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Global Antimicrobial Resistance: Current Burden, Key Drivers, and Strategies for Control

Ayushi Shukla* **and Avinash Tiwari**

Department of Medicine, Heritage Institute of Medical Sciences, Grand Trunk Road, Varanasi, Uttar Pradesh, 221311, India

**Corresponding author*

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A B S T R A C T

Antimicrobial resistance (AMR) is a growing global health threat that makes common infections harder to treat and increases mortality, hospital stays, and healthcare costs. It occurs when microorganisms such as bacteria, viruses, and fungi evolve to resist the effects of antimicrobial drugs. This review aims to summarise the current global situation of antimicrobial resistance, its key causes, and strategies needed to control and prevent its spread. A narrative review of literature was conducted using data from the World Health Organisation (WHO), Centres for Disease Control and Prevention (CDC), and peer-reviewed articles published between 2015 and 2025. Keywords such as "antimicrobial resistance," "global health," and "control strategies" were used to find relevant sources. The literature shows that overuse and misuse of antibiotics in humans and animals, poor infection control, and limited development of new antibiotics are the major drivers of AMR. Low- and middle-income countries face a higher burden due to unregulated antibiotic use. Controlling resistant infections depends on careful and responsible use of antibiotics at all levels of healthcare, infection prevention, public awareness, and a coordinated One Health approach. AMR is a critical threat that demands urgent global action. Strengthening surveillance, promoting rational antibiotic use, and implementing multi-sectoral policies are essential to safeguard the effectiveness of existing treatments and protect public health.

Introduction

Antimicrobial resistance (AMR) refers to the ability of microorganisms including bacteria, viruses, fungi, and parasites to resist the effects of antimicrobial agents that were previously effective against them. Moreover, the 2014 Review on AMR estimated that by 2050, drug-resistant infections could cause up to 10 million deaths per year. As a result, common infections become harder to treat, and usual antibiotics no longer work. AMR develops through genetic mutations or horizontal gene transfer and is significantly accelerated by inappropriate and excessive use of antimicrobials in both humans and animals. Globally, AMR has appeared as one of the most pressing public health challenges. The escalating prevalence of AMR threatens to reverse decades of

medical progress, making common infections difficult to treat and routine medical procedures increasingly risky.

Because this problem is not limited to one country or region, it has now become a matter of global concern. According to the World Health Organisation (WHO, 2024) around 1.27 million deaths each year are directly caused by drug-resistant infections, and many more are linked indirectly. These infections are difficult and expensive to treat, leading to longer hospital stays and a higher risk of death. The problem is worse in countries where antibiotics are easily available without prescription and infection control is weak. If not controlled, AMR can make routine medical treatments like surgeries, organ transplants, and cancer therapy much more dangerous in the future.

With the growing spread of resistance, the need for urgent and coordinated action has become more needed than ever. If antimicrobial resistance continues to rise, many common infections may once again become untreatable, leading to a situation where infections could become as dangerous as they were before the discovery of antibiotics. This would make even minor injuries or routine surgeries life-threatening.

The growing threat of AMR can undo many achievements of modern medicine, including safe childbirth, organ transplantation, and cancer therapy.

Looking at these problems, this paper focuses on understanding the global situation of antimicrobial resistance, its main causes, and the possible ways to control and prevent it.

Antimicrobial resistance is becoming a severe problem all over the world. The World Health Organisation has listed it as one of the top ten global health threats. According to their latest report, drug-resistant infections directly cause more than one million deaths every year.

Many research studies have shown that the main reasons for antimicrobial resistance are the overuse and misuse of antibiotics in humans and animals, poor infection control in hospitals, and the lack of new antibiotics. A review published in 2023 in The Lancet reported that low- and middle-income countries face a higher burden because antibiotics can be bought without prescription and surveillance systems are weak.

Multiple international reports emphasise the growing burden of AMR. The WHO identifies AMR as one of the top ten global health threats, with drug-resistant infections accounting for over one million deaths annually (WHO, 2024). Similarly, the CDC classifies AMR as an urgent public health issue, citing increased morbidity, mortality, and healthcare costs (CDC, 2024). Studies highlight that antibiotic misuse, poor infection control, and limited development of novel antimicrobials are key drivers of resistance (Laxminarayan *et al.,* 2013). Evidence suggests that low- and middle-income countries bear a disproportionate burden due to over-the-counter antibiotic sales and weak surveillance systems (The Lancet, 2023).

In India, rising resistance in E. coli and Klebsiella strains underscores the urgent need for stewardship programs. The ICMR's NARS-Net initiative aims to enhance surveillance and promote rational antibiotic use (ICMR, 2022).

These studies show that antimicrobial resistance is a growing problem worldwide and in India. Understanding these findings helps to find critical areas where strategies can be used to control and prevent AMR.

Materials and Methods

This narrative review was conducted using electronic databases including PubMed, Google Scholar and official reports from the World Health Organisation (WHO) and Centres for Disease Control and Prevention (CDC). Literature publishes between 2015 and 2025 was included. Keywords used were "antimicrobial resistance," "drug resistant infections," "global burden," "one health,' and "antibiotic stewardship."

Peer reviewed articles, meta-analyses, global reports, and guidelines were included. Only English-language sources were considered. Articles unrelated to human health, editorials and opinion pieces were excluded. Findings were synthesised to highlight global burden, drivers, and evidence-based strategies to control AMR.

Results and Discussion

Antimicrobial resistance (AMR) has emerged as one of the most serious global public health threats of the 21st century, driven by complex biological, clinical, environmental, and socio-economic factors. Microorganisms develop resistance through genetic mutations, horizontal gene transfer, and biofilm

formation. Resistant pathogens such as Methicillin-resistant Staphylococcus aureus (MRSA), Extended-Spectrum Beta-Lactamase (ESBL)-producing E. coli, and carbapenem-resistant Enterobacterales highlight the rapid evolution of resistance, especially under persistent antibiotic pressure. The consequences of AMR are significant and far-reaching. Infections caused by drug-resistant organisms result in prolonged hospitalisation, higher mortality, and increased healthcare expenditure. According to the World Bank (2017), uncontrolled AMR could potentially reduce global GDP by up to 3.8% by 2050 due to productivity loss and increased economic burden on healthcare systems. Moreover, AMR threatens critical medical procedures such as chemotherapy, organ transplantation, and complex surgeries, as the absence of effective antibiotics increases the risk of secondary infections. A comprehensive strategy to combat AMR needs a One Health approach that integrates human, animal, and environmental health. Overuse of antibiotics in agriculture and livestock for growth promotion and disease prevention accelerates resistance, with resistant genes transmitted through food chains, water systems, and soil. Coordinated regulatory frameworks across medical, veterinary, and environmental sectors are essential for rational antibiotic use and responsible waste disposal. Surveillance remains fundamental to AMR containment. Global initiatives such as the WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS) and India's National Antimicrobial Resistance Surveillance Network (NARS-Net) have expanded capacity to monitor resistance trends. However, many low- and middle-income countries continue to face challenges due to limited diagnostic infrastructure, inadequate laboratory capacity, and underreporting. Strengthening surveillance and real-time data sharing can support early detection and targeted interventions. Public awareness also plays a pivotal role in reducing misuse. Misconceptions about antibiotics, self-medication, and incomplete courses contribute significantly to the burden of AMR, especially in resource-limited settings. Global initiatives such as the WHO's World Antimicrobial Awareness Week and national stewardship programs are encouraging behavioural change among healthcare workers and communities. Recent policy developments have accelerated global AMR efforts. The 2023 UN High-Level Meeting on AMR emphasised sustainable funding and international collaboration, while the European Union strengthened stewardship frameworks under the EU Pharmaceutical Strategy (2024). The United States expanded its national AMR strategy under the CARB National Action Plan (2024-2028), prioritising faster diagnostics and stewardship. In India, the NARS-Net programme has increased laboratory capacity, and updated antimicrobial stewardship guidelines (2023) support rational prescribing in hospitals. Rising resistance to carbapenems and colistin underscores the urgency for strong infection-control standards and surveillance in tertiary care facilities. Innovation is another cornerstone in combating AMR.

Traditional antimicrobial pipelines are insufficient; however, promising advances include AI-driven antibiotic discovery platforms, bacteriophage therapy, antimicrobial peptides, monoclonal antibodies, and CRISPR-based antimicrobial technologies. Several AI-identified antibiotic candidates entered early-phase testing in 2024, signalling renewed scientific momentum. Vaccination against bacterial pathogens such as Streptococcus pneumoniae and Mycobacterium tuberculosis is also gaining importance as an indirect approach to reduce the need for antibiotics. Infection Prevention and Control (IPC) remain fundamental to hospital-based AMR response. Proper sterilisation, sanitation, hand hygiene, and waste management can reduce hospital-acquired infections by 50%. Implementation of Antimicrobial Stewardship Programs (ASPs) ensures rational prescribing practices, antibiotic audits, and continuous monitoring of drug use.

In summary, addressing AMR requires a sustained global effort combining policy reform, robust surveillance, public health infrastructure, research investment, and multi-sectoral collaboration. Although considerable progress has been made, persistent gaps in diagnostics, funding, awareness, and access to quality antimicrobials demand urgent and coordinated action to preserve the effectiveness of life-saving antibiotics and protect future generations.

Prevention and Strategies

Effective AMR prevention requires coordinated multi-sector strategies aligned with global public health frameworks. Key priorities include:

- Strengthening antimicrobial stewardship programmes in all healthcare settings.
- Enforcing prescription-based antibiotic dispensing and monitoring agricultural antibiotic use.
- Expanding diagnostic capacity and rapid point of care testing to guide targeted therapy.

- Enhancing vaccination programmes to reduce infection burden and antimicrobial dependence.
- Promoting community awareness on responsible antibiotic use and adherence.
- Improving hospital infection-control practices, including hand hygiene, sanitation, and waste management.
- Supporting global and national surveillance networks for timely monitoring of resistance trends.
- Investing in research innovation and incentivizing pharmaceutical development of new antimicrobials.

Collaborative policy implementation across human, veterinary, and environmental sectors is essential for sustainable AMR control.

In conclusion, antimicrobial resistance is a serious global problem that is becoming worse every year. It is caused by misuse and overuse of antibiotics, poor infection control, and the lack of new medicines.

Controlling it requires careful use of antibiotics, better infection prevention, public awareness, and coordinated action at local, national, and global levels. Urgent efforts are needed to prevent resistant infections from becoming untreatable and to protect public health for the future.

Conflict of Interest

The authors declare no conflict of interest

Author Contributions

Ayushi Shukla: Investigation, formal analysis, writing—original draft. Avinash Tiwari: Validation, methodology, writing—reviewing.

Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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