MedCrave Online Journal of Biology and Medicine

Review Article

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Antimicrobial resistance: a global health crisis

Abstract

Antimicrobial resistance (AMR) is really creating problems for treating infections. Due to misuse of antimicrobials, AMR is set to be the reason being the next pandemic and is taking away many lives. Measures like hand hygiene and proper biomedical waste disposal will go a long way in ensuring a low burden of AMR. Policies and frameworks by governments will also be required.

Keywords AMR, burden, stewardship

Volume 9 Issue 4 - 2024

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Received: November 28, 2024 | **Published:** December 13, 2024

Introduction

Antimicrobial resistance (AMR) is one of the most pressing public health challenges of the 21st century. It occurs when microorganisms—such as bacteria, fungi, viruses, and parasites—become resistant to the drugs that once killed them or inhibited their growth. The emergence of AMR is driven by factors such as overuse and misuse of antimicrobial agents in human medicine, agriculture, and animal husbandry, as well as poor infection prevention and control measures. Also, very few new antibiotics are being developed, owing to the cost and time for developing new antibiotics. The implications of AMR are vast, threatening to render many existing antibiotics and other antimicrobial drugs ineffective, complicating the treatment of common infections and leading to higher mortality, longer hospital stays, and increased healthcare costs. Even in our experience, we have seen that there is increasing in-vitro resistance to fluoroquinolones and Nitrofurantoin in uropathogens. Nowadays even mild infections are becoming untreatable by usage of antibiotics, due to widespread antibiotic resistance. The danger of antimicrobial resistance looms over malaria parasite also, with the onset of artemisinin resistance. Additionally, fungi like *Candida auris* are now uniformly resistant to Triazole antifungals, and only susceptible to echinocandins. Hence, it would not be incorrect to say that the next pandemic will be due to AMR.

The rise of antimicrobial resistance

Historically, antibiotics and other antimicrobials have played a pivotal role in controlling infectious diseases, leading to significant reductions in mortality rates from conditions like pneumonia, tuberculosis, and urinary tract infections. Salvarsan, Prontosil and sulfonamides were the first antibiotics, but they were all synthetic ones.[1] Penicillin was the first natural antibiotic produced by Alexander Fleming in 1928. However, over the past few decades, AMR has emerged as a direct result of the excessive and inappropriate use of these drugs. In 1940s Alexander Fleming had also predicted that such a situation will in future, when most or all antibiotics will be rendered inefficacious due to the misuse of these agents. He once said: "The time may come when penicillin can be bought by anyone in the shops. Then there is a danger that the ignorant man may easily under dose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant".[2] Unfortunately his words seem to be coming true now.

Reasons for the alarming rise of antibiotic resistance

Overuse and misuse in healthcare

In many parts of the world, antibiotics are prescribed unnecessarily for viral infections, where they are ineffective, or for conditions that would resolve on their own without treatment, like common cold.[3] Furthermore, non-compliance with prescribed courses of antibiotics can encourage the development of resistance. In veterinary science also, antibiotics are used as growth promoters.

Use in agriculture

The use of antibiotics in livestock and agriculture has contributed significantly to AMR. Antibiotics are often used not only to treat infections in animals but also to promote growth, leading to the exposure of animals and, consequently, humans to suboptimal doses of antimicrobial agents. This would encourage the development of resistant strains of bugs. Antibiotic-resistant bacteria associated with the animals may be pathogenic to humans also, be easily transmitted to humans via food chains, and widely disseminated in the environment via animal wastes.[4]

Inadequate infection prevention and control

In healthcare settings, improper sterilization, inadequate hygiene and handwashing practices, and insufficient infection control measures facilitate the spread of resistant pathogens. Moreover, the global movement of people and goods has allowed resistant bacteria to spread quickly across borders.[5]

Improper biomedical waste disposal also encourages widespread antibiotic resistance due to mixing of resistant bugs in soil and water.[6] Less emphasis on vaccination means that infections will be on the rise, giving rise to more burden of antimicrobial resistance.

Impact of AMR

The consequences of AMR are far-reaching, affecting individuals, healthcare systems, and economies:

Health impact

AMR can make previously treatable infections much harder to manage. Common diseases, including pneumonia, tuberculosis,

and gonorrhea, are becoming increasingly difficult to treat with standard antibiotics. Infections from resistant organisms often result in longer hospital stays, more intensive care, and higher mortality rates. For instance, multi-drug-resistant tuberculosis (MDR-TB) and carbapenem-resistant Enterobacteriaceae (CRE) infections present serious challenges, with limited treatment options available. Patients carrying MDR and XDR strains of M. tuberculosis present a formidable challenge for treatment.[7] As a result of widespread antimicrobial resistance, CRAB (Carbapenem resistant *A. baumannii*) and CRAP (Carbapenem resistant *Pseudomonas aeruginosa*) are becoming increasingly common across all healthcare settings. More occurrence of MDR strains of gram negative bacteria have implied that Colistin remains the only option left for therapy in many cases for treating these infections. Another emergent problem is the NDM beta lactamase (New Delhi metallo-beta lactamases) which renders Carbapanemes ineffective.

Economic impact

The economic burden of AMR is substantial. Resistant infections lead to longer treatment durations, more frequent hospitalizations, and the need for more expensive medications. According to the World Bank, AMR shall be responsible for a decrease of up to 3.8% in global exports, with a lowering of livestock production by 7.5% per cent per year. It will also result in an increase in healthcare-related costs of US$1 trillion by 2050.[8] There may be huge financial losses due to lost productivity, increased healthcare costs, and a rising disease burden.

Public health risk

Resistance to first-line antibiotics also increases the risk of healthcare-associated infections, especially in immunocompromised patients, such as those undergoing chemotherapy or organ transplants. In a post-surgical environment, the risk of infections from resistant bacteria poses a significant challenge to recovery and long-term health outcomes.

Current efforts to combat AMR

Addressing AMR requires coordinated global action, and several strategies are being pursued at the international, national, and local levels:

Global surveillance and monitoring

The World Health Organization (WHO) has led efforts to improve global surveillance of antimicrobial resistance. This includes the establishment of the Global Antimicrobial Resistance Surveillance System (GLASS), which tracks trends in resistance across countries, facilitating the identification of emerging resistant strains and guiding the development of treatment protocols. GLASS monitors not only laboratory data but also epidemiological, clinical, and population-level data.[9]

Antibiotic stewardship

Antibiotic stewardship programs are designed to promote the appropriate use of antibiotics, ensuring that they are only prescribed when necessary and that the correct drug, dose, and duration are used.[10] Stewardship programs tell which antibiotics to use and when, and also formulate escalation and de-escalation strategies very effectively, and thus may help mitigate the burden of AMR. Empirical treatment should be discouraged, and if very necessary, should be instituted with narrow-spectrum drugs. These programs are being implemented in hospitals, clinics, and long-term care facilities to reduce the unnecessary use of antibiotics.

Improved infection prevention

Strengthening infection prevention and control measures, such as proper sanitation, hygiene, vaccination, and the use of personal protective equipment, can reduce the spread of resistant organisms in healthcare settings.

Research and development

Investment in research is critical to the development of new antibiotics, vaccines, and diagnostic tools. However, the development pipeline for new antibiotics has slowed down considerably in recent years, primarily due to scientific challenges, financial disincentives, and regulatory hurdles. Governments and pharmaceutical companies are beginning to increase funding for this area, recognizing that new treatments are essential to staying ahead of resistance. Still some new antibiotics like bedaquiline for XDR tuberculosis , Fidaxomycin and Nafithromycin have been developed.

Policy and regulation

Governments around the world are enacting laws and policies to limit the overuse of antibiotics, particularly in agriculture. The European Union has already banned the use of antibiotics for growth promotion in animals, and similar regulations are being considered globally. National action plans are also being developed to reduce the burden of AMR, with strategies for improving surveillance, stewardship, and infection control. The Chennai declaration by Government of India in 2015 and creating provisions like schedule X and schedule H are welcome steps in that direction.

Public awareness and education

Public education campaigns are crucial for changing behaviour. Raising awareness about the dangers of overusing antibiotics and the importance of adhering to prescribed treatment regimens can play a significant role in reducing unnecessary antibiotic consumption. Educating the public about proper hygiene practices, vaccination, and safe food handling also helps mitigate the risk of infection.

Challenges and future directions

Despite ongoing efforts, several challenges remain in the fight against AMR, which can be listed as below:

Global inequities

In many low- and middle-income countries, access to antibiotics is unregulated, and healthcare infrastructure may be inadequate. Additionally, the affordability of newer, more effective antibiotics is a major barrier. International collaboration is needed to ensure that AMR solutions are accessible globally.

Economic incentives for drug development

The development of new antibiotics is not financially lucrative for pharmaceutical companies, especially given the short duration of use for many of these drugs. Incentivizing research and development in this area, including offering subsidies, grants, and market exclusivity for new antibiotics, is crucial.

Multisectoral coordination

Effective AMR control requires the collaboration of multiple sectors, including healthcare, agriculture, and environmental policy. Governments must ensure that their actions are coordinated across sectors to create an integrated approach to AMR.

Emerging resistant pathogens

As resistance continues to evolve, new and more potent resistant pathogens are emerging. Tackling these threats will require continuous innovation in diagnostics, treatment protocols, and vaccines.

Some ways to manage the menace of AMR

I. Government of India has postulated schedules X and H, H1 to endure patients and consumers show prescriptions before buying antibiotics. In schedule X, one copy of the prescription is to be retained by the shop owner.

II. The Government of India along with BIRAC (Biotechnology Industry Research Assistance Council) has developed a new antibiotic, Nafithromycin, which is up to 10 times more efficacious than Azithromycin in combating community acquired bacterial pneumonia, and has a three-day regime only.[11] This is indeed a welcome sign.

III. Antivirulence strategies and enzyme therapy can be effective.

IV. Phage therapy by employing bacteriophages, can be useful in managing antimicrobial resistance. Other modalities like CRISPR-Cas9 technology, and the exploration of natural compounds, are also being tried.[12] CRISP-R stands for Clustered Regularly Interspaced Short Palindromic Repeats. By leveraging CRISPR, researchers are able to engineer specific genetic changes to halt drug resistance mechanisms in bacterial pathogens. One remarkable example of using CRISPR technology to combat antibiotic resistance is the advent of phage therapy. Researchers have employed CRISPR to modify bacteriophages, so that they target antibiotic-resistant bacterial strains.

V. Meticulous social and surgical hand wash should be emphasized upon to stop the spread of resistant bugs.

VI. The general public needs to be educated about the burden of AMR and ways to manage it.

VII. Despite all such measures, the present burden of AMR in all healthcare facilities in indeed worrisome. More efforts should be channelized in this field to find solutions to bring down the load of AMR in healthcare facilities.

Conclusion

Antimicrobial resistance is a growing threat to global health that requires urgent, coordinated action across all sectors of society.

Acknowledgments

None.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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