

Charting the Course

Analysis of India's state-level policies to counter Antimicrobial Resistance (AMR)



The forgotten pandemic of antimicrobial resistant pathogens

Antimicrobial resistance (AMR) silently threatens global health, resulting in an estimated 4.95 million deaths worldwide and 1.04 million deaths in India in 2019. ⁽¹⁾ AMR poses a significant global threat to human and animal health, plant life, ecosystems, and the attainment of Sustainable Development Goals (SDGs). In our interconnected world, antimicrobial resistance can proliferate across humans, animals, plants, and the environment, necessitating a "One Health" approach. It can also spread between geographies, facilitated through tourism, migration, or trade.

A 2016 report documented that India accounts for 3% of the global consumption of antimicrobial and ranks fourth in the world, following China (23%), the United States (13%), and Brazil (9%).⁽²⁾ In India, there were 297,000 deaths attributable to AMR and 1,042,500 deaths associated with AMR in 2019.⁽³⁾ The most recent global surveillance report from 65 countries, which examined antimicrobial consumption for the year 2015, did not include data from India due to the absence of surveillance data on consumption.⁽⁴⁾

Implementation status of India's National Action Plan on Antimicrobial Resistance

A National Task Force on AMR Containment was constituted in 2010 formulated the first national policy on AMR containment in early 2011. In the same year, the National Programme on AMR Containment under the Twelfth Five-Year Plan (2012–2017) was also established. In 2012, the Indian Council for Medical Research (ICMR) launched the National Program on Antimicrobial Stewardship and Prevention of Infection and Control. The National AMR Surveillance Network was established by ICMR in collaboration with the National Centre for Disease Control in 2013.⁽⁵⁾

Recognizing the urgency of the issue, India launched the National Action Plan on Antimicrobial Resistance (NAP-AMR, 2017–2022) and followed it with the Delhi Declaration on AMR during the Inter-ministerial Consultation on AMR in April 2017. The NAP-AMR called for the development of state action plans for antimicrobial resistance containment (SAP-CAR).⁽⁶⁾ However, as various domains like health, agriculture, food, and the environment are primarily governed by individual states, inter-sectoral collaboration was envisioned as the path forward.⁽⁷⁾ The responsibility of creating SAP-CARs lay with the states, emphasizing

commitment to tackle AMR through the One Health approach. Despite this roadmap, only four states have developed SAP-CARs or equivalent action plans addressing AMR. ^(8,9) As India embarks on revising NAP-AMR 2.0 (10), it is crucial to understand why most states have not adopted SAP-CARs.

Considering this, this policy brief seeks to address two fundamental questions. First, what critical components need revision in the NAP? Second, why have only four states adopted SAP since the launch of the National Action Plan in 2017?

We undertook an extensive literature review spanning from 2017 to August 2023 to identify current gaps in knowledge. We conducted in-depth interviews with national and state-level officials to understand their perspectives and concerns about formulating SAPs. Based on these findings, this policy brief provides revisions and recommendations for improved adoption of NAP-AMR 2.0. Using the One Health framework to comprehensively address AMR in human-animal systems, we present recommendations for national and state governments to leverage existing policies, institutions, and systems to advance AMR containment.

Current strategies and implementation of policy to contain AMR in states

HSTP conducted a review of NAP-AMR 2017 followed by in-depth interviews with the experts. We enquired about the reasons for the lack of adoption and the deterrents in the NAP. We grouped responses received under three broad heads: governance mechanism of NAP-AMR; strategies adopted under NAP-AMR and the progress made so far; challenges and loopholes encountered in implementing NAP-AMR at the national and state levels.

Governance Mechanism of NAP-AMR

The Ministry of Health and Family Welfare (MoH&FW) notified three governance mechanisms for the formulation of NAP-AMR in 2017: an Intersectoral Coordination Committee (ICC-AMR), a Technical Advisory Group (TAG-AMR), and a Core Working Group (CWG-AMR). Notably, there are no representatives from academia or research institutes that encompass veterinary and environmental sciences (see Box 1). This under-representation extends to the formulation and implementation of the NAP as well.

Box 1: Three Committees constituted to design the roadmap of AMR control in India (2017-2022) Inter-sectoral Coordination Committee (ICC-AMR)

The ICC-AMR comprises a 13-member committee, with the Secretary of the Ministry of Health and Family Welfare (MoH&FW) serving as the chairperson. Its composition includes one member from various ministries and departments, such as the Department of Animal Husbandry, Dairying and Fisheries (DADF), Department of Health Research (DHR), Indian Council of Medical Research (ICMR), Department of Biotechnology (DBT), Council of Scientific & Industrial Research (CSIR), Ministry of Food Processing Industries, Ministry of Environment, Forest and Climate Change, Department of Pharmaceuticals, Ministry of Information and Broadcasting, Ministry of Finance, and MoH&FW.

Technical Advisory Group (TAG-AMR): The TAG-AMR consists of a 31-member committee co-chaired by the Director General of Health Services from MoH&FW, the Secretary of DHR, and the Director General of ICMR. Among its 31 members, 21 (68%) represent various aspects

of human health, including clinical and non-clinical faculties of Medical Colleges. Only one member each is designated from other ministries, such as the Food Safety and Standards Authority of India (FSSAI), Ministry of Environment, Forest and Climate Change, Department of Agricultural Research and Education, Ministry of Information and Broadcasting, and Department of Biotechnology.

Core Working Group (CWG-AMR): Comprises a 24-member committee, with 50% representation by experts from medicine and public health. These committees lack representation from animal, wildlife, agriculture and plant health since early discussions.

Source: Ministry of Health & Family Welfare (PH Division) Office Order (File No. Z.18025/9/5/2021-NCDC/AMR Government of India, available at: <https://ncdc.mohfw.gov.in/WriteReadData/l892s/22411472661632383405.pdf>

Box 2: Achievements of NAP-AMR under six strategic heads

We identify progress made under the six strategic priorities under NAP-AMR.

Strategy 1: Awareness & understanding-Communication & IEC and education and training:

Fragmented efforts have been made by Government of India and academic institutes for creating awareness among general public regarding appropriate use of antimicrobial. For instance, World Antimicrobial Awareness Week is celebrated from 18th- 24th November every year to raise community awareness. Similarly, Guru Angad Dev Veterinary & Animal Sciences University (GADVASU) in Ludhiana of Punjab released an 'Awareness Guide on Antimicrobial Resistance' under the aegis of ICAR on 2nd April 2023. Though these individual efforts have been made but studies re-iterate the findings that awareness about the usage of antimicrobial especially when to prescribe- remains low in India.⁽¹¹⁻¹³⁾

Strategy 2: Knowledge & evidence: Surveillance of AMR for human health is done through three large AMR networks which collect data from tertiary hospital settings:

- i. The National Programme on Containment of Antimicrobial Resistance (AMR) is implemented under the supervision of the National Centre for Disease Control (NCDC). NCDC gathers data from a network of approximately 60 tertiary hospitals. The data collection process relies on WHONET, a standalone open-source Windows-based software.
- ii. The Hospital Acquired Infection (HAI) Surveillance Network stands as a collaborative initiative involving the All-India Institute of Medical Sciences (AIIMS), New Delhi, the US Centers for Disease Control and Prevention (CDC), and the Indian Council of Medical Research (ICMR). The primary objective of this network is to enhance the national capacity for monitoring HAIs. To facilitate this, the network has developed a web-based tool for streamlined data collection.
- iii. The Indian Council of Medical Research (ICMR) has been operating the Antimicrobial Resistance Surveillance Network (AMR-SN) since 2013. This network relies on an in-house web-based solution to collect, manage, and analyse data from a widespread network spanning 30 public tertiary care hospitals, along with select private hospitals and laboratories across India. In the realm of animal health: The Indian Network for Fishery and Animal Antimicrobial Resistance (INFAAR) was established in 2017. Its primary functions involve the collection of samples from both terrestrial and aquatic animals, isolation of target bacteria, determination of AMR patterns, and comprehensive reporting. Notably, the targeted pathogens under INFAAR's purview

include *E. coli*, *Staphylococcus*, *Klebsiella*, *Salmonella*, *Pseudomonas*, *Enterococci*, and *Campylobacter*. These samples are sourced from various animal types, including rectal swabs from pigs, sheep, and goats, cloacal swabs from poultry, milk from cattle and buffalo, and nasal swabs from pigs. INFAAR's operations encompass the collaboration of Indian Council of Agricultural Research (ICAR) Veterinary Research Institutes (9), ICAR Fisheries Research Institutes (8), and veterinary colleges (3). The results are analysed using the internationally recognized WHONET software.

Strategy 3: Infection prevention & control:

Infection, prevention and control (IPC) guidelines, National Patient Safety Implementation Framework (2018-2025), Hospital-acquired infection (HAI) surveillance network established, Training of trainers done on IPC

Strategy 4: Rationalise and optimise use: Red Line Campaign 14: MoH&FW launched Red Line awareness campaign on Antimicrobial Resistance, urging people not to use medicines marked with a red vertical line, including antimicrobial, without a doctor's prescription. antimicrobial have been included in Schedule H and H1 of the Drugs Rules, 1945 which regulate its production, sale and trade. Ban on use of streptomycin and tetracycline in agriculture with effect from 1st February 2022¹⁵, Ban on several fixed dose drug combinations in September 2018¹⁶, Ban on colistin use for growth promotion in food animals in July 2019¹⁷, Prevention of OTC sale of antimicrobial strongly enforced under SAP-AMR of Kerala¹⁸, West Bengal state health department started implementing e-prescriptions to keep track of disease and its treatment from 1st July in all medical colleges, government hospitals and 174 block PHCs.¹⁹

Strategy 5: Innovations R&D: Indian Priority Pathogen List has been developed to guide research, discovery and development of new antimicrobial. There is little progress made to incentivize development of new class of antimicrobial.

Strategy 6: Collaborations: National Collaborations: Inter-departmental- Animal and human health sides, environment, pharmaceuticals, research organizations, non-government organizations, academic institutes etc ICMR has taken initiatives to develop new drugs medicines through international collaborations in order to strengthen medical research in AMR: ICMR along with Research Council of Norway (RCN) initiated a joint call for research in antimicrobial resistance in 2017. ICMR along with Federal Ministry of Education and Research (BMBF), Germany has a joint Indo-German collaboration for research on AMR.

Current limitations in implementation: a perspective from states

1. Communication & IEC and education and training:

The literature review reveals that current initiatives aimed at addressing antimicrobial resistance (AMR) suffer from fragmentation, often being carried out on a small scale by different academic, governmental, and non-governmental organizations. Rather than embracing a holistic approach, these endeavours lack coordination. Expert opinions attribute this fragmentation to the absence of clear programmatic guidelines. Roles and responsibilities of stakeholders involved in combatting AMR remain undefined, resulting in a lack of accountability and clarity regarding the implementation of the National Action Plan on Antimicrobial Resistance (NAP-AMR).

2. Surveillance of AMR among humans and animals:

Experts and the literature review have brought to light several concerning gaps in the current approach to antimicrobial resistance (AMR) surveillance. Firstly, the network of sample collection sites and laboratories is limited in both human and animal health sectors. Comprehensive standards and guidelines for conducting AMR surveillance in these domains are lacking, as is a mechanism for collating and analysing information from multiple surveillance sources. Notably, there is an absence of community-level surveillance within the National Action Plan on Antimicrobial Resistance (NAP-AMR). While the Indian Council of Medical Research (ICMR) has made efforts to promote Antimicrobial Stewardship Programs (AMSP) in hospitals, community-based stewardship activities receive less attention.

Furthermore, the lack of action to address environmental AMR is concerning. Although the Ministry of Environment released a draft notification on antimicrobial thresholds in effluents, it has since lapsed. Reports of Active Pharmaceutical Ingredients (APIs) in rivers across India underscore the public health risks associated with environmental AMR. Additionally, while data is continuously collected under the Indian Network for Fishery and Animals Antimicrobial Resistance (INFAAR), it remains unavailable to the public, limiting actionable insights. According to expert perspectives, these challenges persist. The AMR Surveillance Network (AMRSN)

has limited representation in the Northeast region, potentially skewing the understanding of the AMR situation in the region. Surveillance of antimicrobial use is limited and often lacking in government hospitals. Efforts to improve antimicrobial prescription in the private sector, which accounts for a significant portion of healthcare, have been insufficient. Wildlife remains outside the scope of surveillance, and the absence of SAP-AMR adoption in all states hinders the expansion of laboratory networks, even though INFAAR relies on internal funding from the institutes. Addressing these gaps is imperative for effectively combating AMR in India.

3. Infection prevention and control:

The fight against antimicrobial resistance (AMR) in India faces significant challenges, as highlighted by experts and extensive literature reviews. The following are the key shortcomings:

Need for stronger and more responsive surveillance infrastructure: First and foremost, the network of sample collection sites and laboratories dedicated to AMR surveillance is severely limited, especially in both human and animal health sectors. This limitation results in incomplete data collection and an inability to comprehensively assess the AMR landscape. Furthermore, the absence of comprehensive standards and guidelines for conducting AMR surveillance exacerbates this problem, leading to inconsistencies and inefficiencies.

Great emphasis on community-level surveillance: One glaring gap within the National Action Plan on Antimicrobial Resistance (NAP-AMR) is the omission of community-level surveillance. This absence hinders our comprehension of AMR dynamics at the grassroots level, where community-based stewardship activities currently receive inadequate attention. Although the Indian Council of Medical Research (ICMR) has taken steps to promote Antimicrobial Stewardship Programs (AMSP) in hospitals, community-based initiatives remain overlooked. A Public-Private Partnership (PPP) initiative led by the state of Kerala has been taken towards achieving AMSP, which is largely hospital-based as of now. Under this initiative, AMR surveillance and Hospital-Acquired Infections (HAI) surveillance have been instituted using a hub-and-spoke approach:

blood samples are collected from sub-divisional hospitals and sent to a microbiology laboratory at the district hospital for testing. Kerala is the first state to produce antibiograms in 2021 from 18 surveillance sites in nine districts of the state. India's first hub-and-spoke approach has been implemented with some success in Kerala.(20) Samples from sub-divisional hospitals are collected and sent to the pathology or microbiology lab at the District Hospital for drug sensitivity testing. Theoretically, this strategy is designed to encompass a range of healthcare facilities, especially those on the periphery. In practice, the processes of sample collection, testing, reporting, and taking action based on data have been inconsistent and somewhat limited.

Limited focus on environmental surveillance of AMR and pathogens: The lack of action addressing environmental AMR is another significant concern. Despite the initial release of a draft notification on antimicrobial thresholds in effluents by the Ministry of Environment, it has since lapsed. Reports of Active Pharmaceutical Ingredients (APIs) contaminating India's rivers underscore the pressing public health risks associated with environmental AMR. Furthermore, continuous data collection under the Indian Network for Fishery and Animals Antimicrobial Resistance (INFAAR) remains unavailable to the public, hampering our ability to extract actionable insights from this valuable information.

Persisting Challenges from Expert Perspectives: Expert insights further underscore the prevailing challenges. The health of domesticated animals and wildlife constitutes crucial components currently absent from the AMR ecosystem. Furthermore, the failure of state-wide adoption of SAP-AMR impedes the expansion of laboratory networks, despite INFAAR's dependence on internal funding from institutes. Addressing these gaps is imperative to effectively combat the escalating threat of AMR in India.

4. Optimise and rationalise use of antimicrobial: The management of antimicrobial residues presents a multitude of challenges, as uncovered through both the literature review and insights from experts. Furthermore, while the National Action Plan on Antimicrobial Resistance (NAP-AMR)

acknowledges the need to devise a methodology for monitoring antimicrobial use, such a system is not currently in place. According to expert perspectives, despite a ban on the use of colistin as a growth promoter, weak enforcement allows its continued use for this purpose. India has few regulations concerning the use of antimicrobial in livestock management. For instance, while Maximum Residue Limits (MRLs) for veterinary drugs in animal foods exist (21-23), and the CDDEP report mentions a General Statutory Rule (GSR) 28 (E), which mandates a withdrawal period for antimicrobial used in food animals, there is limited enforcement of these rules.(24) There is a near absence of regulation over-the-counter sale of antimicrobial for animals, and the problem of rational antimicrobial usage persists in the animal husbandry sector. Additionally, regulations governing antimicrobial levels in industrial wastewater are currently inadequate. Interviews with pharmaceutical representatives have revealed that three out of five were unaware of any such legal provisions, indicating a lack of awareness and enforcement in this regard. These challenges underscore the imperative need for more robust regulations and enforcement mechanisms to effectively manage antimicrobial residues across sectors.

5. Urgent need for innovations in R&D: Both the literature review and expert insights shed light on critical challenges within antimicrobial innovation. Vaccination coverage, especially among animals, emerges as a neglected aspect requiring focused attention to curtail antimicrobial consumption. Additionally, funding for the development of a new class of antimicrobial remains limited. According to experts, the absence of new antimicrobial classes introduced since the 1980s can be attributed to several factors. Larger pharmaceutical companies have shifted their focus to developing oncology drugs and treatments for renal and hepatic illnesses, considering antimicrobial development less profitable. More than 50% of new molecules are being developed by smaller, specialized companies, often belonging to the same antimicrobial class, thereby increasing the risk of resistance development. Out of the 46 traditional antimicrobial candidates in development, only 28 target pathogens on the World Health Organization's priority list. These challenges

underscore the urgent need for innovative approaches and incentives to reinvigorate antimicrobial research and development, ensuring effective responses to evolving resistance patterns.

6. Collaborations: Efforts to combat antimicrobial resistance (AMR) in India reveal significant gaps. Although the National Action Plan on Antimicrobial Resistance (NAP-AMR) underscores the importance of collaborations among states and districts, as well as across animal, human, and environmental health sectors, such synergistic efforts are currently lacking. Bridging this gap is imperative for the comprehensive and effective management of AMR. Furthermore, the establishment of a robust surveillance network, encompassing both public and private hospitals and laboratories, emerges as a critical component in AMR management. Currently, this aspect represents a weak link in the overall implementation of strategies to combat AMR, demanding urgent attention and reinforcement to enhance surveillance efforts and strengthen the nation's response to this global health challenge.

Progress made so far in the adoption of AMR policies in States

Our interviews with state and national experts reveal that efforts to draft and implement State Action Plans on Containment of Antimicrobial Resistance (SAP-CAR) across states has seen limited progress. While all stakeholders recognized the necessity of SAP-CAR, there were several reasons for states not developing SAPs. We classify states into four distinct stages based on their development and implementation of SAP-CAR:

1. **Nominated Nodal Officers for AMR and constituted an expert committee:** In Assam, Himachal Pradesh, Punjab, Sikkim, Tamil Nadu, and Uttarakhand, AMR nodal officers have been appointed. However, no committees have been notified to advance adoption of SAP.
2. **Sensitization Workshops for Drafting SAP-CAR constituted:** Some states have initiated sensitization workshops as part of the SAP-CAR drafting process.
3. **Drafting SAP initiated:** Although several states claim to have developed drafts of SAP-CAR, these have not been shared publicly.
4. **SAP-CAR released:** Among the 28 Indian states and eight Union Territories, only

four states—Kerala (2018), Madhya Pradesh (2019), Delhi (2020), and Andhra Pradesh (2022)—have officially launched their state action plans for AMR containment in alignment with NAP-AMR.⁽⁸⁾ Notably, Kerala stands out as the sole state to release its first antibiogram for 2021, drawing on data from 18 sentinel sites. This report revealed an alarming increase in bacterial resistance to last-resort antimicrobials, such as carbapenems, across various sectors, including human health, animal husbandry, aquaculture, fisheries, and the environment. In response, Kerala enacted directives prohibiting the sale of antimicrobials without a doctor's prescription, and it even threatened to revoke the licenses of pharmacists engaged in over-the-counter antimicrobial sales.

Why have most states not adopted a comprehensive AMR policy?

The absence of SAP-CAR in all Indian states can be attributed to several critical factors. Firstly, there exists a low level of political and bureaucratic commitment to tackling antimicrobial resistance (AMR). Additionally, in most states, no state-level meetings focusing on AMR have been convened in the past year to facilitate the initiation of SAP-CAR formulation and implementation. Further complicating matters, the turnover rate among technical officers responsible for AMR at the state level is high, with personnel changes occurring every 6–8 months. This frequent turnover disrupts the continuity and progress of AMR-related initiatives. Moreover, these technical officers often handle multiple programs simultaneously, leaving them unaware of specific policies or programs at both the national and state levels. Consequently, they are ill-equipped to effectively implement SAP-CAR or advocate for it within their respective states. Additionally, inadequate communication channels between those attending national-level AMR meetings and their state counterparts result in limited knowledge transfer, further impeding SAP-CAR adoption. Lastly, many stakeholders expressed their need for technical assistance to comprehend and effectively apply the National Action Plan on AMR, highlighting the necessity for support and guidance in developing their individual state action plans.

Broad recommendations on governance of AMR control

Recommendation 1: Strengthen the governance to AMR management effective

At the governance level, a series of strategic measures must be taken to enhance the management of antimicrobial resistance (AMR) effectively.

- 1. Empower a Dedicated Agency with earmarked funds for AMR control under One Health:** To address the multifaceted challenge of AMR, it is imperative to establish a dedicated agency empowered to oversee AMR-related efforts across human, animal (including wildlife), and environmental sectors. This agency should receive adequate financial support to carry out its mission effectively. This ensures that the response to AMR is cohesive, integrated, and consistent across all relevant sectors, emphasizing the One Health approach.
- 2. Constitute of representative Working Group at National, and State Level:** A crucial step is the establishment of diverse working groups at the national level, representing various stakeholders from human, animal, and environmental sectors. These groups will be responsible for planning, coordinating, and implementing different aspects of the National Action Plan on Antimicrobial Resistance (NAP-AMR). This approach should be replicated at the state level, allowing states to adopt and execute their State Action Plans on Containment of Antimicrobial Resistance (SAP-CAR) efficiently. It promotes inclusivity and ensures that all stakeholders are actively engaged in the fight against AMR.
- 3. Develop Programmatic Guidelines and Standard Operating Principles:** To enhance clarity and streamline efforts, comprehensive programmatic guidelines should be established. These guidelines should outline stakeholder roles and responsibilities, specify timelines, and provide detailed programme

components for all six strategies outlined in NAP-AMR. Clear guidelines facilitate better understanding and alignment among stakeholders, fostering a more coordinated and effective response to AMR.

- 4. Strengthen Coordination between Central and State Entities:** Efforts to combat AMR must involve seamless coordination between central and state governments, as well as collaboration among institutions responsible for animal health, public health, and environmental protection. Improved coordination ensures that policies, initiatives, and surveillance efforts are synchronized, reducing the risk of gaps or redundancies. This interconnection is vital for the successful implementation of AMR containment strategies at all levels.
- 5. Setting up Public Private Partnership for comprehensive surveillance:** Since, prescription of more than 60% antimicrobials is attributable to private sector, it becomes important to formulate policies for involving the private sector to collect data on hospital acquired infections and antimicrobial consumption. This is an important step towards achieving antimicrobial stewardship, else it presents the skewed picture of AMR burden; more so in the absence of community based surveillance.

By implementing these governance-level strategies, India can enhance its capacity to address the growing threat of AMR comprehensively, promoting a coordinated, One Health approach to tackle this global health challenge effectively.

Recommendation 2: Enhance Technical Approaches for Strengthening NAP-AMR Strategies

At the technical level, several measures can be taken to bolster the strategies outlined in the National Action Plan on Antimicrobial Resistance (NAP-AMR). These initiatives focus on improving data collection, analysis, and intervention methods.

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- 1. Make Community-Based Stewardship the core of AMR management:** Community-based AMR stewardship is crucial to understanding the extent of AMR in local populations and implementing targeted interventions. It involves engaging with communities to assess the burden of AMR and promoting initiatives at the grassroots level to combat this growing public health concern. By involving communities directly, a more comprehensive understanding of AMR dynamics can be obtained, leading to more effective and community-specific interventions. A community-based surveillance mechanism needs to be established for both humans and animals in India. This can be done through a protocol that tests a fixed number of samples drawn from a representative population by community health workers and veterinary health workers. Laboratory technicians can additionally be assigned to collect specific body fluid samples from humans and animals in the community for further testing.
 - 2. Develop a unified dashboard and platform to monitor and report AMR among animals and humans:** The use of technology can significantly enhance the management of data related to AMR surveillance among humans, animals, and the environment. Establishing a unified platform for data collation, analysis, and interpretation is essential because data is collected through various channels and existing programs. This integrated approach streamlines data management, making it easier to track trends, identify hotspots, and respond effectively to emerging AMR threats. Additionally, linkage documents should be developed within NAP-AMR to align with parallel schemes targeting infection prevention and control (IPC), such as the Swachh Bharat Abhiyaan. This integration facilitates regular data analysis and ensures a more holistic approach to AMR containment. The reporting systems regarding human and animal health currently proceed in parallel with limited or no integration. There is a need to integrate information using networks and systems available at local, national, regional, and global levels."
 - 3. Leverage Technology for Data Management and Integration:** The use of advanced technologies like artificial intelligence (AI), machine learning (ML), and metagenomics can play a crucial role in advancing AMR dynamics within the paradigm of One Health. It can provide accurate and real-time data for developing predictive models, enabling data curation from diverse sources for analysis and for guiding policy decisions.

The real challenge for public health managers will be to consistently generate good-quality primary data on the prevalence of AMR. In the absence of primary data on antimicrobial resistance (AMR), AI can still play a crucial role in several ways. First, by developing AI algorithms that can use existing data, even when limited and scanty, to make predictions about potential AMR trends. By analysing factors like prescription patterns, clinical data, and demographic information, predictive analytics can help identify regions or populations at a higher risk of AMR development. Second, AI can enhance existing data by filling gaps or missing information. For example, it can estimate AMR prevalence in regions where data is scarce by extrapolating from available data in neighbouring areas or similar settings. Third, AI can identify potential AMR outbreaks or increases in resistance rates by monitoring various healthcare data sources, such as clinical records and laboratory reports, even without comprehensive primary data. Fourth, AI-driven simulations can be used to estimate potential AMR scenarios based on known factors, helping healthcare professionals and policymakers prepare for potential outbreaks or increases in resistance. Fifth, AI can continuously monitor various data sources, including prescription patterns, treatment outcomes, and pathogen genomics, to detect emerging resistance trends, even in the absence of extensive primary data. While AI can provide valuable insights and support in the absence of primary AMR data, the importance of comprehensive and accurate primary data can further refine AI models to pre-emptively predict, warn, and identify potential warning signs and suggest strategies to address AMR.

4. **Promote Data Sharing and Analysis:** The data collected under NAP-AMR and related programme should be made accessible to a dedicated group of experts for analysis. This step not only enhances transparency but also encourages the utilization of data for informed decision-making and policy development. Open access to data allows experts to identify patterns, emerging resistance trends, and areas in need of targeted interventions, ultimately contributing to more effective strategies for AMR containment. The lack of investment in proactively collecting data on AMR, analysing it, producing antibiograms and highlighting the implications of the detected resistance to policy makers, practitioners and the community at large is vital. This requires a dedicated budget commitment and ensuring regular capacity building of personnel, followed by careful review by decision-makers. In particular, policies to involve the private sector in collecting data and in consultations and the implementation of AMR protocols are urgently needed. To stay a step ahead of potential resistance building in next-generation antimicrobials, sentinel surveillance to detect resistance for reserve antimicrobials must be done and be made notifiable to a designated authority. Research including genomic sequencing should be added to the arsenal to identify patterns and trends in AMR. By implementing these technical-level initiatives, India can strengthen its approach to tackling AMR by enhancing data-driven decision-making, promoting community engagement, and leveraging technology for more efficient data management and analysis. These measures collectively contribute to a more comprehensive and responsive strategy for combating AMR.

How can we expedite states to adopt Action Plans to Contain AMR?

To enable states to adopt and implement State Action Plans on Containment of Antimicrobial Resistance (SAP-CAR), several policy measures can be put in place to support and guide these efforts.

1. **Provision of a Dedicated Budget for AMR Activities in State's Programme Implementation Programme (PIP):** Allocating a specific budget for AMR activities within the state's Programme Implementation Programme (PIP) is a crucial step. This dedicated financial allocation ensures that states have the necessary resources to implement SAP-CAR effectively. These funds can be used for various activities, including awareness campaigns, training of healthcare professionals, establishing surveillance systems, and promoting responsible antimicrobial use. By providing a dedicated budget, states are better equipped to prioritize and execute their AMR containment plans.
2. **Build capacity in key departments and set up a Technical Support Unit at state-level:** Sensitization workshops play a pivotal role in raising awareness among state officials, healthcare providers, and stakeholders about the importance of SAP-CAR. It can conduct these workshops at the state level and should involve the engagement of a technical support unit. The technical support unit can provide guidance, expertise, and technical assistance to states in drafting, refining, and implementing SAP-CAR. Their role is crucial in ensuring that states develop comprehensive and effective plans that align with national AMR strategies.
3. **Conduct regular state and regional-level Inter-Sectoral Meetings:** Inter-sectoral coordination and collaboration are vital for the successful implementation of SAP-CAR. Regular state-level meetings involving

representatives from various sectors, including health, agriculture, environment, and animal welfare, can help push forward the agenda of SAP-CAR implementation. These meetings provide a platform for stakeholders to discuss progress, share insights, and address challenges collectively. They also enable states to align their efforts with national priorities and strategies, fostering a more integrated and comprehensive approach to AMR containment.

- 4. Improve supply chain management of antimicrobial use across public health systems:** To enhance antimicrobial resistance (AMR) efforts in India, recommended strategies include modifying procurement systems. Critically, processes to improve access should go together with policies to ensure stewardship. Private and government hospitals and healthcare settings should be encouraged to follow stewardship practices and be monitored using an assurance system that extends beyond simple accreditation programmes. Over-the-counter (OTC) sale of antibiotics should also be considered within the private health sphere. Educating pharmacists and chemists will be vital. Together these will involve outlining guidelines for obtaining critical Watch and Reserve antimicrobials in national and state action plans. Collaboration between states, inclusion in drug procurement lists, private aggregators for low-volume antimicrobials, and ensuring stewardship practices are crucial. Monitoring and improving diagnostic facilities and surveillance for these antimicrobials are vital components to prevent future resistance.

The way ahead

To effectively combat AMR, states should align themselves with the newly launched One Health mission and special programmes. Crafting an effective One Health strategy tailored to AMR requires the integration of human, animal, plant, and environmental health. While the One Health approach applies to all AMR prevention and control endeavours, there is an urgent need to prioritize interventions most pertinent to under-resourced health settings and those serving vulnerable populations, where AMR's adverse impacts are most severe and on the rise. This involves pioneering measures for long-term security, fostering collaborative efforts, allocating resources for sustainable responses, and enhancing state and national governance and accountability. Implementing these policy measures can better prepare and support states in their

efforts to adopt and implement SAP-CAR effectively. Dedicated budgets, sensitization workshops, and inter-sectoral meetings contribute to a more coordinated, well-funded, and informed approach to combating antimicrobial resistance at the state level, ultimately contributing to the success of national AMR containment efforts. Achieving success in reducing and reversing AMR demands stringent and efficient regulation and disease-specific protocols that are implemented at the grassroots. Maintaining strict control over the types and quantities of (human, veterinary, and agricultural) antimicrobials used, needs to be bolstered with strong environmental surveillance protocols. This, in turn, provides early warnings about the proliferation of resistant microorganisms in the environment, and points to populations at risk.

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