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Antimicrobial Resistance: Where do We Stand?

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Abstract

Antimicrobial resistance (AMR) remains one of the most pressing global health threats of the 21st century, undermining decades of progress in infectious disease treatment and control. Despite increasing awareness, the misuse and overuse of antibiotics in humans, animals, and agriculture persist worldwide and continue to accelerate the emergence of resistant pathogens. Moreover, inadequate surveillance, limited innovation in antimicrobial development, and poor infection control practices further accelerate the spread of AMR pathogens. This perspective provides a current landscape of AMR, highlighting the most pressing challenges, the national and global action plans, necessity of antimicrobial stewardship, and the urgent need for coordinated, multi-sectoral action. It further underscores the urgent need for coordinated efforts across sectors through a One Health approach, greater investment in antibiotic development, and robust public engagement. As resistance outpaces the development of new treatments, a renewed global commitment is essential to safeguard the efficacy of existing antimicrobials and protect future generations from the avert of a post-antibiotic era.

Keywords: Antimicrobial resistance, Silent pandemic, Drivers of AMR, Bangladesh scenario of AMR, Measures to combat AMR

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Introduction

Antibiotics are among the most important discoveries of the 20th century. The introduction of antibiotics has changed the therapeutic paradigm and continues to save millions of lives from bacterial infections[1]. From simple surgeries and dental procedures to cancer treatment, antibiotics support health systems' ability to deliver safe care to patients. Average human life expectancy has been extended by more than 20 years since the discovery of antibiotics almost a century ago[2]. With the ever-increasing use of antibiotics, especially in developing countries, bacteria have had ample opportunity to develop antimicrobial resistance (AMR) with profound consequences including much higher morbidity and mortality. Microbes have developed acquired AMR to many drugs due to high selection pressure from increasing use and misuse of antibiotics over the years. AMR refers to the ability of microorganisms such as bacteria, viruses, fungi, and parasites to thrive and continue to grow in the midst of drugs designed to kill them. The growing resistance over the recent years renders common infections harder or even impossible to treat[3]. In 2019, nearly 5 million deaths were associated with bacterial antimicrobial resistance worldwide, more than HIV or malaria related deaths[4]. According to 2021 estimates, AMR-attributable deaths stood at 1.14 million, while AMR-associated deaths were 4.71 million. New estimates indicate that AMR has always been, and remains, an urgent global health threat with projections showing over 39 million deaths directly attributable to bacterial antimicrobial resistance from 2025-2050, which equates to three deaths every minute[4]. Regional hotspots indicate that regions like South Asia, Sub-Saharan Africa, Latin America, and parts of North America are projected to have the highest AMR mortality rates, both now and into the future. Globally,

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AMR ranks among the top 3 causes of death, contributing significantly in low- and middle-income countries (LMICs)[4,5]. The latest Global Research on Antimicrobial Resistance (GRAM) estimates suggest that LMICs face a disproportionate AMR burden with Sub-Saharan Africa and South Asia account for the highest rates of attributable and associated AMR deaths. Fortunately, AMR-attributable deaths in children < 5 years dropped by over 50% from about 488,000 in 1990 to roughly 193,000 in 2021 due to vaccination and improved hygiene, while, it rose over 80% in adults ≥ 70 years during the same time line[6]. Apart from human healthcare, the emergence and spread of AMR from the unscientific use of antimicrobials in livestock feed in many developing countries has been a major contributing factor. It necessitates increased surveillance on the impact of excessive and unregulated use of antibiotics in animal feeds to downturn the incidence of drug-resistant bacteria[7,8]. Given the fact that antimicrobials are indispensable tools to treat and prevent infectious diseases, it is now crucial to preserve the efficacy of currently available antimicrobials since there has been no significant discovery of new molecules during recent decades.

Silent Pandemic

Antimicrobial resistance is often referred to as a silent pandemic because it spreads invisibly without the dramatic effects of traditional pandemics[9]. It is a "pandemic" because it is widespread, deadly, and crosses borders, affecting millions around the world. Unlike COVID-19, AMR does not cause widespread panic or noticeable outbreaks, rather it works in the background of silent eroding effectiveness of antimicrobial drugs. AMR develops slowly over time, making it easy to overlook until there is treatment failures or infections become severe or even deadly[10]. There are compelling reasons to consider AMR as a silent pandemic like slow but gradual progression, lack of immediate visibility unlike conventional pandemics, hard to detect without testing and many healthcare systems lack routine diagnostic testing for its early detection, underreported and under researched because of weak or non-existent surveillance systems in many countries, widespread misuse and abuse of antibiotics drive resistance silently and steadily, disproportionately affect the vulnerable groups like elderly, newborns and immunocompromised, global but often goes unnoticed in many LMICs due to unregulated antibiotic sales, poor sanitation, and lack

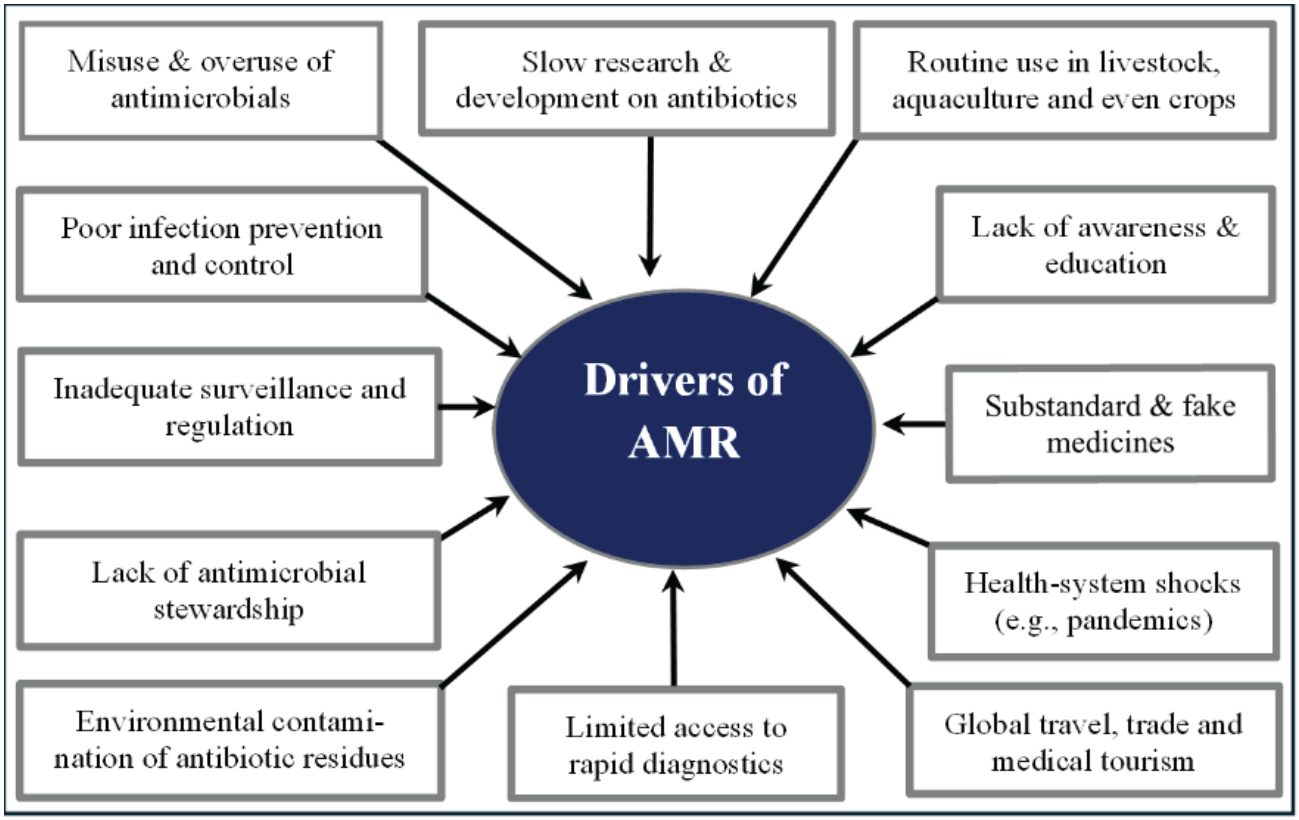

Figure I: Major drivers of AMR including human, animal and environmental health

of awareness and threat to a post-antibiotic era when bacteria become resistant to existing antibiotics and the antibiotics no longer work.

Drivers of AMR

Antimicrobial resistance is driven by a combination of biological, behavioral, environmental, and systemic factors[11] and Figure 1 depicts the major drivers.

AMR-Bangladesh Scenario

The number of AMR deaths in Bangladesh is higher than deaths from chronic respiratory diseases, respiratory infections and tuberculosis, maternal and neonatal disorders, diabetes and kidney diseases, and digestive diseases[12]. In Bangladesh, the lack of awareness about AMR remains a pressing concern with limited understanding among the general population and healthcare practitioners about the responsible use of antibiotics. Overuse and misuse of antibiotics are very common practice here that lead to the development of antibiotic-resistant strains of bacteria[13]. In the absence of comprehensive public health campaigns and educational initiatives, Bangladesh is facing a rapidly escalating AMR crisis, characterized by high and increasing antibiotic consumption, rising resistance across major pathogens with serious outcomes especially in children[14]. The followings are overt scenarios relating to AMR in Bangladesh[15,16].

Antibiotic use and misuse: There is alarming antibiotic consumption rate per 1,000 people/day (55.5 defined daily doses in 2021, against global median of 16.6) including heavy use of broad-spectrum (3rd generation cephalosporins, e.g., cefixime, ceftriaxone, fluoroquinolones, and nitroimidazoles accounted for almost 33% of total use by 2022) "Watch" antibiotics according to WHO AWaRe classification.

Rapid increase in resistance: Institute of Epidemiology Disease Control and Research (IEDCR) reports a 11% rise in overall resistance over 5 years (2017–2023) including a huge drop of efficacy of several common antibiotics from 71% to just 18–29%, with linezolid resistance reaching 70% in ICUs and 82% outside hospitals.

High resistance in key pathogens: Multidrug-resistant uropathogens (*E. coli*- 74%, *Klebsiella* ~49%, *Enterococcus* ~95%) and food-derived from livestock/poultry contains ~37% *Salmonella* with resistance ranging from 4% (neomycin) to 81% (tetracycline).

High pediatric mortality: Studies from Dhaka show 29% mortality in children with bacteremia was caused by antibiotic-resistant gram-negative bacteria, a five times higher than non- bacteremia cases.

Environmental and veterinary risks: AMR spreads from informal veterinary use, heavy antibiotic application in livestock, weak regulations, and poor waste management. Antibiotic residues in water bodies (rivers, soil) create ecosystems that select for resistant bacteria, amplifying the health threat. Bangladesh has taken following initiatives to address AMR[14,15,16].

AMR surveillance network: IEDCR has led nationwide, case-based surveillance through 11 sentinel hospitals and passive surveillance via 21 laboratories since 2016 and the data feed into the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) since 2019.

Regulatory action: Directorate General of Drug Administration (DGDA) has launched red-labeled antibiotic packaging (primary/secondary) and mandated prescriber-only sales since December 2022 to curb self-medication, for which compliance reached ~80% of manufacturers by January 2024.

Education and One Health approach: WHO-led campaigns reached secondary schools and healthcare providers with tools like comic books, posters, and WHO AWaRe posters to improve awareness among students. Further, integrating AMR into school curricula represents a strategic, long-term approach to empower students as advocates within their communities, cultivating a generation knowledgeable and conscientious about antimicrobial use.

National Action Plan (NAP): The AMR NAP (2017–2022) mobilized cross-sectoral training involving human health, livestock and fisheries sectors to promote and ensure rational use of antimicrobial agents. NAP initiated infection prevention and control (IPC) programs to contain the emergence and spread of AMR, though scale and institutionalization remain ongoing challenges[17].

Measures to combat AMR

Combating AMR requires a coordinated, multisectoral approach (One Health) across human health, animal health, agriculture, and the environment[1,14,17]. Figure II depicts key measures to combat AMR from the One Health perspective.

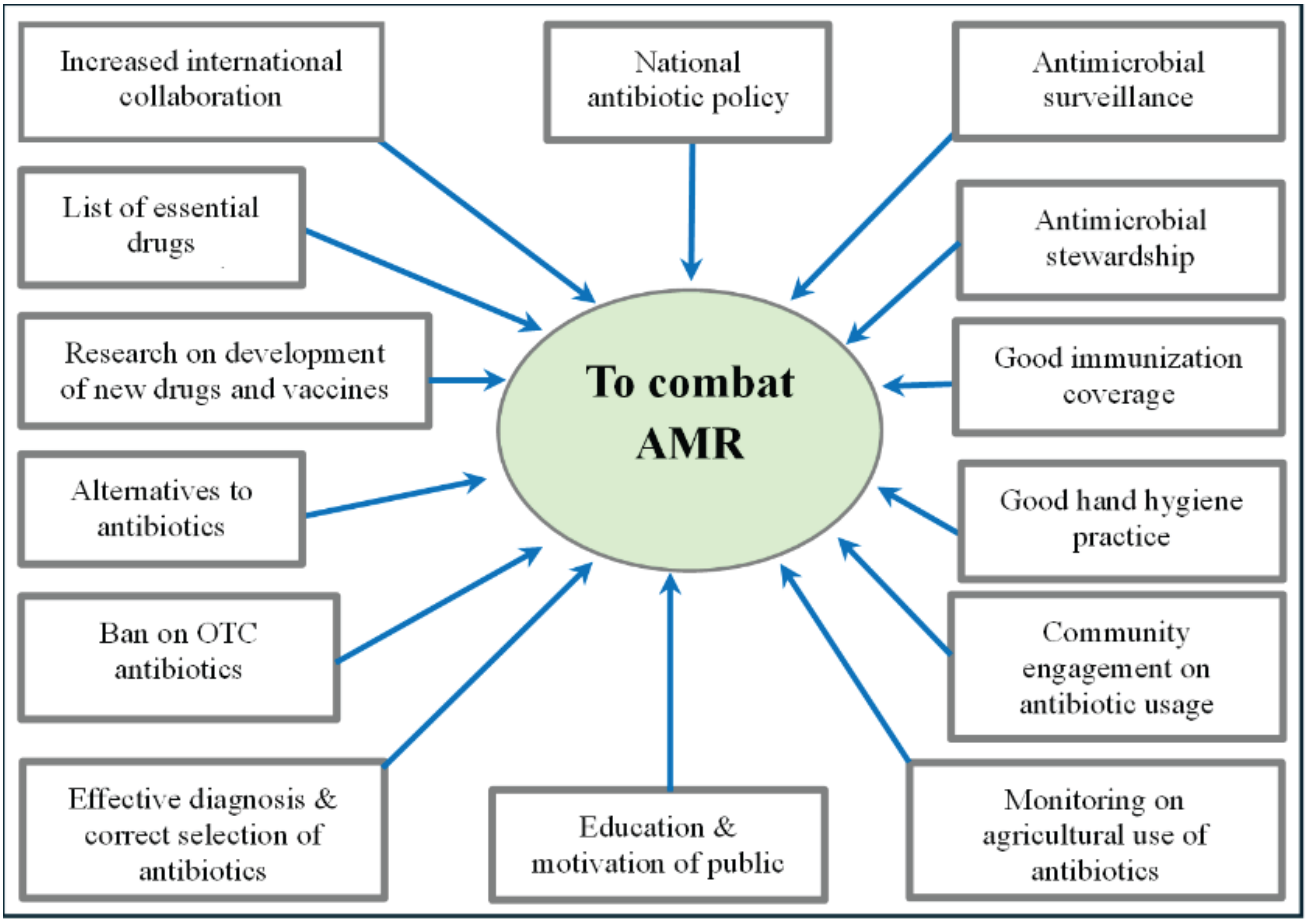

Figure II: Key measures to combat AMR in One Health perspective

Conclusion

Therapeutic options of infections caused by AMR bacteria are limited, resulting in significant morbidity and mortality with huge financial impact. The paucity in discovery and supply of new novel antimicrobials to treat life-threatening infections by resistant pathogens stands in sharp contrast to demand. The world is facing an antibiotic emergency, with devastating human costs for families and communities across the world. There is urgent calls to all sectors to take decisive action now to save lives and save modern medicine for future generations. Time is running out and it has been logically said that "if we lose antibiotics, we lose modern medicine." The scientific community has sounded the alarm for decades, now, action must catch up. AMR requires the same urgency and global coordination as climate change and pandemics. Success is still possible, but it demands political commitment by world leaders, which is vital in driving policy changes, allocating resources, and implementing initiatives to comprehensively address the AMR. The COVID-19 pandemic demonstrated that when political will, scientific innovation, and public health align, rapid progress is possible. We must harness that same urgency to address AMR. An orchestrated collaborative action within and between multiple national and international organizations is required urgently, otherwise, a post antibiotic era can be a more real possibility than an apocalyptic fantasy for the 21st century.

Abbreviations:

AMR: Antimicrobial resistance
GRAM: Global Research on Antimicrobial Resistance
LMICs: Low- and middle-income countries;
AwaRe: Access, Watch, Reserve
IEDCR: Institute of Epidemiology Disease Control and Research
ICUs: Intensive Care Units
GLASS: Global Antimicrobial Resistance and Use Surveillance System
DGDA: Directorate General of Drug Administration
NAP: National Action Plan
IPC: Infection prevention and control
OTC: Over-the-counter

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