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27.3 Antimicrobial Resistance

Vidya Krishna

Antimicrobial resistance (AMR) is an important global health challenge of the 21st century. In line with noncommunicable diseases and climate change, the World Health Organization (WHO) has listed AMR as one of the top 10 major threats facing mankind. AMR has assumed epidemic proportions and is expected to kill 10 million people annually by 2050. 85% of global infectious disease mortality is attributable to common infections such as pneumonia, diarrhea, measles, malaria, human immunodeficiency virus (HIV), tuberculosis (TB), and resistance is a significant problem in most of these infections. Rising AMR along with poor infection-prevention practices is a double-edged sword, and the effect can be compounded in crisis situations such as epidemics and pandemics.

Antimicrobial resistance can lead to:

- Difficult-to-treat infections
- Prolonged hospital stays
- Increased treatment costs
- Poor treatment outcomes, especially in surgical and cancer patients
- Increased mortality
- Increased need for interventions such as drainage or surgery to control infections
- Further spread of AMR due to poor clearance of resistant bugs from patients (increased infectiousness).

DEFINITION

Antimicrobial resistance refers to the ability of a microorganism to resist the action of a previously sensitive antimicrobial agent and survive the exposure.

Antimicrobial resistance is an inevitable effect of bug–drug interaction on a repeated or prolonged basis. When antibiotics are used to treat infections, they cause "collateral damage" to the normal human microbiota. Also, antibiotics kill susceptible agents and select for resistant bugs to survive and multiply (selection pressure).

Antimicrobials are used widely in hospitals to prevent or treat infections. They are also used in animal-rearing industries to preserve animal health by preventing or treating zoonoses and as growth promoters in subtherapeutic levels. Curtailing inappropriate exposure of antimicrobials in healthcare and animal agriculture is vital to controlling the increasing rates of AMR.

SURVEILLANCE AND BURDEN OF ANTIMICROBIAL RESISTANCE

Global

The Global Antimicrobial Resistance and Use Surveillance System (GLASS) was launched by WHO in 2015. It has expanded its scope to include surveillance of AMR in bacteria, invasive fungal infections, antimicrobial consumption (AMC), and a "One Health Surveillance" model relevant to human health. More than 120 countries, territories, and areas (CTAs) participate in the surveillance. The latest GLASS report 2022 informs on the AMR and AMC surveillance data for the year 2020, and it emphasizes the high rates of AMR in bloodstream infections and carbapenem usage, especially in low- and middle-income countries (LMICs). It also reports the inequalities in testing coverage and laboratory quality across the CTAs.

As per 2024 estimates, 4.95 million deaths were associated with bacterial AMR, of which 1.27 million were directly attributable to antibacterial resistance. An annual increase in mortality by 6.75% is expected, with an estimated 1.91 million deaths per year by 2050. The global incidence of AMR is highest in South Asia, Southeast Asia, and sub-Saharan Africa. The United Nations General Assembly (UNGA) leaders have pledged for a drop in AMR-related mortality by 10% by 2030.

India

The Indian Council of Medical Research (ICMR) established the Antimicrobial Resistance Surveillance and Research Network (AMRSN) in 2013, which included 20 regional centers and 7 nodal centers. Based on antimicrobial susceptibility testing (AST) and molecular studies on resistant pathogens, the network reports on the emerging resistance trends in India.

The *National Antimicrobial Resistance Surveillance Network* (NARS-Net) is a Government of India initiative to combat AMR and is coordinated by the National Centre for Disease Control (NCDC). As of June 2024, the network covers 60 state medical college laboratories in 27 states and 6 union territories. These sentinel sites report data on bacterial identification and antibacterial susceptibility testing (AST) for nine priority pathogens from five specimen sites (blood, urine, pus, sterile body fluids, and stool). These data are published on the NCDC website and submitted to WHO–GLASS.

In India in 2019, there were 297,000 deaths attributable to AMR and 1,042,500 deaths associated with AMR. India has the 60th highest age-standardized mortality rate per 100,000 population associated with AMR across 204 countries. The number of AMR deaths in India is higher than deaths from neoplasms, respiratory infections, TB, enteric infections, diabetes, kidney diseases, and maternal and neonatal disorders.

MECHANISMS OF RESISTANCE IN BACTERIA

Bacteria have natural and acquired mechanisms by which they develop resistance to antibiotics **(Table 1)**.

- *Intrinsic resistance:* This refers to the inherent ability of the pathogen to resist the action of an antibiotic, irrespective of prior exposure, due to structural or functional characteristics.
- *Acquired resistance:* Bacteria can acquire resistance to antibiotics after exposure to the agents through genetic mutations or through acquired genetic material from other pathogens. *Chromosomal mutation* can occur de novo in bacteria after antibiotic exposure, leading to altered protein synthesis, which may affect the antibiotic target site and make it ineffective. *Horizontal transfer of genetic material* between bacteria can occur via transformation (direct uptake from the environment), transduction (bacteriophage mediated), or conjugation (plasmid mediated).

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Siddarth Ramji MD ICMR-Dr CG Pandit National Chair and Former Director–Professor, Department of Pediatrics and Neonatology, Maulana Azad Medical College, New Delhi, India, is an eminent Neonatologist, Academician, and Researcher; his primary interest has been perinatal asphyxia, neonatal resuscitation, and low birth weight. He has been involved in pioneering research in neonatal resuscitation. He has several honors for his credit and has over 100 research publications. He has been on several task forces and committees that have been involved in formulating Neonatal Health Policy in India. He has also served as the Chair/Member of WHO technical groups and Data Safety Monitoring Boards of multi-country trials.



Rakesh Lodha MD Professor, Department of Pediatrics, All India Institute of Medical Sciences, New Delhi, India, is an acclaimed Intensivist and Researcher and leads the pediatric intensive care unit. His interests include pediatric intensive care, pulmonology, and infectious diseases. He has conducted multiple clinical trials/research studies. He has more than 600 publications in indexed journals. He is interested in teaching research methods. He is also the Editor of Indian Journal of Pediatrics; an Associate Editor of Indian Pediatrics; and an Associate Editor of National Medical Journal of India. He has been involved in various public health programs globally and nationally. He has also served as the Chair/Member of various WHO technical groups.



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