaccination coverage for children and therefore cause child mortality rates to decrease.

Technological Innovation

In developing countries, even with WHO programs, rural areas still lack access and full coverage of vaccines. One of the most promising ways to address this obstacle is through innovative

[76] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3903915/
[77] https://www.historyofvaccines.org/content/blog/who-top-ten-threat-vaccine-hesitancy
[78] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6339919/
[79] Ibid.

technologies. For a lot of medically trained personnel and even WHO designated vaccination centers, although they may be able to reach rural areas, they often give partial immunizations. This is due to the fact that there is low reliability of citizens showing up to such centers; therefore, healthcare providers will not open a vial if they believe that it is not going to be of use in a certain period of time—this leads to children not receiving full immunization. Technology that is developed that can encompass an all-in-one vaccine dosage such as the cPAD injection system can have significant benefits for those living in rural areas[80]. This type of syringe allows for single use with maximum immunization coverage and can also help to lessen the likelihood of cross-contamination. The development of such innovative technologies is essential to increase vaccine coverage rates in developing countries; there have been few private companies that have invested in this type of technology and it is highly dependent on more developed countries to head a project that develops technology aimed for those living in rural areas.

Increased Vaccine Development

Currently, only a few companies are in control of the vaccine industry and many previous companies no longer produce vaccines due to its harsh regulations and market. In fact, five international companies produce 90% of the world's influenza vaccines and in America, many childhood vaccines come from a sole provider.[81]. This is problematic because sole providers of vaccines can suffer shortages. Although a major cutoff of vaccine supplies has not occurred, researchers believe that it is likely to happen in the future; all companies, however, have had certain shortages in the past—causing the inability to deliver vaccines at times. In addition, vaccine production is substantially less profitable in the pharmaceutical industry in comparison to drugs; companies often switch to producing drugs rather than the less frequently used vaccines. To combat this, financial incentives can be used. This can include encouraging countries to provide tax breaks for companies that manufacture vaccines to motivate companies into the field. Another efficient way to persuade more companies to enter the industry comes in the form of private and public cooperation. This was effectively shown in developing the polio vaccine in 1955; a foundation raised millions of dollars to put towards research which took the financial risk out of companies developing vaccines.[82]

Bloc Positions

Developing Countries in Asia and Africa

For developing countries and those of low to mid-income, the majority of vaccine access is provided by WHO and non-governmental organizations. Due to poverty and undeveloped healthcare systems, many countries in this bloc do not meet the standard of vaccination that WHO has outlined; children are not fully immunized despite government and United Nations intervention. Around 2.5 million deaths still occur due to vaccine-preventable diseases, with a large majority of these cases in Asia and Africa surrounding children.[83] Socioeconomic factors affect the vaccination rate as well and a major issue is a lack of education. As many mothers in rural areas did not receive a formal education, there is skepticism surrounding proper vaccination and oftentimes, interactions between healthcare providers and mothers are poor—leading to irregular vaccination. In serious cases, education gaps cause religious and rural groups to believe that vaccines are

[80] https://www.tandfonline.com/doi/full/10.1185/03007995.2015.1108910
[81] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7097449/
[82] Ibid.
[83] https://www.who.int/bulletin/volumes/86/6/07-047159/en/

dangerous to their children and are a product of Western countries attempting to 'convert' them. This was especially prevalent in countries such as Nigeria where religious and cultural groups believed that vaccines were the cause of a mandate being pushed out by WHO and Western countries; the root of this can be explained as established fears of Westerners due to colonialism or a general distrust of mainstream medicine. In some countries, citizens refuse vaccinations or do not seek them out due to distrust of foreign aid and the disbelief of certain illnesses—such in the case of Ebola.

Western Europe and North America

Countries in this bloc have a strong system to distribute vaccines and a large majority of them impose compulsory vaccinations for all citizens. This bloc also has the power to manufacture and distribute vaccines to their populations as well as those living in developed countries. Improvements can be made to this sector through financial incentives in order for more companies to enter into the vaccine industry so that western countries are not dependent on problematic sole providers of certain vaccines. The responsibility falls onto this bloc to ensure the timely development of necessary vaccines in pandemics—through solutions such as challenge trials—as well as cooperating with WHO to encourage vaccine access in developing countries. However, these countries do have major issues surrounding vaccine hesitancy. The countries in this bloc have the highest rates of vaccine hesitancy and the problem surrounding this issue was shown in the measles outbreak in 2019. Because of high-level internet and social media access, citizens have shown distrust in vaccines; the anti-vaccination movement is of utmost importance and concern because of its dangers to human health.

https://www.loc.gov/law/foreign-news/article/russia-government-expanding-vaccination-for-measles-amid-outbreak-in-neighboring-countries/

https://foreignpolicy.com/2019/04/09/in-the-united-states-russian-trolls-are-peddling-measles-disinformation-on-twitter/

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4078488/

https://www.nature.com/articles/d41586-020-02507-x

https://www.healthaffairs.org/doi/full/10.1377/hlthaff.2011.0405

https://bmcinfectdis.biomedcentral.com/articles/10.1186/s12879-018-3422-0

https://www.asiapacific.ca/blog/vaccine-scandals-china-why-do-they-keep-happening-over-and

Works Cited

Alexandra Minna Stern and Howard Markel, and Allison Kennedy. "The History Of Vaccines And Immunization: Familiar Patterns, New Challenges." *Health Affairs*, www.healthaffairs.org/doi/full/10.1377/hlthaff.24.3.611.

"All Timelines Overview." *Timeline | History of Vaccines*, www.historyofvaccines.org/timeline#EVT_100322.

Arede, Margarida, et al. "Combating Vaccine Hesitancy: Teaching the Next Generation to Navigate Through the Post Truth Era." *Frontiers in Public Health*, Frontiers Media S.A., 14 Jan. 2019, www.ncbi.nlm.nih.gov/pmc/articles/PMC6339919/.

Belluz, Julia. "2019 Is a Very Bad Year for Measles." *Vox*, Vox, 15 Apr. 2019, www.vox.com/2019/4/15/18311377/measles-outbreak-2019.

Bernasconi, Valentina, et al. "Developing Vaccines against Epidemic-Prone Emerging Infectious Diseases." *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*, Springer Berlin Heidelberg, Jan. 2020, www.ncbi.nlm.nih.gov/pmc/articles/PMC6925075/.

Chadwick, Vince. "First Global Vaccination Summit Sounds the Alarm on Access and Hesitancy." *Devex*, Devex, 13 Sept. 2019, www.devex.com/news/first-global-vaccination-summit-sounds-the-alarm-on-access-and-hesitancy-95593.

"Childhood Vaccination in Africa and Asia: the Effects of Parents' Knowledge and Attitudes." *World Health Organization*, World Health Organization, 4 Mar. 2011, www.who.int/bulletin/volumes/86/6/07-047159/en/.

"Cultural Perspectives on Vaccination." *History of Vaccines*, www.historyofvaccines.org/content/articles/cultural-perspectives-vaccination.

"History of Anti-Vaccination Movements." *History of Vaccines*, www.historyofvaccines.org/content/articles/history-anti-vaccination-movements.

"History of Smallpox." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 30 Aug. 2016, www.cdc.gov/smallpox/history/history.html.

Igoe, Katherine J. "Establishing the Truth: Vaccines, Social Media, and the Spread of Misinformation." *Executive and Continuing Professional Education*, 10 July 2019, www.hsph.harvard.edu/ecpe/vaccines-social-media-spread-misinformation/.

Institute of Medicine (US) Committee on the Evaluation of Vaccine Purchase Financing in the United States. "Executive Summary." *Financing Vaccines in the 21st Century: Assuring Access and Availability.*, U.S. National Library of Medicine, 1 Jan. 1970, www.ncbi.nlm.nih.gov/books/NBK221816/.

Institute of Medicine (US) Committee on the Evaluation of Vaccine Purchase Financing in the United States. "Vaccine Supply." *Financing Vaccines in the 21st Century: Assuring Access and Availability.*, U.S. National Library of Medicine, 1 Jan. 1970, www.ncbi.nlm.nih.gov/books/NBK221811/.

Jamrozik, Euzebiusz, and Michael J Selgelid. "COVID-19 Human Challenge Studies: Ethical Issues." *The Lancet Infectious Diseases*, vol. 20, no. 8, 2020, doi:10.1016/s1473-3099(20)30438-2.

Marketing, Hencove. "Vaccines for All: Reaching and Serving Rural Americans." *Atlantic Health Partners*, Atlantic Health Partners, 11 June 2019, www.atlantichealthpartners.com/immunization-insights-1/vaccines-for-all-reaching-rural-americans/2019/6/11.

Marketing, Hencove. "Vaccines for All: Reaching and Serving Rural Americans." *Atlantic Health Partners*, Atlantic Health Partners, 11 June 2019, www.atlantichealthpartners.com/immunization-insights-1/vaccines-for-all-reaching-rural-americans/2019/6/11.

Maslow, Joel N. “The Cost and Challenge of Vaccine Development for Emerging and Emergent Infectious Diseases.” *The Lancet Global Health*, vol. 6, no. 12, 2018, doi:10.1016/s2214-109x(18)30418-2.

Megan Thielking, et al. “18-Year-Old Who Has Advocated for Vaccines Is Now Target of Harassment.” *STAT*, 1 July 2019, www.statnews.com/2019/06/28/ethan-lindenberger-vaccines-harassment/.

National Research Council (US) Division of Health Promotion and Disease Prevention. “Vaccine Availability: Concerns, Barriers, and Impediments.” *Vaccine Supply and Innovation.*, U.S. National Library of Medicine, 1 Jan. 1985, www.ncbi.nlm.nih.gov/books/NBK216807/.

Patel, Suraj. “What a Teenager Who Got Vaccinated against His Parents' Will Can Teach Us about Anti-Vaxxers.” *Quartz*, Quartz, 22 Mar. 2019, qz.com/1579023/how-people-become-anti-vaxxers-and-how-to-stop-them/.

Roberts, Michelle. “Vaccines: Low Trust in Vaccination 'a Global Crisis'.” *BBC News*, BBC, 19 June 2019, www.bbc.com/news/health-48512923.

Sheridan, Cormac. “The Business of Making Vaccines.” *Nature Biotechnology*, Nature Publishing Group US, Nov. 2005, www.ncbi.nlm.nih.gov/pmc/articles/PMC7097449/.

Singh, K, and S Mehta. “The Clinical Development Process for a Novel Preventive Vaccine: An Overview.” *Journal of Postgraduate Medicine*, Medknow Publications & Media Pvt Ltd, 2016, www.ncbi.nlm.nih.gov/pmc/articles/PMC4944327/.

“Vaccine Market.” *World Health Organization*, World Health Organization, 19 Jan. 2015, www.who.int/immunization/programmes_systems/procurement/market/global_supply/en/.

“Vaccines and Immunization.” *World Health Organization*, World Health Organization, www.who.int/health-topics/vaccines-and-immunization.

World Health Organization, www.who.int/bulletin/volumes/89/5/11-030511/en/.

Writers, Staff. “How Vaccines Work.” *PublicHealth.org*, PublicHealth.org, 22 Nov. 2019, www.publichealth.org/public-awareness/understanding-vaccines/vaccines-work/.

VANCOUVER YOUTH MODEL UNITED NATIONS 2020

World Health Organization
Director: Catherlin Lu
Chair: Pierre Collet
Assistant Director: Tony Zhang
Assistant Chair: Talia Pimstone

Dear delegates,

My name is Catherlin Lu and it is my pleasure to be your director of the World Health Organization for VYMUN 2020. I hope to make this year's online conference an enjoyable, rewarding and truly memorable experience that allows you to grow and understand the world of Model United Nations. For this conference, WHO will focus on two urgent topics: Antimicrobial Drug Resistance and Vaccine Development and Distribution.

Our first topic, Antimicrobial Drug Resistance, is of pressing concern to our global health and mortality rate. In the past few decades, resistance to antimicrobial drugs has intensified, leading many patients vulnerable to pathogens that cannot be cured by the current antimicrobial drug market. This topic is rooted in the importance of protecting the current antimicrobial drugs from 2failure while developing solutions to ensure that future generations have the benefits that these drugs bring to human health. There are nuanced situations surrounding antimicrobial drugs in each country and it is essential that WHO takes all of these perspectives into account. With antimicrobial drug resistance on the rise across the world, it is paramount that WHO implements solutions to halt the spread of antimicrobial resistance.

Our second topic, Vaccine Development and Distribution, is a broad one. It involves many areas regarding vaccination including vaccine coverage rates, distribution to hard-to-reach areas and efficient development. As seen in the worldwide pandemic in 2020, developing vaccines is of utmost importance to protecting human health across the world. To ensure global health, WHO has a responsibility to discuss strategies in order to vaccination benefits across the world. In certain circumstances, this involves stopping the rising spread of information regarding vaccines—namely anti-vaccination groups. Vaccines have played a significant role in public health; therefore, it is essential that delegates understand and reflect the importance of this topic in committee sessions.

If you have any questions about either topic or anything related to the structure and guidelines of a Model UN conference, please don't hesitate to contact me at *who@vymun.com*. I am beyond excited to be your director and I am sincerely looking forward to meeting all of you in October.

Kindly,

Catherlin Lu
Director of WHO | VYMUN 2020

TABLE OF CONTENTS

Antimicrobial Drug Resistance

Questions to Consider

1. How are antimicrobial drugs regulated in your country? In what sectors and areas are antimicrobial drug resistance most prominent? How are antimicrobial drugs depicted in your country?
2. How do antimicrobial drugs work in the body? Why do pathogens develop antimicrobial resistance?
3. What are the main causes that accelerate antimicrobial drug resistance around the world? How can WHO address these issues?
4. How should WHO help countries with poor healthcare systems regulate the use of antimicrobial drugs?
5. In what ways can WHO work with other U.N. committees to regulate antimicrobial drug use in various different sectors?
6. What strategies can be employed to ensure antimicrobial resistance awareness?

Overview

Antimicrobial drug resistance is a global health issue in which microorganisms develop resistance to existing antibiotics. Since the discovery of penicillin in 1928, the use of antibiotics has been widespread and extremely helpful in treating diseases. Antibiotics are intended to treat types of bacterial infections, ranging from reducing the prevention of bacterial reproduction to killing bacteria in the human body. However, due to the misuse of antimicrobials in the health and agriculture industry, the world is facing a crisis in which bacteria have become “superbugs” and are causing a major issue to the safety and health of millions around the world. By 2050, experts predict that death caused by antimicrobial resistance will rise to 10 million[1]. Diseases that have become antibiotic resistance are a strain on healthcare systems as they are significantly harder to cure and cause more stress on a patient’s body. [2]

One of the leading causes of antibiotic drug resistance is the overprescription and overuse of antibiotics in healthcare systems. After the introduction of antibiotics, doctors began to overprescribe antibiotics without the knowledge that it could cause detrimental effects. As patients are overly exposed to these drugs, there is a higher possibility of bacteria developing resistance and thus, can cause the spread of antibiotic resistance. This issue is especially prevalent in developing countries due to unstable healthcare systems, resulting in the use of antimicrobial drugs often being unregulated, allowing massive misuse in such countries.

Another major factor is the overuse of antibiotics in agriculture. Research has found that a majority of animal farms in low-middle income countries feed antimicrobial drugs to animals for commercial reasons. This has caused a rise in antibiotic resistance in farm animals around the world and scientists believe that resistance genes in farm animals could pass on to human pathogens. In addition, there is a severe lack of new antibiotic drugs that are being tested and found in these recent years. This severely undermines the efforts to fight drug-resistant pathogens.

[1] https://www.who.int/news-room/detail/29-04-2019-new-report-calls-for-urgent-action-to-avert-antimicrobial-resistance-crisis
[2] Ibid.

Currently, there are many diseases that show signs of developing antimicrobial resistance which causes concerns all over the world. These include Klebsiella pneumoniae and E.Coli which have both caused millions of deaths across the world. Emerging resistance is expanding in HIV, tuberculosis and others[3]. Without the effectiveness of antimicrobial drugs, numerous treatments for cancer and any major surgeries would be impossible.

WHO aims to reduce antimicrobial resistance by educating the public on the proper use of these drugs—by reducing the amount of unnecessary antimicrobial use there is a lessened chance of resistance developing. In addition, much research needs to be conducted to aid the discovery of new and effective antimicrobial drugs. At the moment, antimicrobial drug resistance is on the rise and present in every country around the world.

Timeline

1600s: The existence of microorganisms is discovered through the invention of the microscope, allowing scientists to observe organisms invisible to the human eye. Antonie van Leeuwenhoek was the first to document this type of finding[4].

1928: Alexander Fleming discovers the first antimicrobial substance known: penicillin, an antimicrobial that prevents the growth of staphylococci[5].

1942: The first patient is successfully treated with penicillin. The drug then played an important role in World War 2 as it was commercialized for use[6].

April 1948: The World Health Organization is formed in Geneva, Switzerland.

1947: First bacterium resistant to penicillin was found—a mere four years after the drug was mass-produced.

1950: Researcher E.S. Anderson reports widespread transfer of antimicrobial-resistant bacteria from animals to humans due to the common use of antimicrobials in agriculture[7].

1969: Great Britain generated the Swann Report which urged the ban of therapeutic antibiotics, such as penicillin and tetracyclines, for agricultural use. However, little action became of the reports.

1981: Stuart Levy, a Tufts University scientist, gathered 147 scientists from 27 countries to form a conference in Santo Domingo regarding the “Molecular Biology, Pathogenicity, and Ecology of Bacterial Plasmids.” Levy was one of the first advocates for antibiotic awareness and successfully spearheaded the movement to frame antimicrobial resistance as a global issue. Later that year,

[3] https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
[4] https://www.britannica.com/science/microbiology
[5] https://www.sciencedaily.com/terms/antibiotic_resistance.htm
[6] https://www.nature.com/articles/s41599-018-0181-x
[7] Ibid.

Levy founded the Alliance for the Prudent Use of Antibiotics—an organization that raised awareness about antibiotic usage.[8]

2001: A culmination of WHO organized consultative groups and expert workshops in the 1990s and 2000s about the growing health issues concerning antimicrobial resistance. These events led to the WHO Global Strategy for Containment of Antimicrobial Resistance, which addresses said issues through a "framework of interventions to slow the emergence and reduce the spread of antimicrobial-resistant microorganisms."[9]

July 2004: The Infectious Diseases Society of America championed the movement to bring attention to the pharmaceutical industry's need to focus on the fight against antimicrobial resistance instead of new profitable drugs for chronic illnesses. This is emphasized in the 2004 report "Bad Bugs, No Drugs: As Antibiotic Discovery Stagnates … A Public Health Crisis Brews"[10].

May 2015: WHO creates its first Global Action Plan on Antimicrobial Resistance. This report includes new aspects of prevention primarily highlighting the importance of education in the role of preventing antibiotic and antimicrobial misuse. [11]

September 2016: The United Nations convenes a high-level General Assembly meeting with the sole purpose of discussing antimicrobial resistance. It was only the fourth time that such a meeting had been dedicated to a health issue[12].

Historical Analysis

While the term 'antimicrobial' was not coined until the late 1800s, antimicrobial treatments have been a part of the medical community for centuries, though early doctors were not aware of their real repercussions until later. There has been evidence of antimicrobial use in early Chinese and Egyptian civilizations. However, the modern age of antibiotics came during the 1900s when scientist Alexander Flemming discovered penicillin—the first antibiotic to be widely used in medicine. The following section explores cases of antimicrobial resistance in a variety of contexts and where they arose.

Case Study 1: Penicillin Resistance

The 1940s was revolutionary for the development of antimicrobial treatment. In 1942, the first patient was successfully treated with penicillin and in 1945, penicillin was mass-produced and distributed to medical professionals around the world. During this time, penicillin played a major role in saving the lives of soldiers in World War 2. However, heavy use, a result of its wide success, of the drug led to its unexpected failure in the 1950s. As Flemming himself predicted, the "public will demand [the drug and] then will begin an era … of abuses,"[13] referring to the eventual failure of the drug as a result of heavy demand from the public. By the 1950s, resistance to penicillin had become increasingly prominent across the world and its existence could nearly derail the medical

[8] Ibid.
[9] https://www.ncbi.nlm.nih.gov/books/NBK97127
[10] https://www.nature.com/articles/s41599-018-0181-x
[11] https://www.who.int/antimicrobial-resistance/publications/global-action-plan/en/
[12] https://www.who.int/antimicrobial-resistance/events/UNGA-meeting-amr-sept2016/en/
[13] Ibid.

advancements of the previous decades; the drug began to fail in clinical settings and led to the need for another antimicrobial drug in its place[14]. This pattern repeated itself throughout the 20th century; new drugs were discovered and rendered 'useless' within years of commercialization—a pattern that may continue to repeat if diligent action is not given to the seriousness of this issue.

Case Study 2: Colistin in Chinese Livestock

Colistin was an antibiotic discovered in 1949[15]. Initially too taxing on the human body, it was rarely used in hospital settings; however, as bacteria developed alarming multidrug-resistance, colistin was brought back into use as a last resort for multidrug-resistant bacteria in countries such as the UK and US. In China, colistin is not used to treat patients but instead used as growth enhancers and disease-prevention in livestock and agriculture—specifically in pig farms.

In 2015, there was a discovery of bacteria carrying the MCR-1 gene: a gene that makes bacteria resistant to colistin. This caused alarm around the world as colistin is seen as a final defence against multidrug-resistant bacteria. The bacteria became a global health concern as it causes an illness that is virtually impossible to treat with the existing antimicrobials available in the world; moreover, scientists were certain that the bacteria could eventually gain genes that made it impossible to cure with antimicrobials. Soon after, researchers discovered the gene in 16 out of 1322[16] human patient samples in China, clearly showing that the bacteria had moved from animal to human. As expected, the bacteria quickly worked its way around the world and had been identified in "50 countries across six continents"[17]. After these frightening developments, the Chinese government finally banned the use of colistin for non-medical purposes in April of 2017.

Researchers found the direct short-term effects of banning colistin in a 2020 study. Through looking at colistin residues and colistin-resistant bacteria in samples of pig feces, researchers found that the amount of bacteria resistant to colistin dropped substantially. Across 23 provinces in China, colistin-resistant bacteria was originally found in "34% of feces samples" in 2015-2016 as opposed to the 5.1% found from 2017-2018[18]. Clearly, there is a direct impact of banning antimicrobials from livestock on antimicrobial resistance.

Case Study 3: Drug-Resistant Tuberculosis

Tuberculosis (TB) remains a threat worldwide due to its drug resistance to first and second-line anti-TB drugs. In 2012, there were an estimated 450,000 cases of multidrug-resistant tuberculosis and 170,000[19] of those cases died as a result of tuberculosis. This disease disproportionally affects those with HIV and vulnerable children. It is caused by two strains that are at least resistant to one of the five main antibiotics for tuberculosis; strains of tuberculosis resistant to the second line of anti-TB drugs are known as extensively multidrug-resistant tuberculosis—this has been recorded in

[14] Ibid.
[15] https://academic.oup.com/cid/article/40/9/1333/371785
[16] https://www.theatlantic.com/health/archive/2017/01/colistin-resistance-spread/512705/
[17]https://www.cidrap.umn.edu/news-perspective/2020/06/study-finds-short-term-impact-chinas-ban-colistin-animals
[18] Ibid.
[19] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4790366/

117 countries[20]. More worrisome is that there has been the discovery of a strain of tuberculosis that has developed immunity to all anti-TB drugs and are impossible to cure without new antibiotics.

Managing the resistance in tuberculosis is quite difficult as curing TB requires a complete antibiotic treatment course over 6 months. For multidrug-resistant tuberculosis, this can range from 16-18 months. In developing countries and places where the securement of proper antibiotics is difficult, it is extremely hard to ensure that the full course is taken and TB is fully cured. An incomplete course of treatment will typically increase the chance of drug resistance. For many citizens, there is a lack of knowledge on the importance of finishing the full length of a treatment in order to effectively eliminate the bacteria from the body. Tuberculosis also easily spreads through crowds as it is transmitted through the air from person to person, meaning that spreading drug-resistance TB is rapid as well. Moreover, resistance to anti-TB drugs is a cause of a lack of new drugs emerging to replace ones that bacteria have developed resistance to. The lack of interest pharmaceutical companies possess in the procurement of new antibiotics only accelerates the rate at which tuberculosis resistant to all antibiotics will develop.

Past Action

Since the awareness of the severity of antimicrobial resistance has risen throughout the 20th to 21st century, WHO has taken considerable action to slow the spread of such diseases. The most impactful meetings and resolutions concerning the rise of antimicrobial resistance are the UN Interagency Coordination Group (ICGA) reports, the WHO Global Action Plan and the Worldwide Country Situation Report. Prerequisites to such reports are noted in WHA 67.25[21], a resolution precursor to the WHO Global Action Plan.

The earliest antimicrobial drug resistance centred report by the UN was the Global Strategy for Containment of Antimicrobial Resistance, published in 2001. This report mainly focuses on the findings and recommendations of expert workshops and consultative groups on regulating the use of antimicrobial drugs. It was not until 2010 and onwards that the UN and WHO began to severely focus on the detrimental effects of antimicrobial resistance. While there have been resolutions made in accordance with the issue, the WHO issued its first Worldwide Report regarding the status and action of antimicrobial resistance in 2014.

The Worldwide Country Situation Report consists of surveys in all six WHO regions with the goal of understanding “the extent to which effective practices and structures to address antimicrobial resistance have been put in place and where gaps remain”[22]. WHO hoped to use this report as a way to model upcoming action plans in order for such plans to be effective in multiple different areas of the world. Country authorities completed the surveys and subsequent interviews took place with the conductors of the report. A total of 133 out of 194 WHO member states participated in the survey. The findings found that few countries had national plans regarding the antimicrobial crises and none had implemented these plans for an adequate amount of time to create an effective report.

[20]https://www.who.int/news-room/q-a-detail/what-is-multidrug-resistant-tuberculosis-(mdr-tb)-and-how-do-we-control-it

[21] https://apps.who.int/gb/ebwha/pdf_files/WHA67/A67_R25-en.pdf?ua=1&ua=1

[22] https://apps.who.int/iris/bitstream/handle/10665/163473/WHO_HSE_PED_AIP_2015.1_eng.pdf?sequence=1

The WHO led a series of meetings and consulting sessions to curate the current action plan on antimicrobial drug resistance. Starting in September of 2013, WHO held several meetings with the Strategic and Technical Advisory Group on Antimicrobial Resistance (STAG-AMR) to advise WHO on the proper plan of action to combat the resistance. Ultimately, the meetings led to the creation of the Global Action Plan on Antimicrobial Resistance during the 68th WHO meeting with the goal of the draft being the "continuity of successful treatment and prevention of infectious diseases with effective and safe medicines that are quality-assured, used in a responsible way, and accessible to all who need them"[23]. The action plan strongly emphasized five strategies: improving awareness, increased knowledge through research, reducing incidence of infection, optimizing the use of such agents, and investing in the needs of countries as well as new technologies and drugs. After this report, the WHO also created the World Antibiotic Awareness Week in November of each year to increase awareness surrounding antibiotics and subsequent resistance.

Most recently, the UN Interagency Coordination Group (IACG) generated a report on antimicrobial resistance in April of 2019. The IACG recognized the connection between WHO, Food and Agriculture Organization (FAO) and the World Organization for Animal Health (OIE) in the fight against antimicrobial resistance and highlighted this in its report. Mainly, the report emphasized the place antimicrobial resistance holds in the United Nations' Sustainable Development Goals and the importance of a One Health response to the crisis: a collaborative approach across multiple sectors to ensure success[24].

Current Situation

Right now, antimicrobial drug resistance is seen as a global issue that affects citizens and healthcare systems around the world. Antimicrobial resistance is prevalent in every single country in the world and without urgent action, previously treatable diseases will once again be fatal to the human population. Although progress has been made in the past, there are still many facets of the issue to be addressed. Outlined below are some of the most prevalent matters that must be addressed in order to successfully combat the rise of "superbugs."

Increased Drug Resistance in Global Illnesses

Currently, the emergence of antimicrobial resistance in illnesses that have an impact on global health is of the most alarming concern. Tuberculosis (TB) is one of the ten leading causes of death and leading cause of death from a single infection around the world[25], the development of multidrug-resistant tuberculosis—a type of TB that is resistant to two of the strongest anti-TB drugs—is a worthy cause for alarm. There have been 480,000[26] new cases of such disease in 2014 and this number is expected only to increase in future years. This development causes patients to have a higher mortality rate and take significantly longer to treat—causing harm to both those infected and healthcare systems around the world.

[23] Ibid.
[24]https://www.who.int/antimicrobial-resistance/interagency-coordination-group/IACG_final_report_EN.pdf?ua=1
[25] https://www.who.int/news-room/fact-sheets/detail/tuberculosis
[26] https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance

This is also the case for malaria, as resistance to the first line of treatment has been found in 5 Asian countries: Cambodia, the Lao People's Democratic Republic, Myanmar, Thailand and Viet Nam. The possible spread of these resistant strains to other parts of the world could cause the derailment of progress made in nearly eradicating malaria from the modern world. Furthermore, drug-resistant HIV is quickly emerging in both developing and developed nations. For developing nations, 7% of those seeking treatment had drug-resistant HIV; in developed nations, the figure was much higher at 10-20%. As antiretroviral treatment becomes more widespread, resistance is expected to rise as well. This resistance can cause serious economic impacts for patients as second and third-line treatments are respectively 3% and 18% more expensive[27].

Incorrect Use of Antimicrobial Drugs

A major issue surrounding antimicrobial resistance is the incorrect use of antibiotics and antimicrobial drugs. This is extremely prevalent in developing countries. Due to underdeveloped infrastructure and poorly trained medical personnel, antimicrobial use is often unregulated. Doctors often overprescribe antibiotics to patients. A study showed that a doctor could see 350 patients a month and will prescribe over 60% of these patients with antimicrobial drugs based on symptoms alone.[28] In these cases, problems arose from the absence of proper testing before administering a course of antimicrobial drugs. Beyond this, these drugs are easily accessed in pharmacies, stores, and even market vendors without a doctor's prescription. Moreover, patients often do not finish a full course of treatment due to the inability to afford the high prices of the drugs and may stop after symptoms cease. This is problematic as the disappearance of symptoms does not always reflect the presence of pathogens in the body. In many cases, pathogens are still present in the body even though symptoms have stopped. Thus, antimicrobial resistance easily rises in such unregulated circumstances. It can be noted that due to poor medical systems, antimicrobial resistance is much harder to treat in developing countries as there is a lack of staff and equipment available and oftentimes, these hospitals are poorly equipped to deal with these situations.

This issue is also prevalent in developed countries through the emerging trend of self-medication. Through a Google and Yahoo search, researchers found a total of 138[29] websites in which citizens could find and purchase antibiotics without a prescription. Although governments have created laws forbidding the purchase and selling of such drugs without a prescription, websites often provide a prescription without an examination in order to evade these regulations.

Antimicrobial use for non-therapeutic purposes in agriculture

In the United States, 80% of all antimicrobial drugs sold are to the agriculture sector.[30] In other countries, 4 times the amount of antimicrobials sold to humans are often given to animals and farming industries.[31] The sheer volume of food-producing animals that receive antimicrobials is detrimental to the fight against antibiotic resistance. Antibiotics and antimicrobials are fed to farm-grown animals to decrease the chances of infection and can significantly affect growth rates; this practice is expected to grow over the next few decades. The drugs are often used for commercial purposes of growth and prevention rather than treating diseases in the animals. China

[27] Ibid.
[28] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2272287/
[29] Ibid.
[30] Ibid.
[31] Ibid.

and Brazil currently use the highest amount of antimicrobial drugs in farming. Thus, this constant use, no doubt, creates antimicrobial-resistant strains of bacteria that can be passed from human contact, the food chain and the environment to the human population.[32]
Not only is this an issue on land but antimicrobial resistance has been found in aquaculture. A result of the persistent use of antimicrobials in fish farming, researchers have detected antimicrobial resistance in waters around Latin America.

Possible Solutions

Development of New Antimicrobial Drugs

Currently, there is a severe lack of new antimicrobial drugs being introduced into the global market. There has not been a new class of antibiotic drugs discovered since the 1980s[33]. As antimicrobial resistance develops, there is an increasing need for new drugs to fill the 'pipeline' as drugs become ineffective towards resistance strains of bacteria and microbes. Due to the view of new drugs as the final line of defence, companies see little profit from research into new antimicrobial drugs and therefore there are few companies that actively search and experiment in this field. Thus, there must be joint public and private investment into these projects in order to ensure fruitful progress. One way companies can be incentivized to research this field is through 'market entry rewards': a system in which public institutions and governments pay developers a sum of money for developing a new antimicrobial drug.[34]This can encourage companies to continue to search for new and effective drugs in the fight against antimicrobial resistance.

Support for Universal Health Coverage (UHC)

At least half of the world's population do not have adequate access to essential healthcare services. For developing countries, this situation further aggravates antimicrobial resistance. As citizens of developing countries lack access to proper and adequate healthcare, many turn towards unmonitored use of antibiotics and treatment services that are harmful to human health as well as to the fight against antimicrobial resistance. By supporting and funding UHC, it ensures that citizens in developing countries are able to easily access properly trained medical professionals who are able to advise them on the proper course of treatment. This goal would also allow suffering patients to receive the full treatment course without suffering financial hardships. Similar to the EU, developed countries can be encouraged to fund efforts towards meeting the Sustainable Development Goal of achieving UHC in every country by 2030.[35]

Awareness and Education

Unawareness and lack of education on the effects of antimicrobial drugs and subsequent antimicrobial resistance is often the cause of drug misuse. This is especially prevalent in developing countries, where the education system is undeveloped and children and adults know little of the implications of antimicrobial misuse; without adequate knowledge, many living in these countries do not use antimicrobial drugs properly, causing a rise in resistance rates. Therefore, it can be essential to educate citizens on the importance of proper drug use with the help of NGOs and placing higher value upon WHO's Antimicrobial Resistance Awareness Week. Educating the general public is of great importance to lessen the amount of antimicrobial drug misuse. At the same time,

[32] https://www.who.int/foodsafety/areas_work/antimicrobial-resistance/amrfoodchain/en/
[33] https://wellcome.ac.uk/news/why-is-it-so-hard-develop-new-antibiotics
[34] https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf
[35] https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc)

awareness and education are important in developed countries in order for the eradication of self-medication with antibiotics. This can range from targeted education at the school-level to increased reliable and accessible online sources.

Joint United Nations Response

Through the collaboration of multiple United Nations committees in multiple different sectors, the issue of antimicrobial resistance will be addressed in multiple facets. As recognized previously, the WHO relies on collaboration with the FAO as well as the OIE in order to ensure success. The FAO has worked with WHO in the past to ensure that regulations have been put on antimicrobial drug use in agriculture and the OIE has similarly provided aid on regulations in relation to antimicrobial use on animals. In order to address this issue in areas other than direct human impacts, the WHO must work with other committees to ensure that the issue is being properly addressed in agriculture and aquaculture. Through this collaboration, WHO can encourage countries to strictly regulate the use of antimicrobial drugs in livestock and aquaculture so that resistance is less likely to be developed and passed from animals to humans.

As mentioned earlier, illegal sellings of antimicrobial drugs without a prescription also play a large role in the increase of antimicrobial resistance. To combat this, WHO must partner with other UN committees such as the United Nations Office on Drugs and Crime (UNODC) to eliminate the ability to buy and sell antimicrobial drugs without a prescription. This is an issue in both developed and undeveloped countries as it can range from selling drugs online to in-person pharmacies where antimicrobials can be easily bought. For example, it was found that out of 1106 pharmacies across the country, 95% of them sold customers antimicrobials without prescription[36]. By working with the UNODC, WHO can help and urge countries to strictly regulate illicit antimicrobial drugs.

Bloc Positions

EU and North American Countries

Across the European and North American regions, healthcare systems are already meeting the rising antimicrobial resistance crisis with education and awareness. As these countries have strong healthcare systems, unregulated use usually comes from self-medication rather than overprescription from doctors. However, the United States and other European countries currently have growing trends of anti vaccination[37] which may eventually impact the use of antimicrobials as without vaccinations, there is an increased demand for antimicrobial use. Many countries have also taken the step to ban important human-use antibiotics from non-therapeutic animal feeds including Switzerland and the United States. Yet, this does not exempt these countries from the effect of antimicrobial resistance. Henceforth, with a stable economy and healthcare system, this bloc holds a large amount of power in creating new antimicrobial drugs and researching alternative solutions to the antimicrobial drug resistance crisis. It is also responsible for reducing the amount of antimicrobial drug misuse in developing countries through support.

Africa and South Asia

African and South Asian nations all suffer from underdeveloped healthcare systems and subsequent lack of regulation and control over antimicrobial drug use. This enables many citizens

[36] https://aricjournal.biomedcentral.com/articles/10.1186/s13756-019-0655-7

[37]https://www.who.int/news-room/q-a-detail/why-is-vaccination-important-for-addressing-antibiotic-resistance

to be able to purchase various antibiotics without a prescription. Drug resistance is highest in the developing countries of this bloc. As healthcare systems struggle to cope with drug resistance, doctors continue to overprescribe to the general public. However, it is difficult for the government to track and monitor antimicrobial resistance as there is little data regarding the subject and even fewer resources available to do so. African and South Asian nations primarily focus on developing their healthcare system in order to combat antimicrobial resistance. By creating a stronger healthcare system with proper sanitation and health protocols, there is a lessened need for the prescription and use of antimicrobials. More importantly, in areas of poverty, there are unregulated stands and stalls that sell antibiotics that are counterfeit or contain a minimal amount of antimicrobial agents—this could help accelerate antibiotic resistance. Due to poverty, citizens of developing countries often turn to cheap stalls instead of doctors and often only buy a few tablets rather than the prescribed course in order to save money. These nations must rely on developed countries for aid to regulate antimicrobial use and develop their healthcare system.
It is worth noting that these countries do actively use antimicrobial drugs in livestock to promote growth and prevent disease. Many nations have shown reluctance to cease the use of antimicrobial drugs in these areas as their use can effectively feed a nation's population with higher productivity and lower costs.

China, India and Brazil

These three countries currently have the highest amount of antimicrobial resistance in their farming and livestock industries. As the population in China increases and the demand for meat surges, the industry has turned to multiple antibiotics in order to increase growth in animals. This same phenomenon is observed in Brazil and India. Plus, China has a much higher use of antimicrobials as opposed to other countries with similar economies. There have been government policies that attempt to reduce the amount of antimicrobial drugs used in the healthcare system. However, growing concerns around the world arise from the high volume of antimicrobial agents used in livestock as well as the growing rate at which antimicrobial resistance is developing in the farming industry of these countries. While the governments have banned important human medicines such as colistin, there are still little regulations regarding antimicrobial drugs in livestock practices. Farmers are still able to easily purchase illegal antimicrobials without a prescription and distribute them to livestock. For these countries, although regulations are in place for hospitals, a large majority of the population seeks medical aid in rural areas where antimicrobials are still often overprescribed.

South America

In South American countries, there is little data regarding antimicrobial resistance. Currently, there are no surveillance programs monitoring the spread and mechanisms of resistance. However, hospitals have reported a high level of antimicrobial resistance in hospital settings and according to a study, they can cause up to 50% of such infections in countries such as Bolivia and Peru. Another major concern from South America is the high level of antimicrobial use in aquaculture.[38] Especially in Chile, where an abundance of antibiotics are used for salmon fish farming. In many of these countries, there is not an official registration program for administering antimicrobials for aquaculture use and therefore, little data is known about the amount of antibiotics in Latin American waters. Many Latin American countries do not officially share this data with other

[38] https://www.paho.org/hq/dmdocuments/2015/CD54-12-s.pdf

countries as well, making it difficult to understand the level of antimicrobial resistance that exists. There have also been few studies about the status of antimicrobial resistance in Latin American waters.

Works Cited

Aminov, Rustam I. "A Brief History of the Antibiotic Era: Lessons Learned and Challenges for the Future." *Frontiers in Microbiology*, vol. 1, 2010, doi:10.3389/fmicb.2010.00134.

"Antimicrobial Resistance and Agriculture." *OECD*, www.oecd.org/agriculture/topics/antimicrobial-resistance-and-agriculture/#:~:text=The%20potential%20consequences%20of%20antimicrobial,and%20contamination%20of%20the%20environment.

"Antimicrobial Resistance in the Food Chain." *World Health Organization*, World Health Organization, 28 Nov. 2017, www.who.int/foodsafety/areas_work/antimicrobial-resistance/amrfoodchain/en/.

"Antimicrobial Resistance Is Drastically Rising." *ScienceDaily*, ScienceDaily, 19 Sept. 2019, www.sciencedaily.com/releases/2019/09/190919142211.htm.

"At UN, Global Leaders Commit to Act on Antimicrobial Resistance." *World Health Organization*, World Health Organization, www.who.int/en/news-room/detail/21-09-2016-at-un-global-leaders-commit-to-act-on-antimicrobial-resistance.

Chris Dall | News Reporter | CIDRAP News | Apr 29, 2019. "UN Report Calls for Urgent Action against Antimicrobial Resistance." *CIDRAP*, 29 Apr. 2019, www.cidrap.umn.edu/news-perspective/2019/04/un-report-calls-urgent-action-against-antimicrobial-resistance.

Cui, Dan, et al. "Use of and Microbial Resistance to Antibiotics in China: a Path to Reducing Antimicrobial Resistance." *Journal of International Medical Research*, vol. 45, no. 6, 2017, pp. 1768–1778., doi:10.1177/0300060516686230.

Davies, Julian, and Dorothy Davies. "Origins and Evolution of Antibiotic Resistance." *Microbiology and Molecular Biology Reviews*, vol. 74, no. 3, 2010, pp. 417–433., doi:10.1128/mmbr.00016-10.

"Development Process of the Global Action Plan on Antimicrobial Resistance." *World Health Organization*, World Health Organization, 22 Aug. 2016, www.who.int/antimicrobial-resistance/global-action-plan/development_process/en/.

"Development Process of the Global Action Plan on Antimicrobial Resistance." *World Health Organization*, World Health Organization, 22 Aug. 2016, www.who.int/antimicrobial-resistance/global-action-plan/development_process/en/.

Essack, S.y., et al. "Antimicrobial Resistance in the WHO African Region: Current Status and Roadmap for Action." *Journal of Public Health*, 2016, doi:10.1093/pubmed/fdw015.

"Global Action Plan on AMR." *World Health Organization*, World Health Organization, 19 Sept. 2016, www.who.int/antimicrobial-resistance/global-action-plan/en/.

Jacobs, Andrew, and Matt Richtel. "In a Poor Kenyan Community, Cheap Antibiotics Fuel Deadly Drug-Resistant Infections." *The New York Times*, The New York Times, 7 Apr. 2019, www.nytimes.com/2019/04/07/health/antibiotic-resistance-kenya-drugs.html.

"Lack of New Antibiotics Threatens Global Efforts to Contain Drug-Resistant Infections." *World Health Organization*, World Health Organization, www.who.int/news-room/detail/17-01-2020-lack-of-new-antibiotics-threatens-global-efforts-to-contain-drug-resistant-infections.

Mega, Emiliano Rodríguez. "Alarm as Antimicrobial Resistance Surges among Chickens, Pigs and Cattle." *Nature News*, Nature Publishing Group, 20 Sept. 2019, www.nature.com/articles/d41586-019-02861-5.

Miranda, Claudio D., et al. "Current Status of the Use of Antibiotics and the Antimicrobial Resistance in the Chilean Salmon Farms." *Frontiers in Microbiology*, vol. 9, 2018, doi:10.3389/fmicb.2018.01284.

Moreno-Switt, Andrea I., et al. "Antimicrobial Resistance in Water in Latin America and the Caribbean." *JBI Database of Systematic Reviews and Implementation Reports*, vol. 17, no. 10, 2019, pp. 2174–2186., doi:10.11124/jbisrir-2017-003919.

Qu, Junyan, et al. "Crisis of Antimicrobial Resistance in China: Now and the Future." *Frontiers in Microbiology*, vol. 10, 2019, doi:10.3389/fmicb.2019.02240.

Schoenmakers, Kevin. "China's Farms Are Petri Dishes of Antibiotic Resistance." *Foreign Policy*, 21 May 2020, foreignpolicy.com/2020/05/21/china-farms-antibiotic-resistance-antimicrobial-amr/.

"UN Interagency Coordination Group (IACG) on Antimicrobial Resistance." *World Health Organization*, World Health Organization, 10 Jan. 2020, www.who.int/antimicrobial-resistance/interagency-coordination-group/en/.

"WHO Global Strategy for Containment of Antimicrobial Resistance." *World Health Organization*, World Health Organization, 16 Aug. 2016, www.who.int/drugresistance/WHO_Global_Strategy.htm/en/.

"Worldwide Country Situation Analysis: Response to Antimicrobial Resistance." *World Health Organization*, World Health Organization, 22 Dec. 2015, www.who.int/drugresistance/documents/situationanalysis/en/.

Zimmer, Carl, et al. "The Surprising History of the War on Superbugs." *STAT*, 19 Sept. 2016, www.statnews.com/2016/09/12/superbug-antibiotic-resistance-history/.

Vaccine Development and Distribution

Questions to Consider

1. How do vaccines work? What role do vaccines play in the context of global health?
2. What are the policies regarding vaccination in your country? Is there a steady healthcare system that is able to distribute vaccines to all citizens? What are the reasons for vaccine coverage rates in your country?
3. How can WHO ensure equal access to necessary vaccines in both urban and rural areas? What strategies can be employed to aid countries that lack support for vaccination programs?
4. What can WHO do to address the rising rate of vaccine hesitancy in the developed world? What are the causes of misinformation surrounding vaccines and how can WHO prevent such transmission of information?
5. How can vaccines be more efficiently developed in the setting of a pandemic?

Overview

Vaccines have been an essential part of public health development and are widely known to be one of the greatest medical advancements in human history. First commonly used in the 1800s, vaccines have played a part in eliminating deadly diseases in history, most notably smallpox.[39] Vaccines provide protection for those vaccinated by using the body's immune system to build immunity to a certain disease. The method of vaccines works similarly to that of the human body which typically builds immunity to any viral illnesses that it has suffered and therefore in the future cannot be affected by it anymore. Vaccination occurs by injecting a vaccine which imitates a pathogen; this then creates an immune response where the body produces antibodies to 'fight off' the illness. While the vaccines will not cause the illness in the patient, it does give the patient immunity to the illness that they have been vaccinated against.

As vaccines have been identified as crucial to lowering child mortality rates and increasing global life span, WHO has declared vaccine coverage across the world of utmost importance. According to the United Nations Sustainable Development Goals, vaccination aids the completion of 14 out of 17 goals.[40] Due to its value in aiding global health, WHO aims to give full immunization benefits to all those living in the world by 2030. However, recent trends as well as long-standing issues may cause these goals and developments to derail. Most significantly, vaccine hesitancy has greatly impacted global vaccine coverage; moreover, several issues regarding the equitable distribution of vaccines have yet to be properly addressed. With the modern pandemic of COVID-19, access to vaccines has and could continue to worsen.

Due to regulations and proper precautions required to be met before distributing a vaccine, there is often a long period of time between research and when vaccines can be administered to those in need. In particular, trial periods are of utmost concern because of their length. For many rapidly spreading diseases, this causes concern as in the past, vaccines have often been distributed after the most urgent period is over and many have already contracted the illness. There is a need to

[39] Ibid.
[40] https://www.gavi.org/our-alliance/global-health-development/sustainable-development-goals

discuss how the WHO can aid companies to develop vaccines quicker in order to staunch spreading illnesses. Aside from development, the distribution of vaccines is often hindered as well. Although developed countries can easily reach those living in cities, those living in rural areas of both developed and developing countries do not always receive necessary immunizations. This is unfortunate as vaccines greatly benefit those who receive them and can increase the quality and duration of life for those living in both developed and undeveloped countries.

However, even in areas where vaccines are readily available, an increasing number of people are choosing to opt-out of vaccines. Vaccine hesitancy is on the rise in developing countries, especially in metropolitan areas. Stemming from misinformation and targeted anti-vaccination lobbyists, the movement has spread across North America and Europe as parents refuse to vaccinate their children. As these trends begin to derail previous vaccination efforts, the WHO has declared vaccine hesitancy one of the top ten concerns in 2019.[41] Without proper action, vaccine hesitancy could spread to other countries and cause serious issues regarding vaccine coverage.

Vaccination currently prevents millions of deaths around the world, and WHO is able to provide immunization for more than 20 illnesses through vaccination.[42] By improving vaccine coverage in countries through addressing distribution and development concerns, WHO can greatly prevent global death and illness from vaccine-preventable diseases.

Timeline

1500s: Earliest documentation of smallpox inoculation in China and India.

May 1796: Edward Jenner inoculates eight-year old boy James Phillips with the pus from a cowpox lesion on a cow maid's hand. Jenner later inoculates Phillips with a smallpox lesion to which the boy did not contract the deadly infection. This event is commonly known as the first vaccination.[43]

1800: Benjamin Waterhouse, a Harvard medical professor at the time, brings smallpox vaccinations to America by writing to the soon-to-be US President Thomas Jefferson of the benefits of using cowpox to protect against smallpox infections.[44]

1830s: The working class of Britain protests against new laws by the British government addressing mandatory vaccination for smallpox. Working-class citizens felt that it was a direct assault on their communities to implement such laws.[45]

July 6th, 1885: Louis Pasteur administrates 13 doses of a previously untested rabies vaccine on a boy who has been bitten by a rabid. The boy survives and is the first to be cured of rabies with Pasteur's vaccine.[46]

April 1948: The World Health Organization is formed in Geneva, Switzerland.

---

[41] Ibid.
[42] Ibid.
[43] https://www.healthaffairs.org/doi/full/10.1377/hlthaff.24.3.611
[44] https://www.historyofvaccines.org/timeline/al
[45] ibid.
[46] ibid.

1955: The success of the polio vaccine showed the public that it was possible to create vaccines without the aid of the government as the polio vaccine was mainly funded by philanthropic organizations related to the cause.[47]

January 1st, 1967: The WHO launches its Intensified Smallpox Eradication Programme. At the time, smallpox was endemic in multiple countries in the world. The plan consisted of mass vaccinations and a global surveillance system to track infections.[48]

May 8th, 1980: Smallpox is officially declared eradicated by WHO thanks to aggressive vaccination campaigns and a global surveillance system. It is the first and only disease that has been officially eradicated.[49]

1998: Researchers from England, including Andrew Wakefield, publish a study in The Lancet linking the vaccine for measles and mumps to autism. This cites the beginning of the modern age of anti-vaccination trends.[50]

2010: The Lancet pulls Wakefield's study after he lost his license due to conflict of interest in his study and the numerous counter-studies that have surfaced.[51]

May 2012: WHO launches the Global Vaccine Action Plan which aims to eliminate millions of preventable deaths by 2020 by providing "more equitable access to existing vaccines for people in all communities"[52].

2014: Health officials see a rise in vaccine opposition in major metropolitan areas throughout the developed countries and western world.[53]

January 2019: Measles outbreak in developed countries reaches emergency levels. These countries include Germany, the United States and Brazil.[54]

2020: The COVID-19 is declared a pandemic and at one time, 91% of the world lived in a country where borders were restricted to foreign nations to discourage disease transmission. Due to the rapid transmission rate and unknown long-term effects of the virus, researchers race to create and distribute a vaccine.[55]

[47] https://www.healthaffairs.org/doi/full/10.1377/hlthaff.24.3.622#_i14
[48] https://www.cdc.gov/smallpox/history/history.html
[49] https://www.who.int/health-topics/smallpox#tab=tab_1
[50] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6122668/
[51] https://www.nature.com/articles/ni1208-1317
[52] https://www.who.int/immunization/global_vaccine_action_plan/GVAP_doc_2011_2020/en/
[53] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6122668/
[54] ibid.
[55]https://www.pewresearch.org/fact-tank/2020/04/01/more-than-nine-in-ten-people-worldwide-live-in-countries-with-travel-restrictions-amid-covid-19/

Historical Analysis

Case Study 1: Smallpox Vaccine:
The eradication of smallpox is one of the greatest medical feats in human history. Before its elimination, smallpox killed 3 in 10 people infected and in the 20th century alone, killed around 300 million people.[56] Edward Jenner is widely credited as the first person to vaccinate a patient against a virus. During his studies, Jenner observed that milkmaids that had been infected with cowpox, a less deadly variant of the smallpox virus, were not infected by smallpox after exposure. To test his theory, he inoculated the pus from a cowpox sore into a young boy's arm in 1796. Afterwards, Jenner repeatedly exposed the boy to smallpox to which he received no reaction nor infection. This signified the success of Jenner's theory and proved the effectiveness of modern vaccination. The vaccine was heavily produced in the 1800s to be distributed to citizens.

Although the vaccine had been available for use for decades, smallpox was still an issue in the mid to late 1900s, especially in underdeveloped countries. Thus, WHO planned to rid the world of smallpox in 1959; however, the initiative was underfunded and lacked staff. This caused smallpox outbreaks to continue in developing countries at the time. Finally, in 1967, WHO launched its Intensified Smallpox Eradication Program dedicated to eliminating smallpox from the world. Mass vaccinations occurred in countries to reach 80% coverage in each country[57]. Afterwards, strategies called 'ring vaccinations' where any individual that could possibly have been infected through others were vaccinated as well in order to stop the spread of the disease. Smallpox was also relatively easy to track because of its traditional rashes and therefore, WHO began a global surveillance program to track any cases of smallpox. These efforts were a success as the last naturally occurring case of smallpox was reported in 1975 and in 1980, WHO officially declared smallpox eradicated. This triumph clearly demonstrated to the world the potential of vaccines in protecting human health. To date, there are no proven treatments for smallpox and the only way to prevent its effects are vaccinations.

Case Study 2: Ebola Vaccine:
The Ebola virus is an often fatal viral disease originating from Africa and transmitted through direct contact of blood, body fluid and infected tissue. Ebola was discovered by WHO in 1976 and was thought to be transmitted to humans through bats.[58] Without treatment, the virus has a fatality rate of up to 90%.[59] While Ebola is incredibly deadly, it has sporadic outbreaks which makes developing a vaccine difficult. Ebola is also mostly confined to developing countries in Africa where healthcare systems are poor and outbreaks often occur in rural areas where there is a lack of proper medical care.

In the early 2000s, Canada had already begun to develop an Ebola vaccine and tested it in mice; however, vaccines need an overwhelming amount of investment and because the vaccine was going to be distributed to developing countries, no companies were interested in it. At the time, only 1300 people had died in the 30 years that Ebola had been discovered.

---

[56] https://www.bbc.co.uk/history/british/empire_seapower/smallpox_01.shtml
[57] https://www.who.int/csr/disease/smallpox/vaccines/en/
[58] https://www.livescience.com/47946-where-did-ebola-come-from.html
[59]https://www.health.nsw.gov.au/Infectious/factsheets/Pages/ebola-virus-disease.aspx#:~:text=%E2%80%8BEbola%20virus%20disease%20(formerly,of%20infected%20animals%20or%20people.

With these challenges, an Ebola vaccine was not properly invested in and mass-produced until a major outbreak in West Africa in 2014. Starting in Guinea, the virus travelled to the borders of Liberia and Sierra Leone. A major difference between previous outbreaks was that this was the first outbreak to take hold in urban areas. By this time, possible Ebola vaccines were offered to the WHO, but were turned down due to concerns that countries containing the outbreak were ill-equipped to distribute the vaccine. It was only after WHO declared it a global health emergency that Canada donated its vaccine to the agency to aid the outbreak. This was controversial at the time because the vaccine had not been properly tested and it was commonly known to be unethical to distribute an untested vaccine. Eventually, the vaccine was declared to be 100% effective in certain trials.[60]

When an outbreak occurred in the Democratic Republic of Congo, WHO worked with Doctors without Borders to administer ring vaccinations (similar to that of the smallpox vaccine). However, given the rural areas that Ebola mainly affected, this was still difficult. In these rural areas, determining the number of medical professionals or natural healers was difficult as WHO did not know the exact number of rural hospitals and clinics in the area.[61] Overall, the Ebola outbreaks have served as a reminder of the importance for WHO to establish better vaccination strategies in rural areas where it is difficult to locate many ill patients.

Case Study 3: Measles Outbreak 2019:

In many developed countries, measles has been declared eliminated by WHO—which is defined as "the absence of endemic measles virus transmission in a defined geographical area (e.g. region or country) for at least 12 months"—due to vaccination efforts.[62] These efforts were derailed in 2019 however when measles outbreaks soared high in Western Europe and the United States. In Europe, measles cases in the first half of the year were double that of 2018, and in the United States, there were a total of 1282 cases—the highest since 1992.[63] For these countries, vaccine refusal is the major cause of rising cases; areas in certain cities are 'hotspots' for transmission due to the high number of unvaccinated children. These hotspots are the result of loopholes which allow children to attend school without the proper vaccinations; anti-vax parties typically use these areas to lobby and target cities that have a non-medical exemption for vaccinations.[64] The MMR vaccine, for mumps and measles, in particular, has been the target of false information due to a study linking autism and sudden infant death syndrome to the vaccine. Before the vaccine was developed, measles was one of the most infectious diseases in the world; droplets containing measles could be infectious hours after leaving the body.[65] For herd immunity to work, 85-90% of the population must be vaccinated.[66]

The major challenge that health providers face is the high volume of loopholes that parents are able to use to not their children, such as religious exemptions. In 2019, the UK officially lost its

[60] https://www.statnews.com/2020/01/07/inside-story-scientists-produced-world-first-ebola-vaccine/
[61] https://www.nature.com/articles/d41586-019-02879-9
[62] https://www.who.int/wer/2013/wer8809.pdf
[63] https://www.cdc.gov/measles/cases-outbreaks.html
[64] https://www.theguardian.com/cities/2019/mar/14/are-urban-anti-vaccine-hotspots-putting-children-at-risk
[65] https://www.vox.com/2019/4/15/18311377/measles-outbreak-2019
[66] https://www.nytimes.com/2019/08/29/world/europe/measles-uk-czech-greece-albania.html

'measles-free' status, defined as the absence of measles transmissions for a year, illustrating to the world the dangers of vaccine hesitancy and the potential for eliminated diseases to return to the developed world.

Past Action

Throughout the past decades, the World Health Organization has created some of the greatest public health advancements through its vaccination campaigns. As mentioned previously, WHO had great success in delivering its smallpox vaccination campaigns and in subsequent years, WHO has taken the same campaign and adapted it to suit other preventable diseases. Although WHO has been successful in its Expanded Programme on Immunization, there are still millions unvaccinated against preventable diseases. To address this fact, WHO has launched a Global Vaccine Action Plan along with a recent Global Vaccination Summit.

Before the last case of smallpox was announced, many saw the potential in the application of the Intensified Smallpox Eradication Programme to other diseases that were avoidable through vaccination. This caused the formation of the Expanded Programme on Immunization (EPI), a campaign dedicated to "its goal of universal access to all relevant vaccines for all at risk."[67] Initially having a slow start, the programme soon became effective when the United Nations Children's Fund (UNICEF) began funding efforts and urging country leaders to take part in the immunization initiative. While many countries were eager to deliver vaccination programmes to its citizens, a substantial number of them could not ensure quality vaccine delivery processes; UNICEF responded to this issue by supplying many countries with technologies to aid vaccine transportation, including refrigerators, needles and cold boxes. These efforts resulted in a dramatic rise in immunization rates across the world. Just 6 years after the program began, the diphtheria-tetanus-pertussis vaccine (DTP3) had a global coverage rate of 30% and in 1990, this rate had reached 88%.[68] Similarly, the polio vaccine has caused the infection rate of polio to fall 99% and prevented 5 million from paralysis.[69]

A more recent effort in 2010 marked the importance of private foundations in the combat against diseases. The Global Vaccine Action Plan (GVAP) is a collaboration between WHO and the Bill and Melinda Gates Foundation, along with UNICEF and the National Institute of Allergy and Infectious Diseases. Preceded by the Global Immunization Vision and Strategy, the GVAP is founded on the same principles: a world where all citizens are not encumbered by vaccine-preventable diseases. The GVAP aims to give people "the full benefit of immunization… regardless of where they are born, who they are or where they live,"[70]by 2020. The GVAP has six major strategic objectives: all countries must commit to the importance of immunization, individual rights and responsibility of vaccination, equitable access to immunization, the importance of vaccination in building a health system, access to immunization programs to necessary technology, and global research for vaccines. Along with this plan, WHO also developed the World Immunization Week to highlight the importance of vaccines and vaccine education in the world.

---

[67] https://www.who.int/immunization/programmes_systems/supply_chain/benefits_of_immunization/en/
[68] https://www.who.int/bulletin/volumes/92/5/14-020514/en/
[69]https://www.who.int/immunization/programmes_systems/supply_chain/benefits_of_immunization/en/
[70]https://www.who.int/immunization/global_vaccine_action_plan/GVAP_Introduction_and_Immunization_Landscape_Today.pdf?ua=1

In September of 2019, WHO held the first Global Summit on Vaccination. In the new age of vaccinations, the summit centred around vaccine access and the rising rates of vaccine hesitancy. Addressing the rise of measles cases across the globe in 2019, members of the summit discussed the importance of social media and education in the war on vaccines; similarly, members stressed the value of education in rural areas in order to increase immunization rates.

Current Situation

Length of Vaccine Trials

As seen in the 2020 COVID-19 pandemic, an efficient and rapid process to develop vaccines is increasingly important as new diseases continue to arise. Due to long periods of trial time for vaccines, many essential personnel affected by certain diseases do not receive vaccines until after the pandemic or endemic has already waned out; this can be problematic as new infectious zoonotic diseases emerge as a result of global warming and increased human-to-animal interactions. In order for a vaccine to be approved for public use, it must survive a lengthy clinical trial period consisting of three phases according to WHO. In Phase 1 and Phase 2, the vaccine is used on a small group of roughly 20-80 people to test the vaccine's functionality, if the vaccine passes Phase 1, it then goes on to a few hundred people. These phases are crucial in determining the efficacy and safety of vaccines in different groups of people from different demographics. These trial periods typically only last a few months to a year. In the case of Phase 3 trials, however, the period is significantly longer; this phase involves thousands of individuals spanning different ages and communities in order to gauge the potential side effects that may only occur in 1 out of 10,000 patients. Because of this, Phase 3 trials can take several years to complete. For diseases that are rapidly spreading across the world, the length that it takes for this specific phase of the clinical trial to be completed is a major obstacle.

Unequal distribution and access

Although vaccine access may be a norm for those living in urban areas, vaccine distribution is a major issue for citizens in rural areas in both developing and developed countries. The easiest way to decrease the mortality rate is to vaccinate children;[71] despite this, 20-30% of the causes of death in children were due to vaccine-preventable diseases in developing countries. First off, prices for a standard vaccine package has increased 68 fold over the past few years, and due to this, many governments of developing countries must choose which vaccines they are able to supply to their citizens.[72] In some cases, low to middle-income nations pay more for their vaccines in comparison to developed countries. In a study conducted in a rural area in Pakistan, researchers found that a severe lack of education of the mother could often be accounted as the cause of partially or completely unimmunized children. Only 58.8% of parents were able to produce an immunization card, citing the absence of importance placed around vaccination for their children.[73] Mothers often have to walk long distances to reach a vaccination centre and more problematically, do not always believe that vaccinators will be available for their children. Another issue comes from the vaccination centers themselves: oftentimes, vaccination centers provided by EPI do not have an adequate supply of measles vaccines—this results in the annual outbreak of measles in children in rural areas and developing countries.

[71] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6218029/
[72]https://qz.com/329851/vaccinating-a-child-in-a-poor-country-costs-nearly-70-times-more-than-it-did-in-2001/
[73] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6443532/

In the case of developed countries, fewer individuals in rural areas are still vaccinated than those living in urban areas. This is primarily due to less access to primary care due to physical and distance barriers as well as a lack of urgency to seek medical aid due to inconvenience. It was reported that in America, one-fourth of those needing care in rural areas chose not to receive it.[74] This can be particularly problematic as those living in rural areas are often more exposed to dangerous diseases; for example, rural citizens relying on agriculture and livestock are frequently exposed to zoonotic diseases.

Vaccine Hesitancy

Currently, there is a troubling rise in vaccine refusal or hesitancy. Throughout the past decade, vaccine hesitancy has been on the rise and an increasing number of citizens in developed countries view vaccines, medical professionals that administer them and vaccine researchers with skepticism and distrust. Starting with Andrew Wakefield's study on the correlation between the measles vaccine and autism, many parents protested and opted out of routine vaccination due to unfounded fears for their child. Although the study has been discredited multiple times, the 'anti-vaccination' movement continues to brew with little variation over time. The movement often credits their decisions against vaccination with terms such as human liberty, its 'unnatural' source, and safety. For many, there is also a heightened distrust of major vaccine producers and those who administer vaccines; this causes people to turn away from the advice of health experts and doctors. There was a 31% increase in distrust toward vaccines from 2001-2009.[75] Social media plays a major role in spreading the movement. There are two types of false information spread on these platforms: misinformation from false conclusions and deliberate misinformation from those pursuing an agenda. As social media caters search results to the user, those believing "anti-vax" views easily enter a spiral of misinformation due to curated posted and targeted advertisements. Due to this, platforms such as Facebook and Instagram have begun to censor anti-vaccination groups in an attempt to discourage misinformation. Anti-vaccination movements have caused a resurgence of previously declining diseases such as measles in developed countries. Vaccine hesitancy can potentially unravel the decades of progress made in preventing disease in humans and lead to dangers for those who cannot be protected with vaccines if not promptly addressed.

Possible Solutions

Challenge Trials

To combat lengthy vaccine trials, challenge trials have been introduced and contested around the world. In vaccine trials, it is necessary to test the vaccine's response against the virus in a natural setting; by contrast, challenge trials involve participants receiving the vaccine as well as its corresponding virus or pathogen. Participants of the trial will be willingly exposed to the virus in a lab setting and monitored by research professionals. This can severely lower the amount of time that is needed to test out the vaccine against the intended pathogen in a large number of people. Challenge trials have previously been conducted in malaria and H1N1. While previous challenge trials have typically yielded success and safe results, some have resulted in serious issues like myocarditis in participants. This is a possibility in many developed countries as individuals have previously volunteered for such trials in the past.

[74] https://media.npr.org/documents/2019/may/NPR-RWJF-HARVARD_Rural_Poll_Part_2.pdf
[75] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5597904/

However, in cases where a vaccine is being developed without adequate knowledge of the pathogen, this can lead to several ethical issues. In the case of Covid-19, challenge trials were a topic of debate; scientists did not know yet the implications and long-term effects of the virus and could therefore not supply a cure if the trials were to go array. An ethics debate arises when scientists could be intentionally exposing a healthy human being to potentially deadly pathogens without proper precautions for the safety of the participant. On the other hand, such trials conducted in developing countries are much more concerning. Even in the past with regular trials, underdeveloped countries typically lack regulations surrounding the safety of their trial participants as well as a history "of unethical research.[76] If developed countries were to fund challenge trials in developing countries, there would be little to no support from underdeveloped healthcare systems for the patients and vulnerable populations suffering from poverty could be incentivized to take part in trials that are not properly mandated by the government.

Education

Addressing vaccine hesitancy is of the utmost importance to WHO as it is listed as one of the items on the list of top ten priorities in 2019.[77] A solution to this issue would be to use social media as a way of educating the public in developed countries. As seen in the case of Ethan Lindenberger, a boy who vaccinated himself against his anti-vaccination mother, educating children about the benefits of vaccination can be incredibly beneficial to decrease anti-vaccination trends. Therefore, using social media as a way to give teenagers and children more exposure to vaccination benefits is effective as adolescents can spend an average of 4.5 hours per day on social media platforms.[78] Targeting younger children and teenagers gives those who have not formulated an opinion on vaccines yet to be positively influenced by accurate reports on vaccination; this allows them to make more informed decisions about vaccinations when they come of age. A way to implement this is to collaborate with national health providers to spread accurate research information on media platforms. More importantly, it is essential to educate healthcare professionals on ways to find middle ground with those who hold anti-vaccination views. It is possible to provide intentional education for healthcare providers on the subject of vaccine hesitancy and how to efficiently deal with such views.

On the contrary, there is still a severe lack of general education for those living in developing countries. In particular, maternal education is of concern when regarding vaccine coverage rates. Studies have shown that maternal education greatly impacts whether or not a child will be taken for routine immunizations.[79] Therefore, WHO needs to work with non-governmental organizations as well as the United Nations Girls' Education Initiative to provide quality and accessible education to girls. In the long term, raising education rates for girls will ensure higher rates of vaccination coverage for children and therefore cause child mortality rates to decrease.

Technological Innovation

In developing countries, even with WHO programs, rural areas still lack access and full coverage of vaccines. One of the most promising ways to address this obstacle is through innovative

[76] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3903915/
[77] https://www.historyofvaccines.org/content/blog/who-top-ten-threat-vaccine-hesitancy
[78] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6339919/
[79] Ibid.

technologies. For a lot of medically trained personnel and even WHO designated vaccination centers, although they may be able to reach rural areas, they often give partial immunizations. This is due to the fact that there is low reliability of citizens showing up to such centers; therefore, healthcare providers will not open a vial if they believe that it is not going to be of use in a certain period of time—this leads to children not receiving full immunization. Technology that is developed that can encompass an all-in-one vaccine dosage such as the cPAD injection system can have significant benefits for those living in rural areas[80]. This type of syringe allows for single use with maximum immunization coverage and can also help to lessen the likelihood of cross-contamination. The development of such innovative technologies is essential to increase vaccine coverage rates in developing countries; there have been few private companies that have invested in this type of technology and it is highly dependent on more developed countries to head a project that develops technology aimed for those living in rural areas.

Increased Vaccine Development

Currently, only a few companies are in control of the vaccine industry and many previous companies no longer produce vaccines due to its harsh regulations and market. In fact, five international companies produce 90% of the world's influenza vaccines and in America, many childhood vaccines come from a sole provider.[81]. This is problematic because sole providers of vaccines can suffer shortages. Although a major cutoff of vaccine supplies has not occurred, researchers believe that it is likely to happen in the future; all companies, however, have had certain shortages in the past—causing the inability to deliver vaccines at times. In addition, vaccine production is substantially less profitable in the pharmaceutical industry in comparison to drugs; companies often switch to producing drugs rather than the less frequently used vaccines. To combat this, financial incentives can be used. This can include encouraging countries to provide tax breaks for companies that manufacture vaccines to motivate companies into the field. Another efficient way to persuade more companies to enter the industry comes in the form of private and public cooperation. This was effectively shown in developing the polio vaccine in 1955; a foundation raised millions of dollars to put towards research which took the financial risk out of companies developing vaccines.[82]

Bloc Positions

Developing Countries in Asia and Africa

For developing countries and those of low to mid-income, the majority of vaccine access is provided by WHO and non-governmental organizations. Due to poverty and undeveloped healthcare systems, many countries in this bloc do not meet the standard of vaccination that WHO has outlined; children are not fully immunized despite government and United Nations intervention. Around 2.5 million deaths still occur due to vaccine-preventable diseases, with a large majority of these cases in Asia and Africa surrounding children.[83] Socioeconomic factors affect the vaccination rate as well and a major issue is a lack of education. As many mothers in rural areas did not receive a formal education, there is skepticism surrounding proper vaccination and oftentimes, interactions between healthcare providers and mothers are poor—leading to irregular vaccination. In serious cases, education gaps cause religious and rural groups to believe that vaccines are

[80] https://www.tandfonline.com/doi/full/10.1185/03007995.2015.1108910
[81] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7097449/
[82] Ibid.
[83] https://www.who.int/bulletin/volumes/86/6/07-047159/en/

dangerous to their children and are a product of Western countries attempting to 'convert' them. This was especially prevalent in countries such as Nigeria where religious and cultural groups believed that vaccines were the cause of a mandate being pushed out by WHO and Western countries; the root of this can be explained as established fears of Westerners due to colonialism or a general distrust of mainstream medicine. In some countries, citizens refuse vaccinations or do not seek them out due to distrust of foreign aid and the disbelief of certain illnesses—such in the case of Ebola.

Western Europe, North America and Russia

Countries in this bloc have a strong system to distribute vaccines and a large majority of them impose compulsory vaccinations for all citizens. This bloc also has the power to manufacture and distribute vaccines to their populations as well as those living in developed countries. Improvements can be made to this sector through financial incentives in order for more companies to enter into the vaccine industry so that western countries are not dependent on problematic sole providers of certain vaccines. The responsibility falls onto this bloc to ensure the timely development of necessary vaccines in pandemics—through solutions such as challenge trials—as well as cooperating with WHO to encourage vaccine access in developing countries. However, these countries do have major issues surrounding vaccine hesitancy. The countries in this bloc have the highest rates of vaccine hesitancy and the problem surrounding this issue was shown in the measles outbreak in 2019. Because of high-level internet and social media access, citizens have shown distrust in vaccines; the anti-vaccination movement is of utmost importance and concern because of its dangers to human health.

In a similar trend to Western Europe and North America, Russia has been experiencing a rise of anti-vaccination groups. In fact, Russia allows its decline vaccination at a higher degree of autonomy than does many other countries. Due to this, Russia has seen low coverage rates and the surge of anti-vaccination groups. In addition, Russian users have been known to participate in the spread of misinformation about public health in the United States through social media platforms such as Twitter. Because of this, researchers have seen a correlation between the misinformation deliberately spreading online to vaccination rates in other developed countries.

Middle Eastern Countries:

As a result of ongoing conflict in multiple countries in the middle east, accurate information regarding vaccine coverage is not readily available. However, existing information shows that countries such as Afghanistan and Syria have had declining rates of vaccine coverage. This is especially prevalent in rural areas and those surrounded by conflict as opposed to more urbanized areas inside major cities.[84] The lack of medical personnel and vaccination campaigns in conflict-affected areas have led to multiple outbreaks of polio and measles in these countries. From 2010-2016, 70% of polio cases were found in conflict-ridden areas; therefore, tracking down and distributing vaccines to children in conflict-affected are of utmost importance in order to eliminate unnecessary deaths from vaccine preventable diseases.[85] It is worth noting that in the past, certain extremist militant groups, such as the Taliban, have placed bans on certain vaccines non-government organizations, causing rates of those diseases to rise and deaths to occur.

[84] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6499911/
[85] https://www.sciencedirect.com/science/article/pii/S0264410X18307540

China and India:

In general, both countries have high rates of vaccine coverage in urban areas. India in particular has one of the largest immunisation campaigns in the world and caused a 6.7% rise in their coverage rate from 2015-2017. [86] In China, due to state-mandated vaccines and has vaccine coverage rates in urban areas that mirror those of developed countries in Europe and America. In contrast, both countries have a large number of vaccine recipients without adequate knowledge of the true benefits of vaccination and in rural areas, many children are still unvaccinated despite immunization campaigns. Also, these countries are known as mass producers of vaccines. In the past, however, Chinese manufacturers have been prone to unethical practices and skipping of certain processes; the Chinese government has since taken steps to regulate the vaccine industry.[87] India serves as the world's largest vaccine manufacturer and plays a significant role in manufacturing vaccines in a public health crisis. Currently, both countries are at the forefront of the race for a COVID-19 vaccine.

[86] https://www.bmj.com/content/363/bmj.k4782

[87] https://www.asiapacific.ca/blog/vaccine-scandals-china-why-do-they-keep-happening-over-and

Works Cited

Alexandra Minna Stern and Howard Markel, and Allison Kennedy. "The History Of Vaccines And Immunization: Familiar Patterns, New Challenges." *Health Affairs*, www.healthaffairs.org/doi/full/10.1377/hlthaff.24.3.611.

"All Timelines Overview." *Timeline | History of Vaccines*, www.historyofvaccines.org/timeline#EVT_100322.

Arede, Margarida, et al. "Combating Vaccine Hesitancy: Teaching the Next Generation to Navigate Through the Post Truth Era." *Frontiers in Public Health*, Frontiers Media S.A., 14 Jan. 2019, www.ncbi.nlm.nih.gov/pmc/articles/PMC6339919/.

Belluz, Julia. "2019 Is a Very Bad Year for Measles." *Vox*, Vox, 15 Apr. 2019, www.vox.com/2019/4/15/18311377/measles-outbreak-2019.

Bernasconi, Valentina, et al. "Developing Vaccines against Epidemic-Prone Emerging Infectious Diseases." *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*, Springer Berlin Heidelberg, Jan. 2020, www.ncbi.nlm.nih.gov/pmc/articles/PMC6925075/.

Chadwick, Vince. "First Global Vaccination Summit Sounds the Alarm on Access and Hesitancy." *Devex*, Devex, 13 Sept. 2019, www.devex.com/news/first-global-vaccination-summit-sounds-the-alarm-on-access-and-hesitancy-95593.

"Childhood Vaccination in Africa and Asia: the Effects of Parents' Knowledge and Attitudes." *World Health Organization*, World Health Organization, 4 Mar. 2011, www.who.int/bulletin/volumes/86/6/07-047159/en/.

"Cultural Perspectives on Vaccination." *History of Vaccines*, www.historyofvaccines.org/content/articles/cultural-perspectives-vaccination.

"History of Anti-Vaccination Movements." *History of Vaccines*, www.historyofvaccines.org/content/articles/history-anti-vaccination-movements.

"History of Smallpox." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 30 Aug. 2016, www.cdc.gov/smallpox/history/history.html.

Igoe, Katherine J. “Establishing the Truth: Vaccines, Social Media, and the Spread of Misinformation.” *Executive and Continuing Professional Education*, 10 July 2019, www.hsph.harvard.edu/ecpe/vaccines-social-media-spread-misinformation/.

Institute of Medicine (US) Committee on the Evaluation of Vaccine Purchase Financing in the United States. “Executive Summary.” *Financing Vaccines in the 21st Century: Assuring Access and Availability.*, U.S. National Library of Medicine, 1 Jan. 1970, www.ncbi.nlm.nih.gov/books/NBK221816/.

Institute of Medicine (US) Committee on the Evaluation of Vaccine Purchase Financing in the United States. “Vaccine Supply.” *Financing Vaccines in the 21st Century: Assuring Access and Availability.*, U.S. National Library of Medicine, 1 Jan. 1970, www.ncbi.nlm.nih.gov/books/NBK221811/.

Jamrozik, Euzebiusz, and Michael J Selgelid. “COVID-19 Human Challenge Studies: Ethical Issues.” *The Lancet Infectious Diseases*, vol. 20, no. 8, 2020, doi:10.1016/s1473-3099(20)30438-2.

Marketing, Hencove. “Vaccines for All: Reaching and Serving Rural Americans.” *Atlantic Health Partners*, Atlantic Health Partners, 11 June 2019, www.atlantichealthpartners.com/immunization-insights-1/vaccines-for-all-reaching-rural-americans/2019/6/11.

Marketing, Hencove. “Vaccines for All: Reaching and Serving Rural Americans.” *Atlantic Health Partners*, Atlantic Health Partners, 11 June 2019, www.atlantichealthpartners.com/immunization-insights-1/vaccines-for-all-reaching-rural-americans/2019/6/11.

Maslow, Joel N. “The Cost and Challenge of Vaccine Development for Emerging and Emergent Infectious Diseases.” *The Lancet Global Health*, vol. 6, no. 12, 2018, doi:10.1016/s2214-109x(18)30418-2.

Megan Thielking, et al. “18-Year-Old Who Has Advocated for Vaccines Is Now Target of Harassment.” *STAT*, 1 July 2019, www.statnews.com/2019/06/28/ethan-lindenberger-vaccines-harassment/.

National Research Council (US) Division of Health Promotion and Disease Prevention. “Vaccine Availability: Concerns, Barriers, and Impediments.” *Vaccine Supply and Innovation.*, U.S. National Library of Medicine, 1 Jan. 1985, www.ncbi.nlm.nih.gov/books/NBK216807/.

Patel, Suraj. “What a Teenager Who Got Vaccinated against His Parents' Will Can Teach Us about Anti-Vaxxers.” *Quartz*, Quartz, 22 Mar. 2019, qz.com/1579023/how-people-become-anti-vaxxers-and-how-to-stop-them/.

Roberts, Michelle. “Vaccines: Low Trust in Vaccination 'a Global Crisis'.” *BBC News*, BBC, 19 June 2019, www.bbc.com/news/health-48512923.

Sheridan, Cormac. “The Business of Making Vaccines.” *Nature Biotechnology*, Nature Publishing Group US, Nov. 2005, www.ncbi.nlm.nih.gov/pmc/articles/PMC7097449/.

Singh, K, and S Mehta. “The Clinical Development Process for a Novel Preventive Vaccine: An Overview.” *Journal of Postgraduate Medicine*, Medknow Publications & Media Pvt Ltd, 2016, www.ncbi.nlm.nih.gov/pmc/articles/PMC4944327/.

“Vaccine Market.” *World Health Organization*, World Health Organization, 19 Jan. 2015, www.who.int/immunization/programmes_systems/procurement/market/global_supply/en/.

“Vaccines and Immunization.” *World Health Organization*, World Health Organization, www.who.int/health-topics/vaccines-and-immunization.

World Health Organization, www.who.int/bulletin/volumes/89/5/11-030511/en/.

Writers, Staff. “How Vaccines Work.” *PublicHealth.org*, PublicHealth.org, 22 Nov. 2019, www.publichealth.org/public-awareness/understanding-vaccines/vaccines-work/.