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LETTER TO THE EDITOR

Antimicrobial Resistance (AMR) Prevention is a Shared Responsibility: Superbug Menace is a One Health Challenge

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Dear Editor,

Apropos your timely and highly relevant editorial [1], one critically important but often underemphasized area in India's antimicrobial resistance (AMR) crisis is its environmental dimension. The menace of multidrug-resistant "superbugs" is not merely a clinical or prescribing issue; it represents a profound *One Health* challenge linking human health, animal health, agriculture, and also our interaction with the larger environment.

AMR is frequently attributed to irrational antibiotic use — such as self-medication, overprescribing, and incomplete treatment courses. While these factors are significant, growing scientific evidence demonstrates that the environment plays a major role in the emergence, amplification, and dissemination of resistant organisms [2]. As rightly pointed out in the editorial, antibiotics and resistant bacteria do not remain confined to hospitals or households. They circulate through sewage, wastewater, rivers, soil, agricultural fields, and even air, creating reservoirs where resistance genes can persist and evolve [2].

A major driver is inadequate liquid waste management in healthcare facilities. Hazardous liquid biomedical waste from intensive care units, operation theatres, mortuaries, and laboratories is often discharged into municipal sewage systems without adequate on-site effluent treatment. At the same time, wastewater from patients often contains both unmetabolized antibiotic residues and resistant bacteria. Together, these biologically rich effluents become a favourable medium for the survival and exchange of resistance genes among microbes [3].

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Urban sewage treatment plants, many of which operate sub optimally, receive mixed effluents from households, hospitals, slaughterhouses, and industries. When treatment is incomplete, antibiotic residues and resistant organisms enter surface waters and groundwater. Even low concentrations of antimicrobials exert selective pressure, enabling bacteria to acquire and exchange resistance genes, thereby transforming treatment plants into resistance-amplification hubs [4].

Pharmaceutical manufacturing units represent another ignored critical concern. Industrial effluents may contain high concentrations of active drug compounds. When these are discharged without proper treatment in to the environment, the residues contaminate soil and water bodies, exposing environmental microbes to sustained antibiotic pressure. This resistance can then enter the food chain through contaminated irrigation water, crops, fish, livestock, and ultimately humans [5].

Improper disposal of unused and expired antibiotics further compounds the problem as mentioned in the editorial. Medications discarded into household garbage, sinks, or toilets leach into landfills, soil, and water systems, maintaining low-level environmental antibiotic exposure. These residues persist in soil microbiomes, where resistance genes can be transferred to human and animal pathogens, creating long-term ecological reservoirs of resistance [6].

Environmental co-selection agents such as heavy metals, biocides, pesticides, and microplastics contribute significantly to antimicrobial resistance by exerting selective pressure on microbial populations. These agents often co-select for antibiotic resistance genes located on mobile genetic elements, enabling the persistence and spread of multidrug-resistant organisms even in the absence of antibiotic exposure. Microplastics further facilitate biofilm formation and horizontal gene transfer in aquatic and terrestrial ecosystems, reinforcing environmental reservoirs of resistance [7].

Thus, AMR must be recognized not merely as a clinical failure but as an environmental governance challenge. Effective mitigation requires strengthening hospital effluent treatment systems, enforcing stringent regulation of pharmaceutical and industrial discharges, upgrading sewage treatment infrastructure, promoting safe antibiotic disposal practices, and ensuring rational antimicrobial use across human and veterinary medicine. Without safeguarding environmental pathways, improvements in prescribing practices alone will be insufficient to curb antimicrobial resistance.

While current awareness campaigns represent a positive and necessary first step, substantial and sustained efforts will be required to achieve meaningful and long-term impact.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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