International Journal of Pharmaceutical Research and Applications
Volume 9, Issue 3 May-June 2024, pp: 1978-1984 www.ijprajournal.com ISSN: 2456-4494

Antimicrobial resistance in below poverty line population: A review article

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Date of Submission: 05-06-2024 Date of Acceptance: 15-06-2024

ABSTRACT: Antimicrobial resistance (AMR) is a burgeoning global health crisis, disproportionately affecting populations living below the poverty line. Socio-economic factors such as inadequate housing, poor living conditions, limited access to healthcare, and low education levels exacerbate the spread of resistant infections in these communities. The economic impact of AMR is substantial, particularly in low- and middle-income countries, where the costs of treating resistant infections significantly strain healthcare systems and amplify financial pressures on impoverished populations.

Healthcare systems worldwide are struggling as the effectiveness of existing treatments declines, with multidrug-resistant organisms complicating clinical management and increasing healthcare costs. In response, countries like the United States and India have implemented measures such as surveillance programs and public health campaigns to combat AMR. Effective strategies include involving pharmacists in medication optimization, improving antimicrobial practices in outpatient settings, and leveraging advanced diagnostics and robust surveillance systems.

Addressing AMR requires a multifaceted approach that encompasses both scientific and socio-economic interventions. Policymakers must focus on high-risk groups, allocate resources efficiently, and implement targeted interventions. By understanding and mitigating the factors linking poverty to AMR, we can enhance public health outcomes, reduce economic burdens, and preserve the efficacy of antimicrobials for future generations.

KEYWORDS:AMR, WHO, NSSO, MRSA, ASP

I. INTRODUCTION

The waning efficacy of antimicrobial agents has emerged as a worldwide peril to humanity. The phenomenon of antimicrobial resistance (AMR) is predominantly observed in populations living below the poverty line. The poverty threshold varies from one country to another. However, these factors are exerting a significant impact on the global healthcare system at an increasingly accelerated rate. Antimicrobial resistance (AMR) poses an escalating worldwide public health danger that has the potential to undo the advancements made in extending human lifespan over the past few decades [1]. As a result of antimicrobial resistance (AMR), humanity is entering an era where there are very few effective antimicrobials remaining. Nowadays, in most cases, the antimicrobials that were originally designed or used for a specific disease or infection are no longer highly effective. As a result of antimicrobial resistance (AMR), the majority of antimicrobials are experiencing reduced effectiveness. According to the World Health Organization (WHO), there will come a time in the future referred to as the "post antimicrobial era," where no antimicrobial treatment will be effective against any disease in humans [2]. The World Health Organization has identified poverty as a significant factor contributing to the emergence of antimicrobial resistance [3]. The National Sample Survey Office (NSSO), a department under the Ministry of Statistics and Programme Implementation, conducted a survey in India during the period of 2022-2023. The survey results indicate that the poverty rate in India has fallen to less than 5%. The data classified individuals into 20 groups, unveiling an average monthly expenditure per person of INR 3,773 in rural regions and INR 6,459 in urban regions. The 0-5% percentile group exhibited an average monthly expenditure of INR 1,373 in rural regions and INR 2,001 in urban regions [4]. The study conducted by Balachandra, Swathi S. et al identified several species of microorganisms that exhibit high levels of resistance to most antimicrobial agents. These species include Escherichia coli (E. coli), Klebsiella pneumoniae (K. pneumoniae), pseudomonas species, Staphylococcus aureus (S. aureus), Klebsiella oxytoca, Proteus mirabilis, Enterococcus faecium, Salmonella typhi, Acinetobacter baumannii, Staphylococcus haemolyticus, Staphylococcus warneri, and Candida species. The study collected data from two locations: a rural hospital with 100 beds and an urban tertiary care hospital [5]. A recent prominent report has cautioned that the number of deaths worldwide attributed to antimicrobial resistance (AMR) could increase from 700,000 in 2015 to 10 million in 2050 if no action is taken to reverse this trend. In addition to these significant problems, AMR has a detrimental effect on communities' economies, resulting in substantial annual expenses that are nearly equivalent to those incurred during the global financial crisis [6,7].

Italy has a significant prevalence of infections caused by antibiotic-resistant bacteria in the WHO European Region [8]. The incidence of methicillin-resistant S. aureus (MRSA) among invasive samples is approximately 30% and has remained constant over the past three years. The increase in vancomycin-resistant E. faecium (VRE) strains is causing significant concern. These strains have tripled in number from 2015 to 2022 and currently make up 30% of all E. faecium isolates. E. coli and K. pneumoniae exhibit resistance to third-generation cephalosporins at rates of approximately 25% and 55%, respectively. Carbapenem resistance is observed in more than 80% of Acinetobacter spp. Approximately 25% of K. pneumoniae and over 10% of Pseudomonas aeruginosa exhibit resistance to carbapenem antibiotics [8,9]. AMR organisms in the United States result in over 2 million infections and are linked to around 23,000 deaths annually [10]. AMR is linked to approximately 25000 deaths each year in Europe. The economic ramifications of antimicrobial resistance (AMR) are significant, with an estimated $20 billion in additional healthcare expenses annually in the United States [10]. Published reports have indicated that Asian countries have observed notably high prevalence rates of beta-lactam and macrolide resistance in S. pneumoniae [11,12]. Specifically, there has been a significant surge in erythromycin resistance in numerous Asian countries, with over 70% of clinical isolates demonstrating complete resistance. In Asia, there has been a recent emergence of extremely drug-resistant gram-negative bacilli, leading to high prevalence rates of methicillin-resistant Staphylococcus aureus (MRSA), macrolide-resistant Streptococcus pneumoniae, and multidrug-resistant enteric pathogens. Due to the scarcity of antimicrobial options available for these pathogens, infections caused by antimicrobial-resistant bacteria are frequently linked to inadequate antimicrobial treatment and unfavorable clinical results [12]. The estimated incidence of antimicrobial resistance (AMR) infections in the United Kingdom was 65,162 diagnosed cases in 2019, representing an increase from the 61,946 patients recorded in 2018 [12].

Nevertheless, there is insufficient evidence demonstrating the correlation between the various aspects of poverty and the extent of antimicrobial resistance (AMR). Analyzing the factors linking poverty to antimicrobial resistant infections would provide valuable insights for policymakers. This information would go beyond addressing inappropriate antimicrobial use and allow for targeted interventions to be implemented for high-risk groups. By understanding the dimensions of poverty that contribute to antimicrobial resistance, policymakers can effectively allocate resources to combat this issue. This approach has the potential to benefit not only individual and public health outcomes, but also the economic perspective of the health system and society as a whole [13]. The study conducted by Alividza et al. aimed to examine the correlation between antimicrobial resistance (AMR) and poverty by identifying the specific aspects of poverty that may contribute to the development of antimicrobial-resistant organisms in humans. The study identifies several factors that contribute to or result in antimicrobial resistance (AMR) in humans, such as housing and living conditions, low income and income inequality, education levels, water and sanitation, and social deprivation. The following factors are linked to antimicrobial resistance (AMR) in the population below the poverty line [14].

II. IMPACT OF AMR ON ECONOMY

The costs or economic impacts encompass not only financial aspects but also encompass the social and labor-related consequences. According to the research conducted by the RAND Corporation, if we do not address Antimicrobial Resistance (AMR), the global population by 2050 could be reduced by anywhere between 11 million to 444 million compared to what it would be without AMR. The 2014 World Bank report provides information on the disparities in spending on healthcare and the associated infrastructure [15]. In a study conducted by Founou et al., a systemic literature review and meta-analysis revealed that antibiotic resistance (ABR) and antimicrobial resistance (AMR) are linked to a significant risk of mortality and increased economic burdens. The study identified ESKAPE pathogens as the primary contributors to the elevated mortality rates. High-risk populations were identified as patients with co-morbidities of non-communicable diseases [15,16]. AMR infections also incur substantial economic and societal costs. These expenses are associated with extended hospital stays, elevated medical expenses, and heightened mortality rates. AMR, which stands for antimicrobial resistance, is a worldwide issue. However, it has a greater impact on low- and middle-income countries (LMICs) compared to other nations. This poses a threat to the sustainable development of these countries [16]. The rise of antimicrobial resistance (AMR) could significantly affect the economy, particularly in developing countries where a large portion of the population lives below the poverty line. This vulnerable population will experience greater resistance to treatment, resulting in a more pronounced impact on the economy.

III. IMPACT OF AMR ON HEALTHCARE SYSTEM

Antimicrobial resistance (AMR) poses a significant and immediate danger to global public health. The exponential growth and global dissemination of antimicrobial resistance (AMR) pose a significant threat to the progress made in contemporary medicine, jeopardizing the effectiveness of treating prevalent infections like pneumonia, urinary tract infections, and tuberculosis. Additionally, it compromises the care provided to patients requiring organ transplantation, intricate surgical procedures, cancer chemotherapy, and intensive care [17]. Nevertheless, there has been a significant increase in the use of antimicrobials in the past few decades, leading to substantial selective pressures on bacterial populations. Consequently, this has greatly hastened the evolution of antimicrobial resistance (AMR) [17]. Once humanity creates a new category of tiny chemical compounds to eliminate bacteria, the organisms adapt to withstand their effects. This results in a growing occurrence of multi-drug-resistant (MDR), extended-drug-resistant (XDR), and pan-drug-resistant (PDR) organisms [18].

IV. IMPACT ON TREATMENT PLANS

Undoubtedly, the treatment plans for various diseases will undergo modifications as a result of antimicrobial resistance (AMR). The initial occurrence of a penicillin-resistant strain of S. pneumoniae with a minimum inhibitory concentration (MIC) of 0.25 µg/mL was documented in the United States in 1974. Surveillance studies at the national level have shown a consistent rise in the prevalence of resistance among S pneumoniae during the 1990s. During the periods of 1998-1999 and 1999-2000, there was a notable rise in resistance among clinical S. pneumoniae isolates to amoxicillin/clavulanate (3.7%, $P < 0.001$), cefuroxime (2.2%, $P < 0.05$), clarithromycin (3.1%, $P < 0.001$), and trimethoprim/sulfamethoxazole (TMP/SMX) (2.0%, $P < 0.05$) [19]. According to a recent study conducted in the United States, 37% of S. pneumoniae isolates showed a lack of susceptibility to penicillin, with 12% falling into the intermediate category and 25% being completely resistant to penicillin. The minimum inhibitory concentration (MIC) for the non-susceptible isolates was measured at 0.12 µg/mL, while the MICs for the intermediate and resistant isolates ranged from 0.12–1 µg/mL and 2 µg/mL, respectively [19,20,21].

Enterococcus faecalis was the predominant species reported, accounting for 81.5% of cases, followed by Enterococcus faecium at 8.5%, and other enterococci species at 4.8%. Phenotypically vancomycin-resistant enterococci (VRE) were detected in 1.8% of Enterococcus spp. isolates. The prevalence of vancomycin-resistant enterococci (VRE) was highest for Enterococcus faecium at 8.1%, followed by Enterococcus faecalis at 0.9%. A considerable degree of resistance to glycopeptides, expressed as the percentage of vancomycin-resistant enterococci (%VRE), has been consistently observed in both E. faecalis (0–2.2%) and E. faecium (0–14.2%) over the years. Specifically, in 2010, the resistance levels were 0% for both species, while in 2021, the resistance levels increased to 0.6% for E. faecalis and 5.8% for E. faecium [22].

Due to antimicrobial resistance (AMR), the cost of treating diseases has significantly increased, which has a direct impact on individuals living below the poverty line.

V. STEPS TAKEN BY COUNTRIES AGAINST AMR

In the United States: The Centers for Disease Control and Prevention (CDC) Antibiotic Resistance Laboratory Network (ARLN) in the United States enables the exchange of data and testing between clinical and public health laboratories across the country. The Antimicrobial

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Resistance Laboratory Network (ARLN), which includes laboratories in all 50 states, addresses the lack of local laboratory capabilities in order to enhance the effectiveness of antimicrobial resistance (AMR) surveillance and prevention [23]. The National Antimicrobial Resistance Monitoring System (NARMS) is a collaborative surveillance system overseen by the CDC, FDA, and USDA to monitor and track the development of antimicrobial resistance. The main emphasis is on bacteria that cause foodborne illnesses and other infections in humans, as well as those found in retail meats and food animals. The CDC operates several surveillance programs, each making distinct contributions to the surveillance of antimicrobial resistance (AMR). The programs encompassed are the National Healthcare Safety Network (NHSN), NARMS for Enteric Bacteria, ARLN, Emerging Infections Program (EIP), GISP, and the National Typhoid and Paratyphoid Fever Surveillance (NTPFS) program. NHSN is the predominant healthcare-associated infection surveillance system in the United States, utilized by more than 25,000 healthcare facilities [24].

In the India: i) The Chennai Declaration (2012) is a document that outlines a plan to address the issue of antimicrobial resistance. It was created through a collaborative effort of various medical societies in India.
ii) ICMR- Antimicrobial Stewardship, Prevention of Infection & Control Programme was established in 2012.
iii) Establishment of the Anti-microbial Resistance Surveillance and Research Network in 2013.
iv) The Red Line Campaign was launched in 2016.
v) The Antimicrobial Stewardship Programme Guidelines (2017) were implemented in each institution based on the resources that were available. Prior to the implementation of ASP, there was a noticeable inclination towards a rise in the consumption of antibiotics for all the selected antimicrobials measured. Subsequently, a general decline in antibiotic usage was noted.

The National Action Plan for the years 2017-2021.
vii) The ICMR Treatment Guidelines for Antimicrobial use in Common Syndromes were published in 2019 [25].

VI. STRATEGIES TO OVERCOME AMR

•One of the strategies to address AMR is to involve pharmacists in optimizing medicines.

Pharmacists who practice and provide pharmaceutical care services play a crucial role in coordinating and optimizing the use of medicines among healthcare professionals, patients, and the general public. The pivotal role of pharmacists is crucial for ensuring the optimal utilization of antibiotics [26].

•Approaching antimicrobial resistance (AMR) from a variety of disciplines

Historically, the strategy for combating multidrug resistant organisms (MDROs) has primarily relied on scientific methods. With the emergence of AMR, there was a significant focus on the exploration of novel antibiotics and the advancement of innovative treatments. While significant progress is being achieved in these areas, it is evident that due to the global magnitude of the issue, relying solely on wet-lab methods is no longer adequate. In order to tackle such an intricate threat, we assert that a multidisciplinary approach is essential, and that the involvement of both biological and social sciences is required [27].

• Utilization of antimicrobial agents in outpatient healthcare settings

Enhancing the use of antimicrobials in outpatient settings for acute respiratory infections (ARIs) is particularly crucial during the COVID-19 pandemic. Published studies have indicated that more than 70% of patients with COVID-19 were prescribed antibiotics, including broad-spectrum ones, even when not medically necessary. However, only around 3.2% of infections in outpatient care actually required antibiotics [28].

• Factors related to technology

Technological advancements in diagnostics that can quickly identify infections and antimicrobial resistance (AMR) are crucial for enhancing patient care and enhancing surveillance. Peripheral health facilities frequently suffer from a lack of laboratory facilities and proficient human resources. Point-of-care diagnostics for guiding the proper prescription of antimicrobials are not currently accessible, whereas antimicrobials are readily available over-the-counter and a diverse range of infections are treated based on empirical evidence. Furthermore, the implementation of computerized real-time data reporting is crucial for enhanced surveillance and prompt action in healthcare. It is crucial to have a strong system in place to regularly monitor the use of antimicrobials based on diagnostic information, which can be achieved by improving the reporting of infectious diseases and prescriptions [29].

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VII. CONCLUSION

Antimicrobial resistance (AMR) is a significant worldwide health concern that particularly affects populations living in poverty. This specific demographic is highly susceptible to harm as a result of various socio-economic factors, such as substandard housing, unfavorable living conditions, meager income, limited education, and inadequate availability of clean water and sanitation facilities. These factors contribute to the growing occurrence of infections that are resistant to antimicrobial drugs, making treatment plans more complicated and worsening the financial strain on healthcare systems. The consequences of antimicrobial resistance (AMR) go beyond the realm of health and have a substantial impact on economies across the globe. The economic repercussions include expensive medical treatments, prolonged hospitalizations, and higher death rates. According to the RAND Corporation, failure to address AMR could lead to a significant decline in the global population by 2050. The economic and health impacts of AMR are particularly pronounced in low- and middle-income countries, where a significant proportion of the population lives in poverty.
AMR is causing significant strain on healthcare systems. The efficacy of treatments for prevalent infections is declining, presenting a significant menace to the progress achieved in contemporary medicine. The emergence of multidrug-resistant (MDR), extended-drug-resistant (XDR), and pan-drug-resistant (PDR) organisms adds complexity to the situation, resulting in unfavorable clinical outcomes and increased treatment expenses. Various nations have taken steps to address the issue of antimicrobial resistance (AMR) in light of this crisis. The Centers for Disease Control and Prevention (CDC) in the United States runs several surveillance programs to oversee and monitor antimicrobial resistance (AMR). In India, efforts such as the Chennai Declaration, the Red Line Campaign, and multiple national action plans are being implemented to mitigate the proliferation of antimicrobial resistance (AMR). The strategies to combat antimicrobial resistance (AMR) highlight the significance of adopting a multidisciplinary approach. This encompasses the participation of pharmacists in improving the utilization of medication, improving the use of antimicrobials for outpatients, and utilizing technological advancements in diagnostics. Effective management of antimicrobial resistance (AMR) requires the use of point-of-care diagnostics, real-time data reporting, and enhanced surveillance systems. In order to reduce the risk of AMR, it is crucial to tackle the socio-economic factors that contribute to its high occurrence among impoverished populations. Policymakers should efficiently distribute resources, with a specific focus on high-risk groups and the implementation of targeted interventions. To enhance public health outcomes, alleviate economic burdens, and safeguard the efficacy of antimicrobials for future generations, it is crucial to comprehend and tackle the various aspects of poverty that contribute to antimicrobial resistance (AMR).

VIII. DISCUSSION

Antimicrobial resistance (AMR) poses a significant worldwide health risk, especially impacting populations living below the poverty threshold. The prevalence of resistant infections is perpetuated in these communities due to substandard living conditions, limited healthcare accessibility, and low educational attainment. Consequently, this leads to a vicious cycle of heightened disease burden and escalated healthcare expenses.

From an economic standpoint, antimicrobial resistance (AMR) places a substantial burden on healthcare systems, particularly in countries with low and middle incomes. The management of resistant infections results in extended hospitalization, costlier therapies, and increased mortality rates, exacerbating the financial burdens on disadvantaged populations.

Healthcare systems globally are facing challenges due to the diminishing efficacy of current medical interventions. The emergence of multidrug-resistant organisms poses challenges in clinical management and necessitates the development of novel treatment approaches, leading to increased healthcare expenses. As a reaction, countries such as the United States and India have adopted diverse strategies to address antimicrobial resistance (AMR). The CDC's surveillance programs and India's initiatives, including the Chennai Declaration and Red Line Campaign, have the objective of enhancing antimicrobial stewardship and increasing awareness.

Efficient approaches to address antimicrobial resistance (AMR) encompass engaging pharmacists in optimizing medication, improving antimicrobial practices in outpatient settings, and employing advanced diagnostics. Strong monitoring and immediate data reporting are essential for prompt interventions. To effectively combat antimicrobial resistance (AMR), it is necessary to adopt a comprehensive strategy that encompasses addressing the socio-economic factors that contribute to it. Policymakers should prioritize high-risk groups, effectively allocate resources, and implement specific interventions. By examining the factors that connect poverty to antimicrobial resistance (AMR), we can enhance the results of public health, lessen economic burdens, and safeguard the effectiveness of antimicrobials for the long term.

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