

Antimicrobial Resistance in India: Bridging the Gap Between Policy and Practice Through a One Health Approach

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ABSTRACT

A big and growing concern for public health around the world is antimicrobial resistance (AMR). India is a low- and middle-income country with a lot of infectious diseases and AMR makes it harder to stop and cure infectious disease making it a major concern again. India is facing more problems than other countries because of widespread misuse of antimicrobials, inconsistent enforcement of rules, and problems with the health system. India has come up with a detailed policy approach to this problem called the National Action Plan on Antimicrobial Resistance (NAP-AMR). The latest version of the World Health Organisation's Global Action Plan NAP-AMR 2.0 (2025–2029) contains the One Health strategy. But even all of these couldn't regulate it very well, which shows the contrast between what the policy says and what it does. This review not only compiles existing knowledge regarding the prevalence and dissemination of antimicrobial resistance (AMR) in India but also enumerates the primary factors contributing to resistance in humans, animals, and the environment. This review tries to evaluate the progress, milestones, and shortcomings of national AMR strategies. The study demonstrates the significance of an integrated national action plan by coordinating epidemiological data with policy responses, clarifying the importance of implementation and the challenges that remain. The summary highlights the most crucial gaps and steps that need to be taken to make sure that policy pledges really help public health. To bridge the gap between policy and practice in India, we need long-term political commitment, cooperation across sectors, greater leadership, and systems of accountability.

KEYWORDS

Antimicrobial resistance, One Health, National Action Plan, Antimicrobial stewardship

INTRODUCTION

When germs like bacteria, viruses, fungi, and parasites start surviving drugs that used to kill them, this is called Antimicrobial Resistance (AMR). It's a huge problem as treatments stop working, illnesses last longer, and, unfortunately, more people die. The World Health Organisation (WHO) lists AMR as one of the biggest threats to public health today, warning us about its wide-ranging impact on society and the economy.(1)

In India, the situation is especially challenging. India faces a significant challenge with infectious diseases, and antibiotics are used quite freely, not just for people, but also in animals and farming.(1,2) You can get antibiotics over the counter pretty easily(3), and doctors don't always prescribe them the same way.(4) Plus, there aren't always enough resources for proper diagnosis, and infection control measures aren't always up to the mark. To tackle these problems, the Indian government rolled out the National Action Plan on Antimicrobial Resistance (NAP-AMR) to bring some structure to the fight against

resistance.(5) But even with these policies in place, resistant infections keep going up, which makes you wonder how well these plans are actually being put into practice. This review takes a closer look at the scale of the problem, the reasons behind AMR in India, how the policies have changed over time, and where there are still gaps that need to be addressed.

Burden and Epidemiology of Antimicrobial Resistance: Back in 2019, about 4.95 million deaths worldwide were linked to bacterial antimicrobial resistance (AMR), and around 1.27 million of those were directly caused by resistant infections. If things don't change, some experts believe AMR could be responsible for as many as 10 million deaths each year by 2050, with low- and middle-income countries likely to bear the brunt of the problem.(6)

India is a major contributor to this global AMR crisis. Reports from organisations like the Indian Council of Medical Research (ICMR) and the National Centre for Disease Control (NCDC) show that resistance among

common bacteria is still worryingly high. For example, *Escherichia coli* and *Klebsiella pneumoniae* are often resistant to third-generation cephalosporins, and there's a growing issue with carbapenem resistance in *Klebsiella*, *Acinetobacter baumannii*, and *Pseudomonas aeruginosa*, especially in large hospitals and ICUs.(7) Methicillin-resistant *Staphylococcus aureus* (MRSA) also continues to be a problem, although some recent data suggest a slight drop in certain areas, which is possibly a sign that targeted efforts are making a difference.(8) Many hospital-based studies in different parts of India have shown significantly higher mortality among patients infected with multidrug-resistant (MDR) and extensively

drug-resistant (XDR) organisms, particularly in intensive care settings.(9) But other studies show not only that humans have resistance but also that resistant organisms have been isolated from food-producing animals, aquaculture systems, and environmental samples, highlighting the interconnected nature of AMR across sectors. This substantial and multisectoral burden underscores the urgency for coordinated national action.(10) Table 1 highlights why AMR represents a critical public health challenge and summarises key indicators of the antimicrobial resistance burden globally and in India.

Table 1: Burden of Antimicrobial Resistance: Global and Indian Context

Indicator	Global estimates	India-specific evidence
AMR-associated deaths	4.95 million deaths annually	India is among the highest contributors globally
AMR attributable deaths	1.27 million deaths	High mortality from MDR/XDR infections in ICUs
Common resistant pathogens	<i>E.coli</i> , <i>Klebsiella</i> , <i>S. Aureus</i>	High resistance to cephalosporins and carbapenems
Healthcare impact	Prolonged hospital stays, higher costs	Increased ICU mortality and length of stay
One Health burden	Human-animal-environment interface	Resistant organisms in livestock and the environment

The multisectoral burden of AMR will also lead to economic and health system burden. Globally, a significant economic loss due to drug-resistant infections was already estimated by the World Bank.¹¹ These losses are due to increasing healthcare expenditure, reducing labour productivity, and negatively affecting livestock and food security and this economic loss impact most to the low and middle-income countries like India the most. AMR has the potential to push millions into extreme poverty by increasing out-of-pocket health spending and prolonging illness-related work absenteeism. In healthcare settings, resistant infections are associated with longer hospital stays, increased need for intensive care, and the use of more expensive second- and third-line antibiotics, placing additional strain on already resource-constrained health systems. From a broader economic perspective, antimicrobial resistance threatens the sustainability of advances in modern medicine, including surgery, cancer chemotherapy, organ transplantation, and neonatal care, thereby undermining progress toward universal health coverage. These rising economic and system-level costs reinforce the urgency for effective implementation of national and global AMR containment strategies.(11,12)

Drivers of Antimicrobial Resistance in India: Several factors, which range from individual behaviour to larger systemic issues, are the main contributors to the ongoing problem of antimicrobial resistance (AMR) in India. In the healthcare sector, it's common for doctors to prescribe antibiotics without always following standard treatment guidelines, and broad-spectrum antibiotics are often used as a first line of defence, sometimes without even confirming what kind of infection a patient has. Surveys show that a significant number of people in hospitals receive antibiotics, frequently without lab tests to back

up the decision.(4) On top of that, the fact that antibiotics are easy to buy over the counter in many places means people in the community can use them inappropriately.(3) Weak infection control practices like inconsistent hand hygiene, overcrowded wards, and a lack of proper isolation spaces make it easier for infections (and, by extension, resistant bacteria) to spread. In many rural and smaller healthcare settings, limited access to diagnostic tools means doctors often have to guess and treat based on symptoms rather than solid evidence, which only adds to the problem. Over-the-counter availability of antibiotics without a prescription further fuels inappropriate use at the community level.(3) Inadequate infection prevention and control measures, including poor hand hygiene, overcrowding, and limited isolation facilities, increase infection transmission and antimicrobial consumption. Diagnostic constraints, especially in peripheral and rural healthcare settings, lead to reliance on empirical therapy rather than targeted treatment.(10)

In animal husbandry and agriculture, antimicrobials are frequently used for disease prevention and growth promotion, often without veterinary supervision. Studies from India have demonstrated high levels of resistance among bacterial isolates from poultry, livestock, and aquaculture, reflecting selective pressure from antimicrobial use. Environmental contamination from pharmaceutical manufacturing effluents, hospital waste, and agricultural runoff introduces antimicrobial residues into soil and water, thereby facilitating the emergence and spread of resistant organisms. These interconnected drivers necessitated a comprehensive, multisectoral policy response.(13) Table 2 summarises the major drivers of AMR.

Table2: Major Drivers of Antimicrobial Resistance in India (One Health Perspective)

Sector	Key drivers	Example in the Indian context
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Human health	Irrational prescribing, OTC antibiotic sales, and poor IPC	Empirical broad-spectrum use, overcrowded hospitals
Animal health	Non-therapeutic antimicrobial use	Poultry, livestock, and aquaculture antibiotic use
Agriculture	Prophylactic and growth promotion use	Feed additives and farm-level misuse
Environment	Pharmaceutical and hospital effluents	Antibiotic residues in water and soil
Health systems	Limited diagnostic and regulatory	Reliance on empirical therapy

Rationale for National Policy and Action Plan on AMR

The scale and complexity of AMR in India highlighted the limitations of fragmented and sector-specific interventions, which proved inadequate against the multisectoral threat.(1) Before the introduction of a national action plan, AMR-related activities from 2000 to 2010 were largely confined to isolated surveillance efforts by institutions like the Indian Council of Medical Research (ICMR) and lacked coordination across sectors. Recognising AMR as a national priority amid rising multidrug-resistant infections, India developed the National Policy for Containment of Antimicrobial Resistance in 2011, which laid the groundwork by emphasising surveillance, rational use and research, but fell short on implementation due to weak enforcement mechanisms, followed by the launch of the first National Action Plan on AMR (2017–2021).(7,9) This plan was aligned with the WHO Global Action Plan on AMR, which expanded efforts to 29 AMR surveillance laboratories and a pilot antimicrobial stewardship program. Still, it struggled with inconsistent state-level adoption and limited one-health integration.(8)

So to overcome all these, the updated NAP-AMR 2.0 (2025–2029) was formulated to address gaps identified during the initial phase, including weak intersectoral coordination and limited monitoring mechanisms.(5) Aligned with the WHO Global Action Plan, NAP-AMR 2.0 adopts a One Health approach and outlines six strategic objectives: improving awareness, strengthening surveillance, reducing infection incidence, optimising antimicrobial use, promoting research and innovation, and strengthening governance. The policy framework reflects an understanding that AMR is not solely a biomedical issue but a systemic problem requiring coordinated action across human, animal, and environmental health domains.(13,14)

Implementation Achievements under NAP-AMR

India’s AMR initiatives have yielded several notable achievements. National surveillance networks coordinated by NCDC and ICMR have expanded from 10 labs in 2017 to over 30 across multiple states by 2025, generating standardised resistance data on important pathogens like E.coli, Klebsiella and Staphylococcus aureus from multiple states to inform policy and treatment.(7,8) Increase in these labs for surveillance was a great initiative, but along with this, AMR surveillance networks have implemented uniform protocols for antimicrobial susceptibility testing, quality control, and data reporting, enhancing data consistency and trustworthiness across states. Data generated through these surveillance platforms have been increasingly utilised to inform national standard treatment guidelines, identify priority pathogens, and guide antimicrobial

stewardship initiatives, thereby strengthening the link between surveillance and clinical decision-making.(7) Ongoing feedback to labs and regular training initiatives have bolstered technical capacity while enabling data-driven revisions to national and institutional treatment guidelines. Antimicrobial stewardship programs have been introduced in select tertiary care hospitals, and national standard treatment guidelines have been disseminated. Awareness campaigns, including annual World Antimicrobial Awareness Week activities since 2015, have increased visibility of AMR among healthcare professionals and the public.(5,8) Importantly, AMR containment has been formally extended beyond human health to include animal health, agriculture, and environmental sectors under the One Health framework.(13) These achievements collectively demonstrate substantial progress in bolstering India’s AMR response, especially in surveillance enhancement, public awareness, and institutional capacity, while underscoring the need for broader scaling and sustained integration.

Persistent Gaps and Challenges

Despite policy advancements, significant gaps remain, undermining India’s AMR containment efforts. Implementation varies widely across states, with southern states like Kerala and Tamil Nadu, while many northern and eastern states lag due to limited technical and financial capacity at district and peripheral levels. Surveillance systems are fragmented, and data integration across human, animal, and environmental sectors remains inadequate, leading to incomplete national resistance maps and delayed outbreak responses. Enforcement of regulations governing antibiotic such as Schedule H1 restrictions on sale and use, is weak, particularly in the private healthcare sector(14), but another important reason for antibiotic resistance is that over-the-counter dispensing continues unabated due to lax pharmacy oversight and profit incentives.(3) Antimicrobial stewardship programs are unevenly implemented and largely confined to large hospitals, leaving primary and secondary care settings underserved. One more important challenge because of restricted access to affordable broad-spectrum antibiotics. Compounding this are behavioural issues, including patient pressure for prescriptions, time-pressed clinicians, and insufficient training in evidence-based antibiotic prescribing.(4)

Operationalising the One Health approach remains challenging due to siloed governance structures, limited data sharing, and differing institutional priorities. Environmental surveillance of antimicrobial residues is still in its infancy, and accountability mechanisms for policy implementation require strengthening.(12,14)

CONCLUSION

Antimicrobial resistance in India represents a complex public health challenge that persists despite the presence of a comprehensive policy framework. While NAP-AMR 2.0 provides a strong strategic foundation and reflects a clear commitment to AMR through a One Health approach, translating policy commitments into effective action remains the key challenge. But limitations in the implementation of this policy at sub national level led to a negative impact on national strategies. Sustained political will and multisectoral coordination are critical to ensuring consistent implementation across diverse health system settings. System-level strengthening, expanding antimicrobial stewardship beyond tertiary care, improving access to diagnostics, and addressing behavioural drivers of inappropriate antibiotic use are essential to curb the emergence and spread of antimicrobial resistance. The success of India’s response to AMR will depend on strong policy, its implementation and monitoring progress with adapting interventions to local contexts. Ultimately, closing the policy and practice gap will determine India’s success in overcoming the AMR threat.

RECOMMENDATIONS

Here are some recommendations at different levels which we help us in giving future direction to solve this problem.

1. Health System Strengthening (14)

As NAP-AMR focuses more on tertiary care, but in low-middle countries like India, primary health centres and subcentres are the first contact point for the majority of the population, so strengthening AMR action at the Primary Health Care Level is the need of the hour. The other important concern is that diagnostics for AMR are emphasised, but cost and access are under-addressed, and AMR data exists but is not embedded into routine decision-making. For all of these, we need to create state-level AMR budget lines, and hence AMR indicators should be included in health sector financing reforms.

- a) Integrate antimicrobial stewardship principles into Ayushman Bharat–Health and Wellness Centres, now termed Ayushman Arogya Mandir (AAM).
- b) Develop simplified antibiotic prescribing algorithms for PHC doctors and nurses.

- c) Mandatory AMR modules in Family Medicine and Community Health training
- d) Subsidised rapid diagnostic test at the district hospital
- e) Expand microbiology labs under NHM funding
- f) Incorporate AMR indicators into HMIS and IDSP

2. Regulatory Enforcement: (15,16)

As already discussed, schedule H1 exists, but pharmacy oversight is weak and irrational prescribing of antibiotics and over-the-counter availability of antibiotics are major issues.

- a) Strengthen enforcement of prescription-only antibiotic sales, particularly in the private healthcare sector and retail pharmacies
- b) Enhance pharmacist-focused regulation and capacity building
- c) Strengthen legal and ethical frameworks governing antimicrobial use

3. One Health Implementation: (12,13)

As AMR is involved in the multisectoral burden, establishing integrated One Health surveillance platforms so that AMR data from the human, animal and environmental sectors can be managed using common indicators, an interoperable IT system and well-defined governance frameworks.

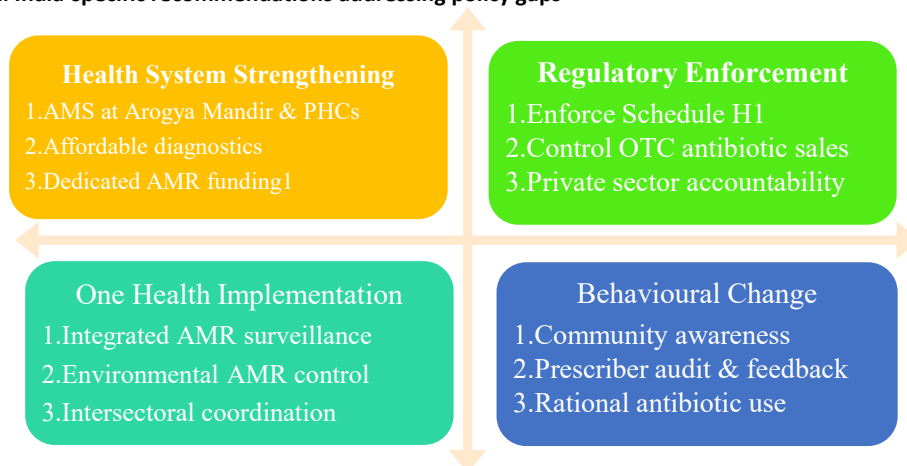
- a) Institutionalise an integrated One Health surveillance platform
- b) Reinforce intersectoral governance mechanisms

4. Behavioural Change and Social Interventions: (17,18)

AMR policies give us surveillance and a one-health approach, but behavioural determinants of antibiotic misuse remain unaddressed. In the community, antibiotics are used even in common febrile illnesses and discontinuing that antibiotics once symptoms improve, both these practices are frequently driven by misconceptions and due to a lack of education regarding it. These behaviours contribute significantly to selection pressure and the emergence of resistant organisms, particularly in primary care and community settings.

- a) Tackle behavioural drives of irrational antibiotic use by awareness activity through ASHA and ANM
- b) Promote rational prescribing among clinicians by using audit- feedback mechanisms and proper training of evidence-based antibiotic prescription

Figure 1: India-specific recommendations addressing policy gaps



Bridging the gap between policy and practice will require strengthening antimicrobial stewardship across all levels of care, enforcing prescription-only antibiotic sales, and expanding access to quality diagnostics. Integrated surveillance platforms encompassing human, animal, and environmental health are essential. Capacity building at state and district levels, greater engagement of the private sector, and sustained investment in research and innovation are critical. Robust monitoring and evaluation mechanisms under NAP-AMR 2.0 should be leveraged to ensure accountability and measurable progress.^{1,5}

AUTHORS CONTRIBUTION

All authors have contributed equally.

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