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Antibiotic Resistance - Challenges in Post-COVID Era

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Abstract

Accidental discovery of the antibiotic properties of penicillin marked a watershed moment in healthcare, transforming the landscape of medicine and saving countless lives of injured and infected. Further research and awareness on the advantages of this "miracle drug" resulted in its bulk production in the 1940s, and played a crucial role in saving lives of thousands during World War II. Subsequent discoveries especially broad-spectrum antibiotics paved the way for further advancement but the misuse and over use of antibiotics lead in to drug resistance, a distinct property the microbes can undergo. By 2013, WHO recognised this and, in its report, accepted this as a global public health issue. Not only WHO, but many other organisations also realised this menace against human and animals, and were in the process of producing newer drugs, arranging awareness programmes, proposing governess etc to overcome the related challenges. But the unpresidential nature of COVID 19 pandemic pushed the world into a peculiar state of uncertainty. Scientific elite started discussing the cause and consequences. The awareness that, increased animal- human contact due to large scale agriculture, deforestation etc, can result in the increase of zoonosis and this made us to take preventive measures in terms of over use of disinfectants etc. Pursuit of wealth overriding considerations of prudence, ethics, and risk seen in the post-COVID era worsened this condition alarmingly. This paper discusses the brief history of antibiotics and its status and measures to be taken to address the challenges in the current scenario.

Keywords: Antibiotic, antibiotic resistance, antibiotic governess, broad spectrum antibiotics, deforestation, microbes, pandemic and zoonosis

INTRODUCTION

The term antibiotics is derived from Greek (anti=against, bios=life); literally means "against life or opposing life". The commonly used other anti-microbial substance are antiviral, anti-fungal, anti-cancerous, anti-parasitic etc. Based on the target, antibiotics are classified into broad and narrow spectrum. Narrow- spectrum antibiotics can target only a specific group of bacteria while, broad spectrum can kill multiple types of bacteria, hence the latter was preferred especially if we have no specific diagnosis or as a prophylaxis where we expect some bacterial infection to happen. But the drawback is, the latter can kill useful or normal microbes also, leading to drug resistance and other related complications. Microbes are unicellular organisms which can undergo rapid changes for their survival especially if the threat is comparably weaker. They can cause various infections, especially in damaged cells and organs resulting in not only morbidity but also mortality.

The accidental discovery of the antibiotic properties of penicillin by Sir Alexander Fleming in 1928 [1] marked a watershed moment in healthcare addressing infections, transforming the landscape of medicine, saving countless lives especially the injured and infected. Fleming's groundbreaking work paved the way for further research leading to

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the bulk production of penicillin in the 1940s, a development that played a crucial role in saving the lives of thousands of people during World War II. Subsequent discoveries, such as Streptomycin in the 1940s and many others during the Golden Age of Antibiotics- 1940s-60s ushered in a new era of medical advancements targeting specific pathogens. But the irrational use of antibiotics created a lot of undesired issues. This article describes the history, challenges faced during various periods, among different population and socio-cultural groups.

HISTORY

In 1920s while working with the staphylococcal variants, a contaminating microbes, in his laboratory at St. Mary's Hospital in London, Sir Alaxander Fleming noticed that a large colony of the staphylococcus become transparent and were obviously undergoing lysis [1] Subsequent experiments over a period of eight years made him to conclude that colonies of the common Staphylococcus aureus bacteria that had been worn down or killed by the Penicillin mould growing on the same plate Petri dish [1, 17].Even though he could not be able to extract Penicillin, Howard W Florey and Ernst Chain purified the first penicillin, penicillin G, in 1942 and this became widely available outside the Allied military in 1945 [2]. A. Schatz and S. Waksman in 1940s discovered the first broad spectrum antibiotic Streptomycin which is useful against both gram negative and positive and also against Mycobacterium tuberculosis and the term antibiotic came in to use and marked as the beginning of antibiotic era [2,16]. More and more antibiotics were discovered and used and the period between 1950s and 1970s was named the golden era of antibiotics. After this, the attempts were to modify the existing drugs rather than the discovery of newer drugs [3].

OVERUSE AND RESISTANCE

Antimicrobial resistance is a complex biosocial phenomenon that threatens global public health and is accelerated by overuse and misuse of antibiotics [4]. CDC AMR data shows that there were an estimated 4·95 million (3·62-6·57) deaths associated with bacterial AMR in 2019, including 1·27 million (95% UI 0·911-1·71) deaths attributable to bacterial AMR. At the regional level, the all-age death rate attributable to resistance to be highest in western sub-Saharan Africa, at 27·3 deaths per 100 000 (20·9-35·3), and lowest in Australasia, at 6·5 deaths (4·3-9·4) per 100 000. Lower respiratory infections accounted for more than 1·5 million deaths associated with resistance in 2019, making it the most burdensome infectious syndrome. The six leading pathogens for deaths associated with resistance (Escherichia coli, followed by Staphylococcus aureus, Klebsiella pneumoniae, Streptococcus pneumoniae, Acinetobacter baumannii, and Pseudomonas aeruginosa) were responsible for 929 000 (660 000-1 270 000) deaths attributable to AMR and 3·57 million (2·62-4·78) deaths associated with AMR in 2019. One pathogen-drug combination, methicillin-resistant S aureus, caused more than 100 000 deaths attributable to AMR in 2019, while six more each caused 50 000-100 000 deaths: multidrug-resistant excluding extensively drug-resistant tuberculosis, third-generation cephalosporin-resistant E coli, carbapenem-resistant A baumannii, fluoroquinolone-resistant E coli, carbapenem-resistant K pneumoniae, and third-generation cephalosporin-resistant K pneumoniae [5].

Many factors even like poverty is a proposed driver of antimicrobial resistance, influencing inappropriate antibiotic use in low income and middle-income countries (LMICs) [4]. In 2013 World Health Organization's (WHO) in its report addressed this issue and the European Union and the Centres for Disease Control and Prevention (CDC) reported the territorial over-view of the situation [6]. By this time, it came to the notice that antibiotic use and misuse is more with low- and middle-income groups because of poverty, social and economic concerns [7]. This made World Health Assembly to adopt an action plan with 5 main objectives; raising public and provider awareness, investment in diagnostic and therapeutic, improving surveillance systems, prevention of infections and optimising the use of antimicrobials [8]. Many research and studies have been conducted during this period on causes and consequences of the pandemic. In 2020 Tollefson put forward the concept that biodiversity loss can lead to new diseases [9], Jameel opined that agriculture, deforestation and other industrial activities have increase animal-human contact resulting in the growth of zoonosis [10], and Jefferson found that the most polluted place had the highest number and most severe case of COVID-19 [11]. These studies showed that industrial scale usage of lands is responsible for climate change, environmental degradation and pandemics. To address these issues, we started using disinfectants and antibiotics extensively. The risks and consequences associated with extensive disinfectant use during the COVID-19 pandemic remain unclear. Genotoxic chemicals contained in the disinfectants can lead to mutations that induce antimicrobial resistance [11]. James Alexander Booth *et al.*, after their experimental study had stated that "two different mutagenesis assays indicate that environmental pH affects antibiotic resistance development [12]. Pollutants from industries, burning of wastage etc can change the pH.

THE POST-COVID ECONOMIC LANDSCAPE

The COVID-19 pandemic has caused severe impacts to global economies on a scale not seen in more than a generation [13,14]. Stay at-home policies, widespread travel cancellations, and restrictions on many communal activities have all dealt a blow to daily economic interactions. The implementation of large-scale containment measures by governments to contain the spread of the COVID-19 virus has resulted in large impacts to the global economy [15].

THE INTERSECTION OF ANTIBIOTICS AND WEALTH

Parallel to the above issue, unethical use and misuse of antibiotics in the current scenario pose significant threats. This includes bulk production, widespread use, and a lack of rational antibiotic prescribing practices, which contribute to the rise of multidrug resistant strains. The consequences of antibiotic resistance may escalate into a major global health issue, challenging the management of once-treatable infections. According to Latour, "The pandemic has shown us- the economy is a very narrow and limited way of organising life and deciding who is important and who is not important." (Watts, 2020) [16]. Considering all this the current question is–are we going to the pre-Fleming era?

ADDRESSING CHALLENGES THROUGH SCIENTIFIC RESEARCH

In recent decades, efforts have focused on discovering new antibiotics, exploring alternative therapies, and addressing antibiotic resistance. These endeavours aim to combat bacterial infections and ensure the continued effectiveness of antibiotics. However, the intersection of the craving for quick wealth and antibiotic resistance poses potential risks to our social fabric. Public health priority programs that have faced drug-resistance challenges associated with diseases, such as tuberculosis, HIV, and malaria, have given less attention to risks attributable to the COVID-19 pandemic [7]. Holmes AH *et al.* in 1916 itself had stated that cognizance and actions are desperately needed to confront the existing and emerging public health threats from drug-resistant, multidrug-resistant, and total drug-resistant microbes [5].

THE ROLE OF JOURNALS ON ANTIBIOTICS

Scientific research serves as the foundation for addressing these challenges. Journals on antibiotics play a crucial role in disseminating research findings, studies, and reviews that contribute to our understanding of antibiotics, their mechanisms of action, and the development of new treatments. These journals publish guidelines, best practices, and recommendations for healthcare professionals, informing them about responsible antibiotic use and stewardship.

DISCUSSION

Introduction of broad-spectrum antibiotics in the 1960s-70s which can be taken orally, including ampicillin and amoxicillin, expanded the range of bacterial infections that could be treated. However, this led to their wider use, even for minor and unwarranted conditions. Further soaps and detergents containing antibiotics were started using to prevent infections. The unintended consequence was the evolution of bacterial resistance mechanisms, resulting in the development of multidrug-resistant strains.

The grey area of our time is a challenge of a new order, a global order of unethical survival. Aim for profit making instead of human service has become the priority. The tragedy is that the gainers don't know how much he has to acquire, for what he is doingit and how long we will do it. He is making use of his opportunity without thinking that his gain is at a loss of another and the end result is total destruction of the world. Governments of various countries are in the process to address this issue. But the change occurring is like how a "mutated virus" spreads and the action of Government is as usual which gives ample time for the "new virus" to mutate further and overcome the threat easily and change to a much vulgar form. Only a new ethic that too acceptable globally: an ethic of a global and profound timely responsibility is useful. This path can only be treated with wisdom and compassion through a model of responsible global governance. This shows that intertwining challenges of wealth pursuit and antibiotic resistance require a multidisciplinary approach. State and National Government and regulatory bodies at domestic and international level have a major role to play not only regionally but also at international level, not only addressing the antibiotic usage but also at multifactorial level like socio cultural, economic, ethical etc. Scientific research, as disseminated through journals on antibiotics, remains integral for guiding policies, educating healthcare professionals, and fostering awareness to address these complex and interconnected issues in our post-COVID world.

CONCLUSION

Subsequent discoveries aimed at better microbial control but without responsible governess and various socio-political issues and COVID -19 like pandemics led to "antibiotic resistance" a global health challenge. WHO and other organisations and regulatory bodies identified this overshadowing effect of the discovery in 2013s itself but when the measures were in progress to address this issue COVID 19 and related new political, social, ethical and wealth related challenges crept in. This not only jeopardised the situation but worsen to a level which mandate amicable urgent actions and governess.

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