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Battle Against the Unseen: Antimicrobial Resistance

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ABSTRACT

Antimicrobial agents have been vital to cure communicable diseases. The emergence and spread of antimicrobial resistance, a mechanism by which the microbes are no longer affected by the antimicrobial agents, has limited our treatment options and health outcomes. Often referred to as "superbugs" the infections associated with the drug-resistant microbes have already affected millions of lives and are projected to cause 10 million deaths annually by 2050, if appropriate measures are not taken. Antimicrobial resistance is, therefore, a major global public health threat ahead of us. This article presents an overview of antimicrobial resistance with focus on emergence and spread of antibiotic resistance and appropriate measures to be taken at individual and community level to combat it.

KEYWORDS: *Antibiotic resistance; One health approach; Public health threat; Silent pandemic.*

INTRODUCTION

While science is making progress to find novel drugs to treat pathogenic microbes, the microbes are rapidly fighting back by developing resistance against the drugs we use to kill them. Antimicrobial resistance is, therefore, a leading cause of death worldwide, with the highest death rates in some low- and middle-income countries.[1] In 2019 infections caused by drug-resistant organisms accounted for almost five million deaths.[1] Unfortunately, the numbers of deaths and the amount of costs associated with antimicrobial resistance are rising, and without timely actions, antimicrobial resistance is projected to cause 10 million deaths each year by 2050.[2]

THE GROWING THREAT

Antimicrobial agents work by killing and/or inhibiting the infectious agent and therefore, help our body's immune system to clear the invading pathogen and restore health (Fig. 1). However, development of antimicrobial resistance in the pathogens makes the drugs ineffective posing challenges to treat the disease. While some drug-resistant pathogens can be treated with a drug from a different class (sometimes at expense of these agents being toxic to the human body), there is a growing group of pathogens for which no effective antimicrobial agents exist (pan-resistance). These pan-resistant microbes can spread from the place of origin, defying geographical boundaries, to any corner of the world and affect millions of lives. Antimicrobial resistance is, therefore, a silent pandemic spreading rapidly and is a huge battle ahead of us that needs urgent action. Recognizing this, the World Health Organization (WHO) has included this problem among the **top ten global public health threats facing humanity**.[3] The focus of this viewpoint will be mainly on antibiotic (anti-bacterial agents) resistance.

ANTIBIOTICS: MUCH MORE THAN TO TREAT INFECTIONS

While most of us are aware of the common use of antibiotics to treat bacterial infections, the scope of antibiotic use is much greater. Without antibiotics, it is hard to benefit from the advancements in modern medicine such as those related to surgery, joint replacement, dialysis, organ transplantation, cancer therapy, premature birth, and elder care, as all of these require use of antibiotics to prevent subsequent

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infection. Antibiotics are also essential in treating chronic conditions such as diabetes, rheumatoid arthritis, and asthma. In addition to improving human health, antibiotics are used in agriculture to increase crop productivity and in animal husbandry either to treat infections or to promote animal growth.[4]

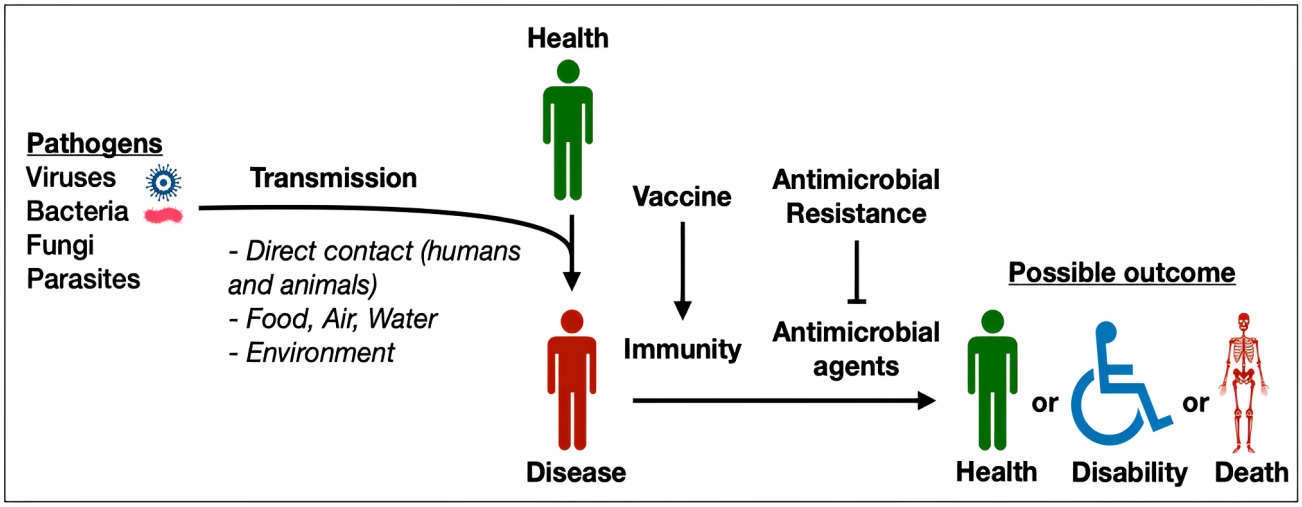

Figure 1. Schematic showing transmission of pathogens affecting health and subsequent possible outcomes. Vaccination helps boost the immunity against the infectious agent and increases chances of healthy recovery whereas antimicrobial resistance renders the antimicrobial agents ineffective and increases the chances of outcome to disability or death.

DEVELOPMENT OF ANTIBIOTIC RESISTANCE

Antimicrobial resistance is a naturally occurring process at a very slow rate. The bacteria can gain resistance against the antibiotics by restricting the antibiotic entry into the cell, by modifying or destructing the antibiotics inside the cell, exporting antibiotics outside of the cell, and/or modifying the cellular targets of the antibiotics.[5] This process, however, is accelerated because of several human activities. These activities include improper use of antibiotics to treat human infections such as taking antibiotics for non-bacterial infections, taking wrong antibiotics due to misdiagnosis of an infection, not completing the antibiotic course, or not taking antibiotics at the indicated times. These activities expose the bacteria to antibiotic concentrations that do not kill them or inhibit their growth, providing the opportunity for them to undergo genetic and/or phenotypic modifications to survive the antibiotics and subsequently develop resistance (Fig. 2). Other activities that accelerate the development of resistance include the misuse of antibiotics in the animal husbandry and agriculture to increase the yield, and improper disposal of antibiotics into the environment, especially from the pharmaceutical industries.

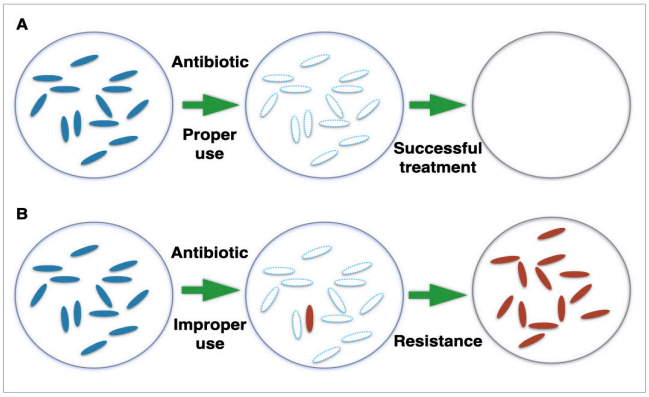

Figure 2. Schematic showing complete killing of bacterial pathogens (dotted blue) after proper use of antibiotic (A) and development of bacterial resistance (red) that could arise from improper antibiotic use (B). The antibiotic is unable to eliminate all the bacteria if appropriate dose of antibiotic is not taken for indicated time giving the bacteria opportunity to develop resistance which can then multiply and spread.

SPREAD OF ANTIBIOTIC RESISTANCE

Once the bacteria develop resistance against the antibiotics, they are passed to the dividing daughter cells and can be transferred to other bacterial cells by the transfer of DNA. These resistant organisms can be present in humans, animals, food, plants, and the environment. The spread of the antibiotic resistant bacteria in a community, like any other infectious agent, occurs through direct contact with the person harboring them, contact with animals, contaminated water, food, or air. Antibiotic resistant organisms are more common

in healthcare facilities as compared to our community, adding the risks to the health of patients staying in such facilities. Health care-associated infection not only increases financial loss but also increases mortality and these burdens are significantly higher in low- and middle-income countries as compared to high-income countries.[6]

WHAT CAN WE DO

Addressing antibiotic resistance requires One Health Approach as One Health recognizes the connection between the health of people, animals, and the environment.[7] This helps understand the emergence and spread of antibiotic resistance in humans, animals, and the environment shared by us. As with any other communicable disease- "Prevention is better than cure" is applicable to infections by antibiotic resistant bacteria. We need to block the transmission of the pathogens by developing healthy habits. Washing hands, as simple as it sounds, is one of the most efficient ways to prevent transmission of the pathogens. Proper use of a mask is effective in preventing many air-borne infections. Keeping up with the available vaccines for diseases endemic in a specific geographical region helps prevent infection. Vaccination is a way of educating our immune system about the pathogens by providing information about specific features of the microbe. The immune system later utilizes this knowledge to fight the invading pathogen including those that are antibiotic resistant, with the aim of preventing the progression of the infection to disease. If the preventative measures fail resulting in disease, consultation with a physician before starting antibiotics and if prescribed, taking the complete dose of antibiotics at indicated times help prevent rapid emergence of antibiotic resistance. Minimizing or if possible, avoiding the use of antibiotics in animal husbandry and agriculture helps lower the amount of antibiotics deposited in the environment. This significantly reduces the exposure of bacteria to the lower concentration of antibiotics, preventing the rapid emergence of resistance.

At community and government levels providing clean water supply helps to maintain healthy practices. In addition, regular monitoring of food for the presence of infectious agents helps prevent food-borne illness including those with antibiotic resistant bacteria. The global antibiotic consumption increased by 65% globally in 2015 as compared to that in the year 2000.[8] These numbers are as high as 114% in low and middle income countries during the same time.[8] The easy availability of antibiotics and increase in the antibiotic use has saved millions of lives, however, to prevent its misuse policies regulating correct diagnosis of disease and prescription of antibiotics should be placed and implemented. Health care facilities should have an infection control plan and protocols in place to reduce the health care-associated infections. Pharmaceutical companies should be properly regulated on how they handle and dispose antibiotics.

WAY FORWARD

Overall, antimicrobial resistance is a huge challenge that can only be solved by the integration of One Health Approach addressing human behavior to live in harmony with the animals, and the environment. The COVID-19 pandemic is the evidence on how an infectious agent originated at one part affects the whole world which is also true for the antimicrobial resistant organisms. While global efforts have been made and are being strengthened, each country should prioritize addressing the problem of antimicrobial resistance and implement the policies and regulations in place. At an individual level, we should start discussing the use of antibiotics, emergence of resistance, and the ways we can stop the emergence and spread of antimicrobial resistance.

CONFLICT OF INTEREST

None

REFERENCES

1. Antimicrobial Resistance Collaborators. Global burden of bacterial antimicrobial resistance in 2019: a systematic analysis. Lancet. 2022 Feb 12;399(10325):629–55.
2. O'Neill J. Tackling drug-resistant infections globally: final report and recommendations. 2016 May 19.
3. Antimicrobial resistance. Available ar: https://www.who.int/news-room/fact-sheets/detail/antimicrobial-resistance
4. Mann A, Nehra K, Rana JS, Dahiya T. Antibiotic resistance in agriculture: Perspectives on upcoming strategies to overcome upsurge in resistance. Current Research in Microbial Sciences. 2021 Dec;2:100030.
5. Centers for Disease Control and Prevention. How Antibiotic Resistance Happens. CDC. Available ar: https://www.cdc.gov/drugresistance/about/how-resistance-happens.html
6. World Health Organization. The burden of health care-associated infection worldwide. WHO. Available from: https://www.who.int/news-room/feature-stories/detail/the-burden-of-health-care-associated-infection-worldwide
7. Centers for Disease Control and Prevention. Combating Antimicrobial Resistance in People and Animals: A One Health Approach. CDC. Available from: https://www.cdc.gov/onehealth/in-action/combating-ar-in-people-and-animals.html
8. Klein EY, Milkowska-Shibata M, Tseng KK, Sharland M, Gandra S, Pulcini C, et al. Assessment of WHO antibiotic consumption and access targets in 76 countries, 2000-15: an analysis of pharmaceutical sales data. Lancet Infect Dis. 2021 Jan;21(1):107–15.