Priorities for the Environmental Dimension of Antimicrobial Resistance in India

POLICY BRIEF

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The present state of environmental antimicrobial resistance (AMR) in India, and a road map for the way forward

Importance of environment in AMR control

Environmental health plays an important role in preventing the spread of many infectious diseases, including the spread of antimicrobial-resistant (AMR) bacteria. For this reason, AMR has been recognized as 'One health', owing to its linkages with human health, animal health, and the environment. Water and soil are the major environmental reservoirs and modes of transmission of AMR bacteria in humans and animals. Water (groundwater and surface water), especially, is getting more attention for spreading antibiotic-resistant bacteria (ARBs) and antibiotic-resistant genes (ARGs). AMR bacteria from various sources, like pharmaceutical effluents, biomedical waste and effluents, litter and manure from poultry and livestock farms, aquaculture, plant agriculture, household sewage, and slaughterhouse waste either directly contaminate the aquatic environments or contaminate the soil (Figure 1). AMR bacteria present in the soil is eventually transferred to surface water through runoff or groundwater through leaching. Again, the resistant bacterial strains get transferred to crops and vegetables through this contaminated water and soil. The subsequent consumption of drinking water and food or contaminated surface water leads to human morbidity and mortality. Further, these resistant bacteria can be transmitted to the human population and other animals through environmental pathways. Therefore, environment should be the focal point towards containing AMR. In developing countries like India, where the burden of infections is very high, environmental health can be maintained through the prudent use of antibiotics, improved water, sanitation and hygiene (WASH), waste management, and food safety.

Present state of knowledge and gaps on the environmental dimension of AMR in India

The understanding that environment plays a pivotal role in both the development of resistance among bacteria and their transmission has gradually developed. The major sectors contributing to antibiotic pollution and AMR have now been identified through different national-level initiatives and research conducted by various institutes. Researchers have also identified the resistance patterns of many bacteria to different antibiotics, even for the last-resort antibiotics. Based on these studies and other national-level initiatives, it has become possible to identify some of the major bacterial species to be considered for regular surveillance in AMR-related studies. Though the importance of environment in the transmission of AMR bacteria is clear, many other dimensions still need to be explored and ascertained. Accordingly, researchers are trying to explore the role of the environment in the genetic evolution of resistant bacteria, the drivers augmenting the evolution, evaluate the risk for human and animals' health, and identify suitable interventions to optimize the impact of AMR bacteria.

Policies, programs, regulations and guidelines related to environment and AMR

Given the seriousness of the problem of AMR, the sixty-eighth World Health Assembly (WHA) came up with the Global Action Plan on AMR (GAP-AMR) in 2015. This action plan streamlined the major objectives and outlined the activities to be adopted by the nations. In addition, the WHA also urged the member-states to develop their National Action Plan on AMR (NAP-AMR) in line with the GAP-AMR. In keeping with the same, India developed the National Action Plan on AMR in April 2017. India's NAP-AMR focuses on followimg six strategic priorities — (i) improving awareness and understanding of AMR through effective communication, education, and training; (ii) strengthening knowledge and evidence through surveillance; (iii) reducing the incidence of infection through effective infection prevention and control; (iv) optimizing the use of antimicrobial agents in health, animals, and food; (v) promoting investments for AMR activities, research and innovations; and (vi) strengthening India's leadership on AMR. In addition to this, several other policies, guidelines, and programs related to human health, animal health and the environment were introduced at the national level.

In the environmental sector, national programs, regulations and guidelines such as Swachh Bharat Mission, 2014, the Biomedical Waste (BMW) Management Rules, 2016, and the MoEF&CC guideline, 2020 are developed that mandate the residual limit of antibiotics in the pharmaceutical effluents. In addition, a collaborative platform called 'Responsible Antibiotic Manufacturing Platform (RAMP)' has been recently lauched in India by Stockholm International Water Institute (SIWI) and Shawview Consulting. The RAMP platform aims to fight against AMR by reducing antibiotic emission from the manufacturers. In this regard Shawview Consulting and SIWI have developed the action plan in collaboration with the state governments and industries. In the latest '*Sameeksha*' (review) on antimicrobial resistance by World Health Organization (WHO), India, *E. coli* has been designated as the potential indicator for the surveillance of AMR in the environment. However, it is observed that these regulations are currently focused on residual antibiotics in the effluent streams of the antibiotic manufacturing facilities and not addressing the issues of AMR contamination in effluents in the sectors where antobiotics are used e.g., households, livestock and aquaculture farms, vetenarary facilities etc.

In the human health sector, the National Programme on AMR Containment by the National Centre for Disease Control (NCDC), the Antimicrobial Stewardship Program (AMSP), 2018, the Treatment guideline for Antimicrobial Use in Common Syndromes (ICMR), 2019, and the National Guidelines for Infection Prevention and Control in Healthcare Facilities, 2020, have been implemented. Likewise, in the animal health sector, the Coastal Aquaculture Authority (CAA) guideline on antibiotic use, the National Policy for Containment of Antimicrobial Resistance, 2011, the National Animal Disease Reporting System (NADRS), 2014, the National Residue Control Plan (NRCP), and the Pre-harvest testing (PHT) by Marine Products Export Development Authority (MPEDA), the Indian Network of Fisheries and Animal Antimicrobial Resistance (INFAAR) in 2018 have been developed and implemented.

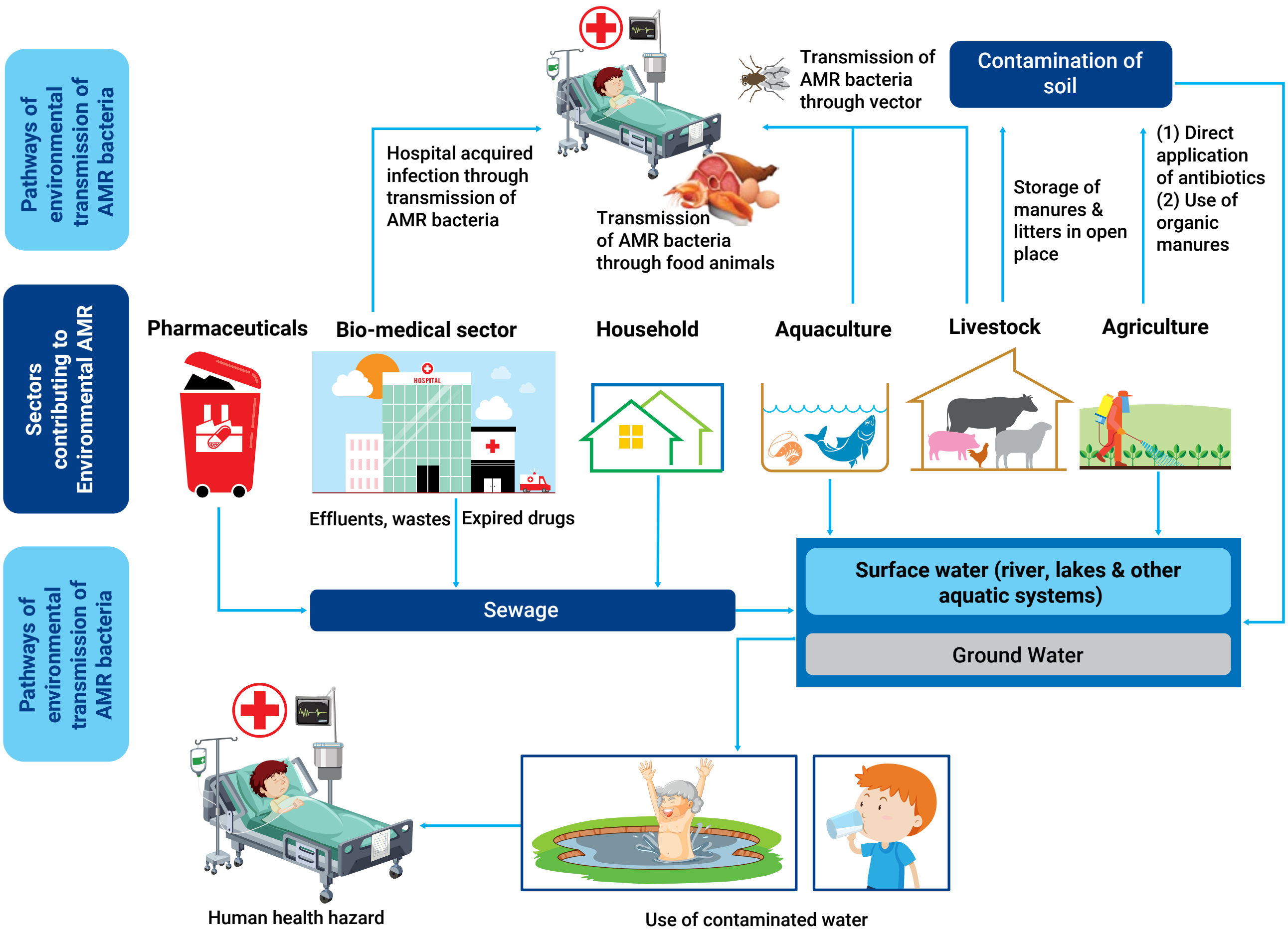

Figure 1: Rationale for selecting different domains for searching AMR literature

In the animal health sector, the Coastal Aquaculture Authority (CAA) has banned the use of twenty antibiotics and pharmacologically-active substances in aquaculture. The Drug and Cosmetics Rules, 2012, emphasizes labeling withdrawal periods on medicine being used for treating animals. The National Policy for Containment of Antimicrobial Resistance focuses on the development of suitable protocols for antibiotic use in food animals, to regulate the use of non-therapeutic antibiotics in animals, and to control the selling of antibiotics, especially Schedule H1, without prescriptions issued by registered practitioners. Under the National Animal Disease Reporting System (NADRS) surveillance program, different animal diseases in India can be monitored and collected. The MPEDA has developed the National Residue Control Plan (NRCP) and Pre-harvest testing (PHT) of antibiotic residues in exportable aquaculture products to EU countries. The Export Inspection Council (EIC, 2011 and 2019) has surveillance over antibiotic residues in animal food, especially milk and honey. INFAAR was introduced in 2018 with the aim to generate data on AMR as well as to describe the spread of resistance.

Table 2: Recommendations on mainstreaming environment in NAP-AMR strategies

Strategic Priorities of NAP	Recommendations
Improve awareness and understanding of AMR through effective communication, education and training	• Capacity building of State Pollution Control Boards in terms of number of resources and their skillsets to carry out AMR monitoring. • Awareness generation amongst the affected communities, e.g., farmers, livestock farm owners/operators on benefits of non-antibiotic growth promoters, adverse impacts of AMR bacteria on livestock health, human health, good practices on disposal of dead animals.
Strengthen knowledge and evidence through surveillance	• Development of guidelines field testing and monitoring of residual antibiotic in effluent streams – mass balance of antibiotic traces in effluent streams, LC-MS and fiber optic sensor technology. • Enhanced and evidence-based surveillance of impacts of presence of residual antibiotics in flora, fauna and humans.
Reduce the incidence of infection through effective infection prevention and control	• Inclusion of regulations on collection, segregation, handling and treatment of end-of-life antibiotics, residual antibiotics, ARBs, ARGs in environmental effluents in existing environmental rules (e.g., solid waste management and biomedical waste management rules).
Optimize the use of antimicrobial agents in health, animals and food	• Enforceable regulations to ban OTC sale of antibiotics (e.g., prohibitive penal clauses in the regulations). • Promote alternatives to antibiotics in livestock and aquaculture.
Promote investments for AMR activities, research and innovations	• Enhanced private sector participation (e.g., the pharmaceutical majors, companies with large agriculture value chain etc) in AMR prevention – e.g., developing laboratory testing infrastructure. • Government incentives (e.g., subsidies) on use of non-antibiotic growth promoters. • Development of environmental standards for residual levels of antibiotics in different environmental pathways e.g., at the inlet and outlets of CETPs, dischargeable limits at the factory outlets for pharmaceuticals, dead livestock, rural waterbodies in and around livestock farms etc. • Development of remediation guidelines for residual antibiotics in both soil and water.
Strengthen India's leadership on AMR	• Collaborative approaches amongst Department of Environment (State Pollution Control Boards), Department of Animal Husbandry, Dairying, & Fisheries Organizations, Department of Agriculture & Farmer Welfare and Public Health • Promote judicious consumer practice as a part of Responsible Antibiotic Manufacturing Platform.

Major challenges in containing AMR in the context of environment

Programmatic

- The existing policies on environment do not include aspects of AMR, similarly the health policies do not cover environmental pathways of AMR
- Inadequate regulations on OTC sale of antibiotics
- Inadequate capacity with the environmental regulators (in terms of resources and skill sets) to develop and implement guidelines around prevention of AMR in environmental streams
- Inadequate healthcare infrastructure compared to the magnitude of infections
- Lack of institutional guidelines for rational antibiotic use in healthcare settings.

Water Treatment & Sanitation

- Poor WASH system allows indiscriminate mixing of disposed end of life antibiotics in the effluent streams

Soil Testing and Treatment

- Inadequate soil testing guidelines for detection of residual antibiotics in soil
- No standards around soil remediation for residual antibiotics

Waste handling and Disposal

- Injudicious handling of antibiotics waste in terms of collection, segregation, treatment and disposal
- Poor management of collection, segregation, treatment and disposal of antibiotics in the solid waste/municipal waste

Technological

- Lack of laboratory-based strong surveillance on AMR.
- Methods of measuring traces of antibiotics in different environmental streams, guidelines on allowable thresholds, instrumentation needed for such measurements etc. are either not clearly laid out in any environmental standards or not field tested for validation and large-scale adoption.
- Lack of innovation on cost-effective alternatives to antibiotic growth promoters.
- Lack of technology for attaining Zero liquid discharge of effluents (ZLD) from antibiotic manufacturers.
- Inadequate technical standardization of laboratory cultures and biomarkers to assess the need of antibiotic administration.

Institutional

- Lack of research and development on monitoring and containing AMR in different environmental streams.
- Absence of collaboration amongst Departments of Environment (State Pollution Control Boards), Department of Animal Husbandry, Dairying, & Fisheries Organizations, Department of Agriculture & Farmer Welfare and Public Health
- Inadequate awareness amongst farmers on use and benefits of non-antibiotic growth promoters and adverse impacts of AMR bacteria on human health.

Financial

- Absence of incentivization (e.g., subsidies) mechanism to take up costlier alternatives to antibiotic growth promoters leads to rampant use of antibiotics in livestock and aquaculture sectors

Major challenges to containing environmental AMR in India

Containing environmental AMR in countries like India is an extremely challenging endeavour, where the huge burden of infection is being managed with limited healthcare resources. The major challenges identified through the scoping review are presented in Table 1.

A road map for the way forward

As the health system comes under the purview of the state government, it is often difficult to allocate funds separately for the implementation of national policies managing various other schemes. Therefore, a liaison between the authorities at the state and national levels is the primary requisite for addressing AMR. Specific committees that include representatives from the different governmental departments, practitioners, farmers' associations, and institutes may be constituted at the state-level, to make concerted efforts in addressing the knowledge gaps from the grass root level (practitioners and farmers) to the higher level (policymakers). Such a bottom-up system will also ensure that policies formulated at the higher level can percolate to the lower level. As the 'One health' approach requires interlinking of sector-specific issues of human, animal, and environmental health, there may be a steering committee governed by a national-level administrator, with representation from the sector-specific committees at the state level, to address sector-specific issues and develop suitable policy intervention and governance. The policies should focus on certain short term and long term action points as listed below:

The short-term action points include:

Institutional and regulatory strengthening for improved effluent treatment and handling in sectors

Inclusion of Residual Antibiotic Management in Environmental policies and guidelines from the perspective of both manufacturing and use of antibiotics

Provision of subsidies or incentives to farmers for encouraging them to adopt alternatives to antibiotic growth promoters

Enhanced participation of pharmaceutical companies towards sustainable antibiotic manufacturing practices

The long-term action points include:

Rational use of antibiotics both in humans and animals

Multisectoral engagement for tracking and collection of AMR data from human health, animal health and the environment, using the ‘One Health’ approach

Development of strong surveillance to monitor the antibiotic residues and transmission of AMR bacteria from healthcare facilities, pharmaceutical effluents, food animals, water etc.

Promotion of more research and technological innovation to optimize the use of antibiotics in certain sectors as well as to reduce the incidence of AMR

Making the engagement of microbiologists and environmental specialists in the sectors contributing to environmental AMR mandatory, for time-to-time monitoring and reporting of the resistance patterns of the different bacteria in the environmental samples

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