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Editorial

Antimicrobial Resistance in India: The Critical Need for Integrated Systemic Action

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Antimicrobial resistance (AMR) has emerged as one of the most pressing public health challenges facing India. Unlike infectious disease outbreaks that rapidly capture public attention, AMR advances silently, progressively diminishing the effectiveness of life-saving antibiotics and threatening the very foundation of modern medicine. Routine surgical procedures, cancer chemotherapy, organ transplantation, neonatal intensive care, and the management of critically ill patients all depend on effective antimicrobial therapy. As resistance continues to increase, treatment failures, prolonged hospitalizations, escalating healthcare costs, and preventable deaths are becoming increasingly common. The Institute for Health Metrics and Evaluation (IHME) estimates that more than 290,000 deaths annually in India are directly attributable to AMR, highlighting its growing significance as both a healthcare crisis and a national security concern [1,6].

Behind every resistant pathogen is a patient whose treatment options have narrowed, a family facing mounting emotional and financial burdens, and a healthcare system struggling to preserve the effectiveness of its remaining therapeutic arsenal. AMR is therefore no longer merely a microbiological challenge; it is a clinical, economic, environmental, and societal emergency demanding immediate and coordinated action.

The clinical reality: Resistant pathogens in Indian hospitals

Evidence generated through the Indian Council of Medical Research (ICMR) Antimicrobial Resistance Research and Surveillance Network demonstrates a steady decline in antimicrobial susceptibility among major bacterial pathogens across India [3,4].

Among the Enterobacteriaceae, *Escherichia coli* and *Klebsiella pneumoniae* continue to exhibit alarmingly high resistance to third-generation cephalosporins and carbapenems. National surveillance data indicate that susceptibility of *E. coli* to cefotaxime has declined to only 15.8%, while *K. pneumoniae* demonstrates merely 20–24% susceptibility to third-generation cephalosporins. More concerning is the situation in tertiary-care intensive care units, where carbapenem susceptibility among *K. pneumoniae* has fallen to approximately 22–25%, making empirical antimicrobial therapy increasingly unreliable and significantly increasing the risk of treatment failure and mortality [4].

The therapeutic outlook is even more concerning for non-fermenting Gram-negative pathogens. *Acinetobacter baumannii* now demonstrates 91% resistance to meropenem, leaving only a limited number of last-line therapeutic options, including colistin, which still retains approximately 97% susceptibility, and newer antibiotics such as cefiderocol. However, increasing dependence on these reserve agents inevitably threatens their long-term effectiveness [4,6]. Similarly, *Pseudomonas aeruginosa* continues to exhibit multidrug resistance, further complicating the management of healthcare-associated infections.

The growing threat is not limited to bacteria. Multidrug-resistant *Candida auris* has rapidly emerged as an important nosocomial fungal pathogen. National surveillance data indicate fluconazole susceptibility of only 40.8%, while early resistance to echinocandins has also been reported, suggesting that even the final line of antifungal therapy is beginning to erode [4].

Among Gram-positive organisms, methicillin-resistant *Staphylococcus aureus* (MRSA) now constitutes nearly 53% of *S. aureus* isolates reported through national surveillance. Consequently, clinicians increasingly rely on glycopeptides such as vancomycin and teicoplanin, together with oxazolidinones such as linezolid. Although these agents continue to maintain excellent in vitro activity, the emergence of heteroresistant vancomycin-intermediate *S. aureus* (hVISA) serves as an early warning that resistance continues to evolve even against our most dependable therapies [1,4].

Collectively, these resistance trends translate into longer hospital stays, higher treatment costs, increased intensive care admissions, and avoidable mortality. In a healthcare system where a substantial proportion of medical expenses are paid out of pocket, AMR has evolved from a microbiological issue into a major socioeconomic challenge.

Structural bottlenecks and environmental amplification

India's AMR crisis extends well beyond hospitals and is driven by several interconnected systemic factors. The continued empirical use of broad-spectrum antibiotics, often necessitated by delayed microbiological confirmation, remains a major contributor to resistance. Although Schedule H1 regulations were introduced to restrict over-the-counter sales of critical antibiotics, enforcement remains inconsistent, particularly in rural and semi-urban regions [1,2].

Another major limitation is inadequate access to rapid and affordable diagnostics. Delays in pathogen identification and antimicrobial susceptibility testing frequently compel clinicians to initiate empirical therapy, increasing unnecessary antimicrobial exposure and accelerating the emergence of resistant organisms. Expanding access to rapid molecular diagnostic technologies must therefore become a national priority [2,5].

Environmental contamination has emerged as an equally important driver of resistance. Pharmaceutical manufacturing effluents, untreated hospital wastewater, municipal sewage, and agricultural runoff continuously introduce antimicrobial residues and resistant microorganisms into aquatic ecosystems. These environments function as reservoirs for resistant bacteria and facilitate horizontal transfer of clinically significant resistance determinants, including blaNDM-1. Consequently, AMR should be viewed not only as a healthcare challenge but also as an environmental and ecological crisis requiring coordinated multisectoral intervention [1,2,6].

Policy Evolution: From NAP-AMR 1.0 to NAP-AMR 2.0

Recognizing the growing threat of AMR, India introduced the National Action Plan on Antimicrobial Resistance (NAP-AMR) in 2017, establishing the country's surveillance framework and promoting antimicrobial stewardship. Building upon this foundation, the recently launched National Action Plan on AMR 2025–2029 (NAP-AMR 2.0) represents a significant evolution in national strategy [2].

The revised policy adopts a comprehensive One Health framework by integrating the human, animal, agricultural, fisheries, and environmental sectors. Under the leadership of NITI Aayog, more than twenty ministries and government departments are now expected to develop measurable action plans supported by dedicated budgets, timelines, and accountability mechanisms. This transition represents an important shift from voluntary coordination toward structured implementation.

NAP-AMR 2.0 also expands surveillance beyond healthcare institutions by introducing systematic monitoring of antimicrobial residues in pharmaceutical waste, hospital effluents, municipal wastewater, livestock production, aquaculture, and agricultural environments. Such integrated surveillance recognizes that resistant pathogens and resistance genes move freely across human, animal, and environmental interfaces and therefore require equally integrated control strategies [2].

Translating policy into clinical practice

While national policies provide strategic direction, meaningful progress will ultimately depend on implementation within healthcare institutions. Every hospital should establish multidisciplinary Antimicrobial Stewardship (AMS) committees responsible for evidence-based prescribing, antimicrobial auditing, and restriction of unnecessary use of antibiotics classified under the WHO AWaRe Watch and Reserve groups. Strengthening diagnostic stewardship through rapid molecular diagnostic platforms can substantially reduce inappropriate empirical therapy by enabling earlier pathogen identification and targeted treatment [2,5].

Hospitals should also generate standardized, hospital-specific antibiograms at least every six months to guide empirical prescribing based on local resistance patterns. Equally important is sustained investment in microbiology laboratories, workforce training, external quality assurance, standardized reporting systems, genomic surveillance, and wastewater-based AMR monitoring. These components should be recognized as essential elements of patient care rather than optional laboratory services.

Conclusion: A Present Emergency Demanding Immediate Action

Antimicrobial resistance is no longer a distant scientific concern—it is an unfolding clinical emergency that threatens every advance achieved by modern medicine. India has established a robust policy framework through NAP-AMR 2.0, strengthened surveillance through the ICMR AMR Network, and embraced the One Health approach. However, policies alone cannot preserve antibiotic effectiveness. Their success depends upon sustained implementation, political commitment, institutional accountability, scientific innovation, and responsible antimicrobial use across all sectors.

The opportunity to preserve the effectiveness of existing antibiotics is rapidly narrowing. Without decisive action, India risks entering a post-antibiotic era in which common bacterial infections, routine surgical procedures, neonatal care, organ transplantation, and cancer chemotherapy become substantially more hazardous. Protecting these life-saving medicines requires coordinated action from clinicians, microbiologists, researchers, policymakers, regulatory agencies, environmental authorities, industry, veterinarians, and the public alike.

Only a comprehensive One Health approach—integrating antimicrobial stewardship, rapid diagnostics, surveillance, environmental protection, research, innovation, and responsible antimicrobial use—offers a sustainable pathway to contain antimicrobial resistance and safeguard the future of modern medicine.

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