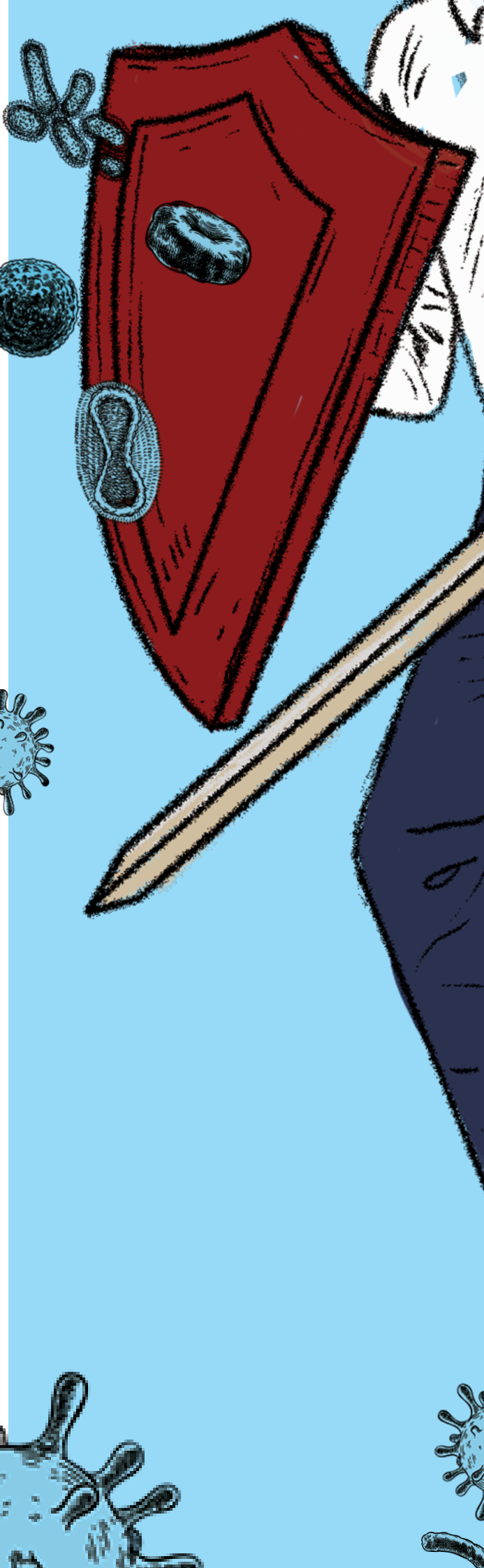
PREVENT AMR

CSE

THE WAR AGAINST AMR

A SELECTION OF OPINION PIECES BY EXPERTS PUBLISHED IN DOWN TO EARTH DURING WORLD AMR AWARENESS WEEK 2024



CSE IN WAAW 2024

THE WAR AGAINST AMR

A SELECTION OF OPINION PIECES BY EXPERTS PUBLISHED IN DOWN TO EARTH DURING WORLD AMR AWARENESS WEEK 2024

CSE IN WAAW 2024

Direction: Amit Khurana

Expert coordination and review: Rajeshwari Sinha and Neeraj Kumar

Editing: Rajat Ghai

Cover: Ajit Bajaj

Design: Ajit Bajaj, Vineet Tripathi

Citation: Collection directed and coordinated by Amit Khurana, Rajeshwari Sinha and Neeraj Kumar, 2025, *The War Against AMR,* Centre for Science and Environment, New Delhi

Compiled by
Centre for Science and Environment
41, Tughlakabad Institutional Area
New Delhi 110062
Phones: 91-11-40616000
Fax: 91-11-29955879
E-mail: sales@cseinida.org
Website: www.cseindia.org

Contents

1. AS AN INFECTION SPECIALIST, DOCTORS DIAL ME UP FOR ADVICE, SOME CALLS MAKE ME WONDER — IS NEXT PANDEMIC ALREADY KNOCKING ON OUR DOORS?

Doctors need to avoid injudicious and wanton use of antibiotics to minimise the threat posed by AMR

Benedict Sim Lim Heng

CLICK HERE TO READ ONLINE

How can this be happening!" – was the angry greeting from my neonatologist (specialist with neonatal healthcare) on a Tuesday morning a couple of years ago.

I then heard him talk about how he was struggling to save the life of a prematurely born boy, who was born six days back and had been in the neonatal ICU ever since.

Somewhere within these six days in the hospital, he had contracted a bacteria called carbapenem resistant *Enterobacteriaceae* (CRE) that was now causing sepsis (bloodstream poisoning).

The chances of a patient surviving this infection are as low as 60 per cent let alone a prematurely born infant with an undeveloped immune system.

Almost miraculously, after a month-long fierce struggle in the hospital, this boy went home alive.

A month later, a couple of twin infants, who were two weeks old, were admitted into this same neonatal ICU, both of whom had contracted another pathogenic bacteria called multi-resistant *Acinetobacter baumannii* (MRAB) sepsis.

Tragically, only one of the two infants survived.

In my 26 years as a physician in which 22 years have been spent as an infectious diseases physician in a busy tertiary public hospital in Malaysia's Klang valley, I am used to receiving many requests for consultation when it comes to pathogenic infections.

Most are routine calls from colleagues seeking advice or reassurances on recognising or managing endemic infections like HIV, TB, dengue, COVID-19, syphilis or other common bacteria or viruses.

Sometimes rare and interesting (to the extent of being exotic) germs or long forgotten infections like whooping cough, leprosy, tetanus, diphtheria rear their malicious heads.

I am grateful for the great minds of the past who had figured out these bugs and by whose training I am able to guide others on how to manage and often cure these infections.

'GUT-WRENCHING CALLS'

However, the trouble begins when gut-wrenching calls like the ones above are received. I call them gut-wrenching because CRE and MRAB are two bacteria specifically mentioned in the World Health Organization's list of 'critically prioritised bacteria' due to their ability to resist treatment and spread resistance to other bacteria – a phenomenon widely referred to as antimicrobial resistance (AMR).

In other words, these two germs occupy the top spots for being the nastiest bacteria on the planet.

I also find them gut-wrenching because it is usually the infants or the vulnerable people they infect. While every human life is precious, we would all agree that there is something intrinsic-

ally tragic when one of the weakest, most vulnerable people among us battle these nasty germs — and often lose.

What is even more alarming is that these bugs are no longer uncommon in our hospitals.

Just 10-15 years ago, CRE and MRAB would belong in the rare category I mentioned earlier. Today, they have found their way into many patients in our wards and ICUs.

Even then, there are still hallowed areas in our hospitals like the neonatal ICU and the operation theatres, that have remained largely protected from the scourge of these bugs.

Witnessing these nasty germs now cross these thresholds makes me shudder — which explains the outburst from my neonatologist colleague.

For some patients who contract these germs, even if they survive, they would be permanently scarred by the obligatory use of aggressive curative means which even includes surgeries or amputations or be left with permanently damaged internal organs.

Not to mention, a prolonged and highly expensive hospital stay.

How did we get to this state and what are the implications if this threat is left unchecked? From the earliest days of the discovery of antibiotics, it had already been recognised that bacteria are capable of evolving in the presence of antibiotics, where stronger or more 'fortunate' strains among their species are able to resist the antibiotic and propagate through selection pressure.

ANTIBIOTICS — WHEN LESS IS MORE

Thus, while antibiotics can be life and limb saving when used appropriately, doctors need to avoid injudicious and wanton use to minimise the threat posed by AMR.

In the words of Alexander Fleming, the discoverer of antibiotic penicillin himself, after receiving his Nobel Prize for discovering antibiotics – "The thoughtless person playing with penicillin treatment is morally responsible for the death of the man who succumbs to infection with the penicillin-resistant organism."

Once a resistant bacterium emerges, given the right circumstances and environment, it will spread especially to those more vulnerable.

This occurs especially so in crowded hospitals and in areas where infection prevention practices are less than perfect. Just like other infections (COVID-19, influenza, Mpox, leptospirosis), AMR also exists in animals, often being selected out in animal farming environments and from there, spreading to the human sphere, often through the food chain.

This is why today we address AMR through the lenses of 'One Health', which combines human, animal, plant and environment concerns.

One only needs a casual Google search to realise how totally life changing antibiotics have been in these last 100 years, providing the essential building blocks of modern health and allowing for the possibility and advances in surgery, chemotherapy, transplants and critical care.

The emergence and continued march of AMR threatens this very fabric of modern medicine.

Globally and locally, from governments and the United Nations down to the average human or animal health care practitioner, AMR is now being recognised for the looming disaster it threatens to be, and all of us are charged to be responsible stewards of antibiotics and prevent spread of AMR.

This battle requires the average man on the street to be thoughtful of AMR and learn necessary precautions to avoid its spread (e.g. seek advice from qualified health professionals before taking antibiotics).

We all share this responsibility to ensure antibiotics are properly stewarded and judiciously prescribed both in human as well as animal health. We owe it to our forefathers to ensure the generations to come continue to reap the benefits of these miraculous and wonderful but easily abused precious resource.

Benedict Sim Lim Heng is an Infectious Disease Consultant at Sungai Buloh Hospital, Ministry of Health, Malaysia

2. LESSONS FROM TB PROGRAMME IN ENSURING TIMELY AVAILABILITY OF NEW ANTIBIOTICS IN INDIA

Any future regulatory framework for introducing new antibiotics must closely align with the National Programme on AMR Containment

Leena Menghaney

Dusan Jasovsky

CLICK HERE TO READ ONLINE

ANTIMICROBIAL resistance (AMR) presents a significant public health challenge to governments worldwide, including India. The rise of multidrug-resistant (MDR) pathogens globally has rendered many existing antibiotics ineffective, necessitating the development and introduction of new treatment options.

Regulatory approvals for some new antibiotics may be filed before the Indian National Drug Regulatory Authority (NDRA), including for plazomicin, cefiderocol and combination drugs such as cefepime / zidebactam, cefepime / enmetazobactam, meropenem / vaborbactam, and imipenem / cilastatin / relebactam. These drugs, primarily injectable treatments, are intended for serious infections caused by multidrug-resistant bacterial pathogens.

However, the introduction of these drugs in India presents several challenges. Introduction of new antibiotics requires enhanced microbiology laboratory capacity in health facilities, trained human resources in antimicrobial stewardship, robust supply chains for timely and affordable access to new antibiotics and effective regulation of the private sector to prevent irrational use to optimise clinical outcomes as well as preserve the effectiveness of antibiotics.

Given these multifaceted concerns, there is an urgent need for a national policy framework — under the National Programme on AMR Containment, the Indian Council of Medical Research (ICMR) and the Central Drugs Standard Control Organization (CDSCO) — to ensure both access to these new antibiotics and regulation of their use in the public health system and private health sector.

This framework is essential to prevent the emergence of resistance due to irrational use, while also ensuring that patients with life-threatening infections have timely access to the treatments they need.

REGULATORY, SUPPLY FRAMEWORK FOR NEW ANTIBIOTICS

India and many other low- and middle-income countries currently lack a dedicated regulatory, supply and access framework for the introduction of new antibiotics, particularly those with demonstrated efficacy against severe bacterial infections. Such a framework is essential for making life-saving drugs available to patients, while safeguarding against irrational use and overuse.

A valuable precedent can be found in India's regulatory and supply framework for drug-resistant tuberculosis (DR-TB). When new TB drugs bedaquiline and delamanid were first registered by the US Food and Drug Administration in 2012 and the European Medicines Agency in 2014, India faced one of the highest burdens of DR-TB and many patients with extensively drug-resistant TB were dying after failing the then-available regimens.

At the time, the CDSCO and the Revised National Tuberculosis Control Program (RNTCP) allowed approval of the new TB drugs, with the condition that they could only be supplied to the

programme. These new TB antibiotics were available through RNTCP only under a conditional access programme and later rolled out more widely as part of all-oral DR-TB regimens, in line with evolving WHO guidelines.

RNTCP manages forecasting and pooled procurement through tendering at the national level for bedaquiline and delamanid, along with other DR-TB drugs. Private healthcare providers can enrol as DR-TB centres in the Programmatic Management of Drug-Resistant Tuberculosis to access these drugs for their DR-TB patients, based on drug susceptibility testing and report treatment outcomes to the RNTCP. This approach is aimed at ensuring the appropriate use of the new TB drugs minimising the risk of resistance, and providing them free of cost to DR-TB patients across the country.

Similarly, a regulatory and supply framework modelled on this approach could be adapted to introduce new antibiotics targeting acute, life-threatening infections caused by MDR pathogens.

The partnership between the NDRA and the TB programme in managing new TB drugs offers valuable insights for introducing new antibiotics to treat multidrug-resistant (MDR) infections. Acute infections caused by MDR pathogens, where reliable microbiological diagnosis is available, often demand immediate access to new antibiotics.

The TB programme's experience offers a useful model for introducing new antibiotics, but adjustments will be necessary to address the unique challenges associated with treating MDR infections in critically ill patients.

Any future regulatory framework for introducing new antibiotics must closely align with the National Programme on AMR Containment, integrating a pooled procurement and supply chain system. Such a system would accommodate the urgency of treating severe infections while ensuring proper oversight to prevent irrational use.

CLOSING THE ACCESS GAP

The recently adopted UN political declaration AMR emphasised that more people die from the lack of access to effective antibiotics than from AMR itself, yet the magnitude of the access gap remains largely unknown with limited monitoring capacities.

Furthermore, the declaration put forward the necessity for nations to coordinate efforts and take actionable steps, including by leveraging existing financial mechanisms to support global and regional access initiatives, such as SECURE — the Antibiotic Facility.

The Indian government's commitment as part of the political declaration to ensure timely and equitable access to affordable medical tools, including antimicrobials and diagnostic tests, must translate into concrete action, balancing stewardship efforts with ensuring that patients receive the necessary treatments as part of its national strategy.

As India confronts the growing threat of drug-resistant infections, it is essential for the National Programme on AMR Containment, ICMR and CDSCO to prioritise regulations that not only mitigate the risk of irrational use of new antibiotics but also ensure timely access to life-saving treatments.

By adapting the lessons learnt from the TB programme to managing MDR infections, India can strike a delicate balance between expanding access to new antibiotics and ensuring their responsible use. This approach will ultimately protect both patients and public health, safeguarding the long-term effectiveness of these essential drugs.

Leena Menghaney is a public health lawyer, currently working as global IP advisor and India head of MSF's Access Campaign.
Dušan Jasovský is a Global Health Pharmacist focusing on AMR with MSF/Doctors Wthout Borders.

3. KERALA'S 'SMART ANTIBIOTIC HOSPITAL INITIATIVE' IS A MULTI-FACETED APPROACH TO PREVENT ANTIMICROBIAL RESISTANCE

Kerala has launched a unique health initiative to ensure that antibiotic medications aren't abused at its health centres

Aravind Reghukumar

CLICK HERE TO READ ONLINE

"THE time may come when penicillin can be bought by anyone in the shops. Then there is the danger that the ignorant man may easily underdose himself and by exposing his microbes to non-lethal quantities of the drug make them resistant."

The above mentioned quote, authored by Alexander Fleming, doesn't seem to have aged well. Fleming, the renowned microbiologist and the discoverer of world's first antibiotic, the penicillin, said so as part of his lecture during his acceptance of the Nobel Prize for his pioneering achievement. What he prophesied came true.

Through unscrupulous actions, we have squandered away all most all antimicrobials and are staring at a post antibiotic era.

Antimicrobial resistance (AMR) is one of the most pressing global health challenges of the 21st century. AMR threatens to undo decades of medical progress, rendering many of the common treatments and procedures, such as surgeries, cancer treatments and organ transplants, far riskier and less effective.

The efficacy of antimicrobials is declining rapidly, alongside the emergence of pandrug resistant bacteria and uncontrolled dissemination of antibiotic resistant genes in non-clinical environments.

AMR does not only affect individual health but also has serious implications for public health systems worldwide. The problem is compounded by the fact that the development of new antibiotics and other antimicrobials has slowed dramatically, making it even more critical to prevent resistance from spreading.

Therefore, preventing AMR is not just a scientific challenge but also a moral imperative for safeguarding public health globally. This article outlines the concept of the 'Antibiotic Smart Hospital Initiative' — one of the key people-centered strategies adopted by the Kerala government for preventing AMR .

ANTIBIOTIC SMART HOSPITAL INITIATIVE (ASHI)

The Kerala government, as part of KARSAP [Kerala Antimicrobial Resistance Strategic Action Plan], took an important step in preventing AMR by launching ASHI and participatory antimicrobial stewardship.

ASHI is based on the concept that effective stewardship initiatives adopt the theragnostic model of combining antimicrobial stewardship with infection prevention and control and diagnostic stewardship. ASHI is part of the Antibiotic Literate Kerala Campaign (ALKC) which aims at engaging all stakeholders including the public in AMR mitigation efforts.

Through ASHI, Kerala has carved a template to address all strategic priorities under KARSAP.

These hospitals are actually healthcare institutions which adopt and execute a pragmatic model of antimicrobial and diagnostic stewardship while ensuring compliance with standard IPC practices.

Each of these hospitals in local self government bodies [LSGD] like panchayats act as a constant source of continuous IEC [Information, education, communication] activities to healthcare workers and public thereby fostering participatory stewardship.

Antibiotic smart primary care institutions act as the pivot and nidus for community engagement at the grassroot level.

The criteria for qualifying for the status of antibiotic smart hospitals are different for primary, secondary and tertiary care institutions based on the patient profile to which they cater and available resources.

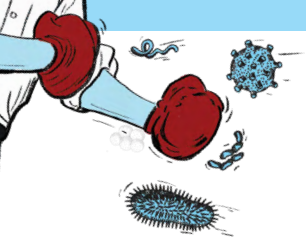
The criteria to be satisfied have been issued as two government orders to foster uniformity and standardisation across hospitals.

The table below highlights the criteria to be satisfied by hospitals in each tier to be declared as antibiotic smart. Primary care hospitals should satisfy 10 criteria and secondary/tertiary care hospitals should satisfy 15 criteria. For primary care, 95 per cent of antibiotics used in outpatient departments [OPD] should be from the access category whereas for secondary care it is 90 per cent and tertiary care 85 per cent.

CRITERIA FOR ANTIBIOTIC SMART HOSPITALS AT EACH TIER OF HEALTH CARE

	Primary care level	Secondary care level	Tertiary care level
Display of posters of AMR in Malayalam	√	√	√
All health care workers and students fully trained in AMR and IPC	√	√	√
Prescription audit quarterly	√	√	√
Antibiotics utilization metrics calculation quarterly by pharmacy	√	√	√
AWaRe metrics – ACCESS usage in OPD	95%	90%	85%
Functional HICC and AMSP committee	√	√	√
IEC for public fortnightly	√	√	√
Posters for AWaRe classification in prescribing areas	√	√	√
Certified by	NQAS (or within 1 year)	NQAS/KAYAKALP/NABH (or within 2 years)	NQAS/KAYAKALP/ NABH (or within 2 years)
Implementation of PROUD programme	√	√	√
Surgical safety checklist in surgical specialities		√	√
Prospective audit and feedback for Reserve antibiotics by AMSP team		√	√
Low hanging fruit model of AMSP		√	√
HAI surveillance		√	√
STPs (sewage treatment plants)/ ETP (Effluent treatment plants) as per the guidelines of pollution control board		√	√

As of now, two family health centres in Kerala [FHC Kakkody and Ozhalapathy] have been lauded with the status of being antibiotic smart hospitals. The remaining hospitals in the state are expected to become antibiotic smart in a time sensitive manner.



A colour grid based on a scoring system has been designed to assess the number of criteria achieved by each hospital in the state in its progress towards attaining antibiotic smart status.

Preventing antimicrobial resistance is a multifaceted challenge that requires coordinated action at local, national, and international levels. Optimising the use of antimicrobials, strengthening infection control measures, reducing the overuse of antibiotics in animal husbandry and agriculture, and fostering the development of new drugs are all essential components of a comprehensive strategy to combat AMR.

ASHI of Kerala is a unique multi-pronged approach to prevent AMR by ensuring that all tiers of hospitals in the State achieve minimum standards with respect to antimicrobial stewardship, IPC and diagnostic stewardship. Antibiotic smart hospitals also act as the pivot around which people centred participatory stewardship strategies aimed at making communities antibiotic literate are being carried out.

"A post-antibiotic era — in which common infections and minor injuries can kill — far from being an apocalyptic fantasy, is instead a very real possibility for the twenty-first century," wrote Keiji Fukuda, WHO assistant director-general for health security.

The onus is on us doctors to lead by example by practising diagnostic stewardship, IPC and antimicrobial stewardship.

As Helen Keller said "Alone we can do so little, but together we can do so much", we need to join hands in the fight against AMR, it is something that we owe to each other and to the future generations. Just like climate change, AMR is one of the most urgent and complex challenges of our time and the time to act is now.

Dr Aravind Reghukumar is head of department of Infectious Diseases at GMC Thiruvananthapuram and is also the Convenor of the Working Committee of KARSAP.

4. MOBILISING PROFESSIONAL ORGANISATIONS IN IMPLEMENTING STATE ACTION PLANS TO COMBAT AMR IS CRUCIAL

These organisations help monitor AMR trends, support guideline adherence and advocate for policies to enhance infection prevention

Sangeeta Sharma

CLICK HERE TO READ ONLINE

THE escalating threat of antimicrobial resistance (AMR) demands early education on antibiotics and infection prevention to foster responsible use. AMR is a significant global health challenge with severe implications for patient safety, economic stability and healthcare outcomes—especially in India, where high infectious disease rates, widespread misuse of antimicrobials and environmental pollution exacerbate the issue.

In India's animal agriculture sector, antibiotics are extensively used, often as growth promoters, accelerating AMR and endangering both animal and human health.

Antibiotics exemplify the tragedy of the commons, where individual misuse creates a collective problem. When antibiotics are overused or misused — whether in healthcare, agriculture, or self-medication — they lose their effectiveness for everyone as bacteria develop resistance. This selfish overconsumption depletes the antibiotic "commons," rendering these life-saving drugs less effective or even useless, thereby creating a public health crisis.

The tragedy lies in how individual actions that prioritise immediate benefits undermine the collective resource of effective antibiotics, ultimately harming global health.

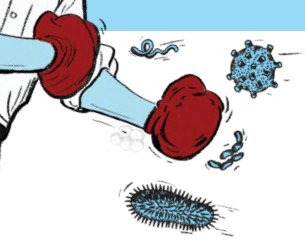
While responsible use of antimicrobials can slow AMR, misuse — such as over-prescribing and self-medication — amplifies its spread, threatening public health advancements. AMR's economic impact will disproportionately harm low-income countries, undermining efforts towards Universal Health Coverage and the United Nations-mandated Sustainable Development Goals. Urgent, coordinated global action is essential to address this pressing issue.

In response to the global AMR crisis, India launched the National Action Plan on Antimicrobial Resistance (NAP-AMR) in April 2017. Since then, six Indian states have developed State Action Plans for Containment of AMR (SAP-CAR). Effective AMR containment in India's federal system depends on strong, accountable state-level governance.

NAP-AMR sets key priorities: increasing AMR awareness, enhancing surveillance and research, strengthening infection control, optimising antimicrobial use and ensuring sustainable funding. Each state customises its SAP-AMR to address local needs while aligning with national goals. The State Action Plan to Combat AMR (SAP-CARD) was introduced in January 2020, with the Delhi Society for Promotion of Rational Use of Drugs (DSPRUD), a non-governmental professional organisation, playing an active role.

Delhi faces challenges in tackling AMR due to its diverse healthcare infrastructure, socioeconomic disparities and widespread antibiotic misuse. Implementing the SAP-AMR requires collaboration among stakeholders, including healthcare providers, government agencies, research institutions and professional organisations.

Professional organisations play a critical role by promoting AMR awareness, training healthcare professionals in antimicrobial stewardship and fostering responsible



antibiotic use. By working closely with government bodies, they help monitor AMR trends, support guideline adherence and advocate for policies to enhance infection prevention. For over 25 years, DSPRUD has been at the forefront of these efforts, making key contributions to AMR control in India.

Strategic Priority 1 emphasises raising AMR awareness through communication, education and training for healthcare professionals, policymakers and the public. This aligns with the 2024 World Antimicrobial Awareness Week (WAAW) theme: Educate. Advocate. Act now.

DSPRUD has led impactful initiatives under this strategy, including targeted educational programmes, workshops and campaigns promoting responsible antimicrobial use among various stakeholders, including the public.

Since 2019, DSPRUD has organised AMR awareness campaigns in Delhi schools, reaching over 3,500 teachers and over 900,000 students in collaboration with WHO, the Delhi Government and the National Centre for Disease Control.

Since 2023, DSPRUD, in partnership with ECHO India, has launched a focused three-month online campaign involving more than 250 teachers. These initiatives underscore the critical role of teachers in educating future generations, advocating responsible antibiotic use and fostering a culture of AMR awareness among students and communities.

The recent political declaration on AMR, adopted at the high-level UN General Assembly meeting, also emphasises AMR prevention as a global priority, highlighting the importance of robust national and state action plans.

Capacity building is vital for implementing the NAP-AMR, involving the training of healthcare professionals in antimicrobial stewardship and infection control. DSPRUD has played a key role in this effort, conducting antimicrobial stewardship courses for around 500 clinicians. DSPRUD's flagship diagnostic stewardship programme addresses the challenge of diagnostic uncertainty — a common reason for "just-in-case" antibiotic use.

This programme guides healthcare professionals through the diagnostic process, integrating infection prevention and control (IPC), diagnostic stewardship and antimicrobial stewardship to enhance accuracy and reduce unnecessary antibiotic use. To date, this course has reached over 1,000 medical professionals and 1,600 nurses.

Through these initiatives, DSPRUD supports Strategic Priority 4 of the NAP-AMR, aiming to optimise antimicrobial use across human, animal and agricultural sectors by promoting appropriate selection, dosage and treatment duration of antimicrobials, ensuring a coordinated response to AMR.

In collaboration with World Health Organization (WHO) India and the National Centre for Disease Control (NCDC), DSPRUD has supported training on the Union Ministry of Health and Family Welfare's (MoHFW) 2020 IPC modules.

Additionally, DSPRUD tracks AMR trends and antibiotic use, providing essential data to inform stewardship strategies. Statewide prescription audits reveal high antibiotic prescribing rates, underscoring the need for ongoing monitoring to enhance antibiotic practices and guide future interventions.

Strategic Priority 5 identifies research and innovation as critical to advancing the fight against AMR by developing new tools, methods and strategies for effective intervention. DSPRUD contributes significantly in this area by assessing the impact of various AMR interventions, providing valuable data to refine approaches to antimicrobial use.

Furthermore, DSPRUD explores the use of artificial intelligence to predict AMR trends and support clinicians in making informed decisions on antibiotic use. These efforts not only contribute to more targeted and effective AMR management but also pave the way for innovative, data-driven solutions in healthcare.

WAY FORWARD

While DSPRUD remains committed to combating AMR through a multifaceted approach, the way forward involves statewide awareness campaigns, continuous monitoring of antimicrobial

consumption and classifying antibiotics under WHO's AWaRe framework to foster responsible use at various levels of healthcare.

A comprehensive State AMR Operational Plan, focusing on collaboration among government agencies, healthcare providers and research institutions, will ensure a structured and coordinated response to monitor antimicrobial use and assess the effectiveness of interventions. Regular evaluations will promote accountability and continuous improvement, ultimately enhancing health outcomes and preserving the effectiveness of antibiotics for future generations.

Moreover, collaborative platforms for researchers and the pharmaceutical sector should be established, alongside increased funding and infrastructure. This commitment, coupled with integrating artificial intelligence in AMR monitoring, offers innovative, data-driven solutions to tackle the growing AMR challenge effectively.

Sangeeta Sharma is professor of neuropsychopharmacology, Institute of Human Behaviour & Allied Sciences (IHBAS), and president for Delhi Society for Promotion of Rational Use of Drugs (DSPRUD), Delhi

5. WE FINALLY HAVE A POLITICAL DECLARATION ON AMR; IT IS NOW TIME TO ADVANCE ITS IMPLEMENTATION

Prioritising equity, facilitating country-led NAP development, informing the development of an effective IPEA and contributing to AMR policy ecosystem are some areas to be looked into

Geneviève Boily-Larouche

Mathieu Poirier

CLICK HERE TO READ ONLINE

THE UN General Assembly High-Level Meeting on Antimicrobial Resistance (AMR) and the resulting political declaration have provided a crucial opportunity to spotlight the challenge of AMR, elevate its profile, and promote international cooperation to address one of the defining global health challenges of our time. Perhaps most importantly, the political declaration provides the foundation for revitalised national and global responses to AMR.

The political declaration includes commitments in critical areas of AMR response including governance, finance, access and coordinated multisectoral response. It also includes formal recognition that low- and middle-income countries (LMICs) disproportionately bear the burden of AMR.

A major commitment within the declaration is the establishment of an independent panel on evidence for action against AMR (IPEA) by 2025, reflecting the urgent need for a new institution tasked with facilitating the generation and use of the best possible research to guide effective, evidence-informed policymaking. The declaration also calls for each country to develop actionable multisectoral national action plans (NAPs) with national targets and sustainable financial resources by 2030 while also acknowledging the need to leave no one behind and reach the furthest behind first.

The declaration has the potential to accelerate meaningful global, regional, national and local AMR response with all stakeholders having a role to play in its successful implementation. For the AMR Policy Accelerator, an innovative university-based think tank established to provide rigorous policy research, customised advisory services and capacity strengthening for evidence-informed policymaking, it's an opportunity to step up and ensure our offerings support national governments as they interpret the declaration and develop NAPs that are equitable, effective and impactful.

Developing and implementing actionable multisectoral action plans can be a challenge for many countries, especially those with limited financial resources. The declaration outlines that while 178 countries currently have multisectoral NAPs, only 68 per cent are implementing them, 52 per cent of countries have functioning multisectoral coordinating mechanisms, and 11 per cent of countries have dedicated funding in their national budget for NAP implementation. The Accelerator supports countries by providing evidence-informed advice on One Health Governance, and through the Smart Choice Process — a facilitated country-led process that brings together relevant stakeholders to systematically and transparently prioritise AMR interventions for effective multisectoral NAPs.

Developing national targets for NAPs is also a challenge for many countries. Countries cannot simply adopt the global target set out in the declaration — a 10 per cent reduction in global

deaths associated with bacterial AMR by 2030. For each country, local realities will need to be considered to identify the relevant markers of progress. Success may need to be measured more qualitatively, looking at progress of One Health Governance, and NAP implementation before a reduction in deaths associated with bacterial AMR can be measured meaningfully. A context-specific perspective on impact, which can be enabled through AMR Policy Accelerator offerings, can provide countries with a sense of progress and foster a more inclusive vision of success that can serve as a catalyser for financing.

For the AMR Policy Accelerator, the political declaration is also an opportunity to continue bridging national AMR responses to the global agenda. We provided evidence-informed options for an IPEA design, examining lessons learned from other scientific panels, such as the Intergovernmental Panel on Climate Change. As the development of an IPEA is now set in motion as a result of the political declaration, we will continue to advise international organisations and countries to ensure IPEA can contribute to equitable and evidence-informed AMR policies as a global public good.

By prioritising equity, facilitating country-led NAP development, informing the development of an effective IPEA, contributing to the AMR policy ecosystem, the Accelerator hopes to contribute to a future of sustainable antimicrobial access and use for all.

Geneviève Boily-Larouche is the Managing Director of the AMR Policy Accelerator at the Global Strategy Lab

Mathieu Poirier is the Director of the Global Strategy Lab, York Research Chair (Tier II) in Global Health Equity, and Assistant Professor of Social Epidemiology at the School of Global Health

6. ONE HEALTH HOLDS THE KEY TO INDIA'S FIGHT AGAINST AMR

India's One Health approach to combating AMR emphasises integrated actions across healthcare, agriculture and environmental sectors

Rajib Dasgupta

Pallavi Mishra

CLICK HERE TO READ ONLINE

ANTIBIOTICS are life-saving drugs for humans and animals, with their therapeutic benefits well recognised in treating humans, livestock and companion animals. However, antimicrobial resistance (AMR) has emerged as one of the biggest threats to human, animal, environmental and planetary health. It has the potential to undermine and destabilise medical progress, making it a critical health issue requiring urgent attention.

Goal 3 of the United Nations-mandated Sustainable Development Goals (SDG) highlights the threat of bloodstream infections due to antimicrobial-resistant organisms and the increased costs of treatment due to AMR. The World Health Organization (WHO) estimates that by 2050, AMR could lead to 10 million deaths annually.

India is no exception, with an exponential rise in AMR in human, animal and environmental sectors over the last decade. Following the WHO's Global Action Plan on AMR, India launched a National Action Plan (NAP) on AMR in 2017.

Some Indian states have followed suit by developing their respective state action plans. Despite these efforts, the irrational use of antibiotics remains inadequately regulated, with the COVID-19 pandemic marked by significant misuse.

There are various reasons for the irrational and high consumption of antibiotics in India, including over-the-counter medication, unprescribed usage (both over- and under-use), lack of diagnostic facilities for humans and animals, inadequate training among healthcare providers and a weak regulatory structure.

The industrial-scale expansion of agricultural production, including fisheries, dairy and poultry, has increased susceptibility to AMR, posing a potential threat to the growth and productivity of these sectors.

It is essential to address these issues urgently by aligning them with the SDGs, not only to understand their impacts on health but also to recognise the intersectionality of issues such as poverty, hunger, food security, nutrition, agriculture, water and sanitation and economic growth. Thus, a comprehensive, multi-sectoral approach premised on equity across sectors and settings is required.

INDIA'S ONE HEALTH RESPONSE TO AMR

In the past decade, various efforts have been made in India, including the development of the NAP and state action plans, which emphasise a multi-sectoral approach to address the complex challenges of AMR. These policy documents represent some of the first One Health initiatives by the government of India to address AMR.

The NAP and state action plans highlight the urgency of rational antibiotic use, strengthened infection prevention and control measures and lay down a roadmap for AMR surveillance.

The Indian Council of Medical Research (ICMR) established the AMR Surveillance and Research Network (AMRSN) in 2013 to generate evidence and monitor trends and patterns of

drug-resistant infections across India. This network includes 30 tertiary care hospitals, both private and public.

As part of the 12th Five-Year Plan (2012–17), the Programme for Strengthening Intersectoral Coordination for Prevention and Control of Zoonotic Diseases was launched, which continues as the National One Health Programme for Prevention and Control of Zoonoses, set to run until 2026.

Furthering the One Health approach, ICMR has collaborated with the Indian Council of Agriculture Research on the project Integrated One Health Surveillance Network for Antimicrobial Resistance, aimed at preparing Indian veterinary laboratories for integrated AMR surveillance. Similarly, the National Centre for Disease Control (NCDC) has developed a network of 151 laboratories to contain AMR and has also developed national treatment and infection control guidelines.

In 2022, the Prime Minister's Science, Technology and Innovation Advisory Council (PM-STIAC) approved the National One Health Mission under the leadership of the Principal Scientific Adviser's Office of the Government of India. This mission focuses on the interconnections between human, animal and environmental health and aims to develop an integrated approach to address AMR, zoonotic diseases and environmental degradation.

CHALLENGES YET TO BE ADDRESSED

The One Health approach to tackling AMR and planetary health is promising, yet several challenges require prompt attention for a healthier future. One of the biggest challenges is the lack of social and behavioural science data and existing structural disparities in healthcare access.

There is also a need to strengthen the implementation of training, guidelines and behaviour change interventions through locally tailored community engagement plans that consider contextual factors at all levels of the health system and within communities. Furthermore, timely updates to the curricula for human, animal, agricultural and environmental health professionals are necessary, focusing on integrated health programmes across sectors.

In conclusion, policymakers and practitioners must balance upstream and downstream issues; for example, regulatory changes should ensure resource availability at local levels. Finally, it is essential to gather surveillance data from tertiary to community levels to enable informed health plans that address AMR.

Rajib Dasgupta is Professor and Chairperson, Centre of Social Medicine & Community Health, Jawaharlal Nehru University, New Delhi and a former Co-Investigator, UKRI-GCRF One Health Poultry Hub
Pallavi Mishra is a researcher in international politics and global health and former Senior Consultant, UKRI-GCRF One Health Poultry Hub

7. A CLINICIAN'S PERSPECTIVE ON UNGA POLITICAL DECLARATION ON AMR

Equitable, timely access to effective antimicrobials as well as stricter regulations for over-the-counter antibiotics are needed

Dhanya Dharmapalan

CLICK HERE TO READ ONLINE

ON September 26, 2024, a historic political declaration to combat the rising antimicrobial resistance (AMR) was made at the United Nations General Assembly held in New York. It highlighted the need for equitable and timely access to effective antimicrobials, diagnostics and vaccines in developing countries.

A clinician's perspective is presented below on some of the points in the declaration, in the Indian context.

EQUITABLE ACCESS TO DIAGNOSTICS

Diagnostic tests can distinguish between viral and bacterial infections, thereby preventing the misuse of antibiotics for viral infections.

In relevant clinical settings, diagnostic tools such as culture tests or molecular tests are frequently used to determine if a bacterial infection caused by a multidrug-resistant organism is present. This information assists clinicians in optimising the most effective antibiotic treatment for the patient.

The test sensitivity and specificity as well as delayed turnaround time for results of over 48 hours of the culture reports have been some major limitations of these tests.

Molecular tests have revolutionized the treatment of certain infectious diseases such as tuberculosis (TB). These tests can determine within a few hours if a patient has TB and whether the first-line treatment will be effective by detecting resistance to one or more anti-TB drugs.

Since delays in administering antibiotics to critically ill patients can lead to deadly outcomes, an ideal diagnostic test would be an affordable, point-of-care solution that provides reliable results within minutes, even before starting antibiotic treatment.

In the absence of such ideal diagnostic facilities, atleast the basic diagnostic tests that are currently available for detection of resistance, such as culture tests, need to be made easily available and affordable in the rural and urban regions.

The personnel trained in microbiology can play a crucial role in the correct interpretation of reports, guidance of clinicians as well as help in timely infection control practices whenever relevant, to prevent the spread of multidrug resistant organisms.

EQUITABLE, TIMELY ACCESS OF ANTIMICROBIALS AND VACCINES

While equitable and timely access to effective antimicrobials are needed, stricter regulations are required for antimicrobials that can be purchased over the counter without a valid prescription.

Manufacturers of the antibiotics recommended by national and World Health Organization (WHO) guidelines as the first line of choice for treatment need to be encouraged for sustained production as these are usually difficult to avail these in pharmacies while more expensive antibiotics are reportedly more easily available.

The antibiotics recommended as first line for many community acquired infections such as

amoxicillin, cloxacillin, cefazolin are classified in the Access group of the Access, Watch, Reserve (AWaRe) antibiotic classification of WHO.

The political declaration aims for a consumption of the Access group of atleast 70 per cent of overall human antibiotic consumption globally by 2030. This can be achieved only by improving the availability of these antibiotics and effective antimicrobial stewardship practices.

Special attention needs to be provided for antimicrobial availability for special groups such as children, with increase in availability of dispersible tablets in different strengths for more accurate dosing. Research on newer molecules or alternative therapeutics for multidrug resistant organisms needs to be encouraged.

While there are many effective vaccines available in the National Immunisation Schedule against bacterial infections like pertussis, pneumococcal, H influenza B, it is also important to consider inclusion of vaccine against other bacterial diseases of public health importance like typhoid for which an effective and safe vaccine is available.

Despite a global high priority pathogen list for vaccine development that includes commonly isolated multidrug resistant bacteria like Escherichia coli, Staphylococcus aureus and Klebsiella pneumoniae, the progress has been painfully slow.

ONE HEALTH APPROACH TO PROMOTE AWARENESS

The awareness about rational use of antimicrobials as well as antimicrobial resistance needs to be improved with sustained efforts both among the healthcare providers and the community.

Basic concepts like how infections spread, hand hygiene, meaning of antimicrobials and antimicrobial resistance can be introduced as early as in the school curriculums through cartoons or stories.

Effective practical training on basics of choosing the right antimicrobial during medical college days can avoid the gullibility of using a particular antibiotic based purely on the interactions with the representatives from pharmaceutical industry.

Antimicrobial waste disposal at industry level and healthcare setting needs particular attention as these can promote the antimicrobial rise in the environment and food chain. Similarly, the unrestricted use of antibiotics in the animal health sector has a direct negative impact on AMR in human health.

The vectors that transmit infections are mainly air, water, food, insects and contact. If basic standards of hygiene can be improved with better reduced air pollution, water sanitation, avoiding breeding of mosquitoes, better sewage disposal and hand hygiene, we would be able to control the spread of infections to a significant proportion.

Such preventive strategies, which also include effective vaccination, would reduce the healthcare burden of infectious diseases to a very large extent and, therefore, opportunities to use antimicrobials which are main drivers of AMR.

AMR is currently a very complex problem requiring intersectoral coordination and multipronged approach at several levels. Leadership commitment in form of an united igh level political declaration is a welcome step in this direction.

At the same time, a responsible use of antimicrobials at an individual level, whether as a provider or a recipient can contribute greatly to atleast control the rapid rise of AMR.

Dhanya Dharmapalan is senior consultant in Paediatric Infectious Diseases, Apollo Hospitals, Navi Mumbai National Coordinator of Apollo Antimicrobial Stewardship Programme.

8. THE WORLD NEEDS ROBUST ANTIMICROBIAL RESISTANCE SURVEILLANCE SYSTEMS

Conducting AMR surveillance involves several limitations, all of which can impede the analysis of resistance drivers

Geetanjali Kapoor

CLICK HERE TO READ ONLINE

ANTIBIOTICS and vaccines stand among the most transformative medical innovations, revolutionising healthcare and saving millions of lives. However, antimicrobial resistance (AMR)—an unavoidable outcome of microbial evolution, with many resistance mechanisms still unknown—has already exacted a significant toll on human health, threatening the efficacy of essential therapies and medical procedures. In 2019, bacterial AMR alone directly caused 1.27 million deaths, with an additional 4.95 million deaths associated with drug-resistant infections, disproportionately impacting children under five. The economic toll of AMR could reach up to $1.2 trillion annually in a high-resistance scenario in the near future. Modelling studies often provide limited, one-time assessments, underscoring the need for robust surveillance systems to capture real-world data.

The World Health Organization's 2015 Global Action Plan guides countries to enhance surveillance, infection prevention, antimicrobial stewardship, research, partnerships, and awareness to mitigate AMR. The WHO's Global Antimicrobial Resistance and Use Surveillance System (GLASS) has led these efforts globally and highlights critical challenges like limited diagnostic capacity, workforce shortages, and inadequate information systems. Addressing these barriers is essential to achieving the 2024 Political Declaration's target to reduce AMR-related deaths by 10 per cent by 2030. The availability of reliable AMR data is fundamental for formulating evidence-based policies to optimise antimicrobial stewardship.

Setting up a new AMR surveillance system—or strengthening an existing one—requires systematic, often concurrent and sequential processes. At the outset, a multidisciplinary team led by a microbiologist should be constituted, including data collectors, laboratory personnel, data managers, administrators, clinicians, and communication specialists. AMR surveillance can be conducted at an institutional level or as part of an external funding initiative, involving single or multiple centres across countries or regions. Surveillance may focus on analysing existing data or be designed as prospective studies to gather new information over time. Engagement with local health authorities and regular communication (through in-person or virtual meetings) is essential, especially in externally funded studies. A Data Sharing Agreement (DSA) should be signed by stakeholders to clarify responsibilities, data handling protocols, and security measures to prevent unauthorised access. In multicentric studies, the selection of participating laboratories should consider quality standards, project timelines, and funding availability.

AMR surveillance can range from focusing solely on laboratory data to incorporating patient demographics and clinical information, depending on the study's scope. Local data collectors should ideally have experience in healthcare settings and receive comprehensive training on data entry procedures and troubleshooting. Once data is collected, it undergoes rigorous review for standardisation, and any ambiguities are clarified promptly. Data from positive cultures with antimicrobial susceptibility test (AST) results are analysed to estimate AMR rates, calculated as the proportion of non-susceptible isolates to a specific antimicrobial class over a defined per-

iod. Confidence intervals at the 95 per cent level are calculated to quantify uncertainties in resistance estimates. In addition to estimating AMR rates, supplementary analyses can help identify drivers of resistance when relevant data is available.

Results should be presented in a clear, accessible format, incorporating graphs, charts, and infographics to communicate findings effectively to diverse audiences. Disseminating results ensures they reach key stakeholders, inform policy, and support broader public health objectives. Findings can be shared through workshops, webinars, and conferences, providing opportunities for direct engagement with stakeholders to contextualise results and encourage collaboration. Publishing results in peer-reviewed journals adds credibility and contributes to the global body of AMR knowledge. At the same time, dissemination through digital platforms—such as social media, institutional websites, and AMR databases—can expand visibility and reach.

Conducting AMR surveillance involves several limitations, including challenges in data retrieval, variability in laboratory practices, limited data representation, and insufficient clinical data, all of which can impede the analysis of resistance drivers. Establishing feedback mechanisms is vital to assess the impact of disseminated results (e.g., how findings influence antimicrobial stewardship practices, treatment protocols, or funding decisions) and to refine communication strategies for future initiatives. Finally, documenting all dissemination activities is essential for future reference, helping to improve the design of dissemination strategies.

Geetanjali Kapoor is Acting Head and Researcher, One Health Trust (previously Center for Disease Dynamics, Economics & Policy [CDDEP])

9. COLLABORATION IS KEY FOR AMR CONTAINMENT IN INDIA

From policies to grassroots, efforts have to be aligned to tackle AMR in every sector

Jaya Ranjalkar

CLICK HERE TO READ ONLINE

IT is time to reflect, renew and reignite India's commitment to antimicrobial resistance (AMR) containment efforts on the occasion of World AMR Awareness Week (WAAW) 2024. Since the launch of the National Action Plan on AMR in 2017, significant progress has been made in addressing some of its strategic objectives, thanks to the relentless efforts of key organisations within and outside the government, civil society groups and academic entities.

At the national level, India has implemented several significant initiatives to combat AMR. These include enrolment in the Global Antimicrobial Resistance and Use Surveillance System, the establishment of surveillance networks by the National Centre for Disease Control (NCDC) and the Indian Council of Medical Research and the adoption of policies on Infection Prevention and Control (IPC) and Antimicrobial Stewardship (AMS).

Other achievements include the inclusion of AMR in the Integrated Disease Surveillance Programme, the launch of the Indian Network for Fishery and Animal Antimicrobial Resistance under the FAO and ICAR, a ban on the use of the antibiotic colistin in the animal sector and the establishment of India's AMR innovation hub.

Among the various sectors, progress in the environmental sector has been slow despite efforts from many organisations. The environment, especially water, is contaminated by inadequately treated pharmaceutical effluents, hospital waste and waste from animal and agricultural farms. The improper disposal of expired or unused antibiotics is also a major concern. The environment acts as a platform for drug-resistant strains to emerge and spread, although more data is needed on the value chain analysis for each contributor.

India's role as a major global manufacturer and exporter of medicines, coupled with its large pharmaceutical market, adds another layer of economic complexity. Ensuring sustainable access to effective antibiotics, particularly from the access and watch groups, is a global priority. At the same time, innovative models are needed to support methods that minimise environmental pollution.

To date, only a few Indian states have introduced state action plans (SAP) on AMR, while others are still in the drafting stage. Except for Kerala, many states continue to face challenges such as mobilising adequate resources and funding, ensuring intra-sectoral and inter-sectoral coordination and engaging broader civil society organisations and private entities. Most SAPs adopt a top-down approach, making it difficult to implement measures effectively at the grassroots level.

Moreover, there are gaps such as the lack of good-quality representative data on antibiotic consumption and resistance in human and animal sectors (both nationally and at the state level) and limited awareness of the economic consequences of inaction against AMR. Such data, if available, could guide policymakers in prioritising AMR interventions.

The recent United Nations General Assembly High-Level Meeting on AMR in September 2024 adopted a declaration aiming to reduce deaths caused by drug-resistant infections by 10 per

cent by 2030 compared to the 2019 baseline. While having a common unifying target is a good starting point, given India's diverse contexts, each state must generate context-specific data and continuously adapt its targets as part of monitoring and accountability.

Data on antibiotic consumption by the AWaRe category (a tool for monitoring antibiotic consumption, defining targets and monitoring the effects of stewardship policies) in humans, surveys on the implementation of AMS and IPC practices in hospitals and the use of medically important antimicrobials in animals should be collected. This will help prioritise efforts across sectors and allocate resources effectively.

These efforts should go hand in hand with addressing the social determinants of health, such as poverty, malnutrition, access to healthcare, access to standard antibiotics, safe drinking water, sanitation services and improved childhood vaccination rates.

Given that a significant proportion of India's population relies on agriculture and livestock for their livelihoods, there is an urgent need to sensitise farmers about AMR. Innovative models must be scaled up to promote biosecurity measures, along with designing incentives to mitigate economic losses from livestock mortality due to infections during the transition phase.

Further research is needed on alternatives to antibiotics, the role of vaccines in the animal sector, cost-benefit analyses, capacity building among veterinary workers and farmer associations.

In addition to high-quality representative data on antibiotic consumption and resistance in human and animal sectors, initiatives that promote behavioural change in communities — such as the Antibiotic Smart Communities programme piloted by ReAct Asia Pacific in rural Kerala — are essential. These efforts should engage diverse stakeholders, particularly students, communities, civil society organisations, professional associations and consumer groups.

We need more AMR champions across sectors to initiate, educate, advocate and implement on-ground action.

Furthermore, strategies should focus on preventive measures by promoting investments in WASH and IPC at all levels across sectors, adopting a One Health approach with intra-sectoral and inter-sectoral collaboration, strengthening healthcare systems through universal health coverage, increasing budget allocations for health and intensifying efforts to mobilise funds. These measures are critical to ensuring that current and future generations continue to benefit from the life-saving efficacy of antibiotics.

Jaya Ranjalkar is former deputy director, ReAct Asia Pacific

10. LACK OF COMMUNITY ENGAGEMENT IS A MAJOR SHORTCOMING OF THE AMR BUSINESS MODEL

In absence of AMR literacy among the community consumers of urban and rural India, there is an absolute dearth of demand of the AMR campaign

Sagar Khadanga, Shweta Kumar

CLICK HERE TO READ ONLINE

ANTIMICROBIAL resistance (AMR) has emerged as an urgent global health concern. The World Health Organization (WHO) embarked the Global Action Plan (GAP) on AMR in 2015 and since then, many partners have collaborated.

This comprehensive framework aimed to guide the signatory countries in developing locally feasible strategies in tackling AMR. The strategic priorities of GAP AMR included improving knowledge and awareness, reducing infection risks, optimising antibiotic use, increasing AMR surveillance, and securing sustainable investment for treatment and research.

On the template of GAP AMR, India launched its National Action Plan on Antimicrobial Resistance (NAP-AMR) in 2017. India as a country, has advocated for multi-sectoral approaches involving human and animal health, agriculture and environmental sectors with a closely knit collaboration between healthcare workers, regulatory bodies and industrial partners. These NAP AMR strategies were tailored to India's unique healthcare landscape, addressing the widespread issues of antibiotic misuse, easy access to over-the-counter antibiotics, and limited awareness among the public.

Though GAP AMR and NAP AMR established broader goals, effective implementation at the grassroots level is the major challenge. Even after seven years of launch of NAP AMR, only four states have developed their state action plans which clearly demonstrate the lack of political commitment and willingness of attitude by enlarge.

State action plans align with the objectives of the NAP AMR, specifically targeting healthcare professionals, institutions, policymakers and governing bodies. However, several factors contribute to its limited success.

Among many other shortcomings, lack of community engagement is the fulcrum of this not-so-popular movement, particularly in rural and underserved areas. It is an unfortunate paradox that AMR momentum is least advocated where antibiotic usage is most, because of limited financial resources, inadequate infrastructure, and insufficient monitoring. These barriers hinder the implemention of AMR education and antibiotic stewardship on a broad scale. This lack of community-inclusive programs creates a perception that AMR is an issue primarily of the middle class and elite population in urban areas and cities.

Community engagement is essential in the AMR movement because public behaviour and knowledge directly impact antibiotic consumption patterns. Community consumers with limited AMR literacy are the most important unaddressed stakeholders. Engaging communities in AMR education will empower more individuals for informed decisions and mitigating AMR.

AMR awareness campaigns should move out to community settings of various socioeconomic strata. Tailored geopolitical campaigns with due consideration of socio-cultural issues will bring out a paradigm shift in the AMR momentum. Simple and relatable messages distributed through community health workers, local events, social media, schools, police stations, traffic signals and railway stations can significantly increase community AMR literacy. More community leaders,

schoolteachers, priests and motivational speakers have to be roped in along with healthcare providers, fostering trust and responsibility among the common public.

At this point, it appears that while AMR advocacy is well-presented and well accepted, especially among the educated white collared classes in urban areas, there is still a long way to travel to even create an impact among consumers in rural India. In absence of AMR literacy among the community consumers of urban and rural India, there is an absolute dearth of demand of the AMR campaign. As a successful business model, the demand of community AMR campaign has to be created before the supply of various mitigating strategies to its consumers.

Sagar Khadanga is Associate Professor, Department of General Medicine, AIIMS Bhopal, N.O. Technical Committee MPSAPCAR
Shweta Kumar is Lecturer, Department of Pharmacy, S.V. Polytechnic College, Bhopal

11. HOW NIGERIA IS MITIGATING AMR IN ANIMAL SECTOR USING ONE HEALTH APPROACH

The country is strengthening leadership, collaboration, coordination and AMR governance structures at national and subnational levels

Mwapu Dika Ndahi

CLICK HERE TO READ ONLINE

ANTIMICROBIAL resistance (AMR) is a complex global public health threat requiring a multidisciplinary and multi-sectoral approach to mitigation. To address this, Nigeria established a multi-sectoral AMR governance structure, guided by a One Health governance manual.

This structure includes a National One Health Steering Committee from the Ministries of Agriculture, Environment, Health, Finance, and Information. This committee serves as the national policy and decision-making body, overseeing the National One Health Technical Committee and the Antimicrobial Resistance Coordinating Committee.

An Antimicrobial Resistance Coordinating Committee (AMRCC), comprising focal points from the One Health sectors is also part of it. The AMRCC coordinates AMR and antimicrobial use (AMU) activities planned by technical working groups across sectors.

National One Health AMR Technical Working Group (NTWG), made up of representatives from ministries, departments and agencies, academia, civil societies, regulatory bodies, and research institutions is also part of the structure. The NTWG is organised into sub-technical working groups focused on awareness, surveillance, stewardship, and infection prevention and control (IPC).

Similar structures are established at subnational levels in two out of the 36 states in the federation. The One Health AMRCC and NTWG, alongside other stakeholders, have developed Nigeria's first and second One Health AMR National Action Plans.

IMPROVING AMR AWARENESS AMONG ALL RELEVANT STAKEHOLDERS

Poor awareness of AMR among professionals, farmers, decision-makers and other stakeholders is a major challenge. To address this, the AMRCC has established a Community of Practice (CoP) for AMR, where stakeholders discuss stewardship, awareness creation, and evidence-based actions through data and information sharing. These exchanges occur via webinars and the CoP website.

The animal health sector has also engaged secondary school and university students in AMR awareness campaigns. These students have formed AMR clubs, participating annually in World AMR Awareness Week through debate competitions and sharing information on AMR within their communities.

AMR Club activities in Secondary Schools and universities (Author provided)

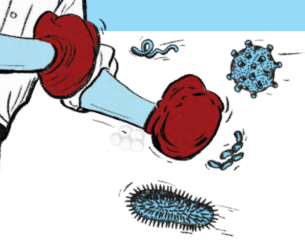
To promote safe animal handling and proper sanitation, sensitisation workshops have been held for abattoir workers, emphasising clean water, sanitation, and hygiene (WASH) practices before, during and after animal slaughter.

Sensitisation of abattoir workers on IPC and WASH (Author provided)

To extend AMR awareness to rural areas, a traditional ruler in one local district has been designated as an AMR Champion. This leader promotes antimicrobial stewardship and raises awareness among rural communities.

STRENGTHENING ONE HEALTH AMR SURVEILLANCE SYSTEMS

Nigeria has established a comprehensive AMR surveillance system across human, animal, and environmental health sectors, supported by national reference and sentinel laboratories. The National Reference Laboratories for human and animal health are ISO-certified and participate in External Quality Assessment programmes.



Human health AMR data is used at the national level and reported to the WHO GLASS, while the animal health sector conducts active and passive AMR surveillance and participates in the FAO InFARM for global data sharing. Surveillance agents and AMR Focal Points in sentinel labs are trained in AMR surveillance and data management using WHONET.

The country has also developed the Antimicrobial Resistance Information System for AMR and AMU data sharing and reporting. All three sectors collaborate in the WHO One Health TRICYCLE Project, monitoring extended spectrum beta-lactamase-producing Escherichia coli in humans, poultry, and the environment.

The animal health sector conducts mass vaccinations against bacterial and viral diseases, reducing antimicrobial needs. Biosecurity guidelines and standard operating procedures have been established for poultry and aquaculture, with farmer representatives trained on effective biosecurity measures in all 774 local government areas.

IMPROVING ACCESS TO QUALITY ANTIMICROBIALS

Nigeria has developed a One Health Antimicrobial Stewardship Plan to guide implementation of AMS activities. The animal health sector has developed a draft antimicrobial stewardship strategy that would guide the establishment of stewardship programs in veterinary hospitals and clinics.

The sector has a surveillance system for antimicrobial consumption and has generated data for nine years, contributing to global AMC data in ANIMUse at WOAH. This data is used at the national level for decision-making and policy formulation. Also, the sector has developed and disseminated national guidelines for the use of antimicrobial drugs in animals and is about developing a prescription policy and essential medicines list.

Mwapu Dika Ndahi is a veterinarian with a PhD in Veterinary Public Health and Preventive Medicine. She is a Fleming Fund Fellow for AMU/C surveillance.

12. A MULTIFACETED APPROACH IS NEEDED TO COMBAT AMR IN AQUACULTURE

Antimicrobial resistance in aquatic life can escalate the crisis and have a cascading effect


S.R. Krupesha Sharma


T.G. Sumithra


Joe Kizhakudan


Grinson George

CLICK HERE TO READ ONLINE

ANTIMICROBIAL resistance (AMR) occurs when microorganisms like bacteria, fungi and viruses adapt over time and no longer respond to antimicrobials used to treat the infections caused by them.

AMR is a growing global health crisis that poses significant threats to human, animal, and environmental health with far-reaching consequences due partly to the undermentioned reasons:

- Ineffective treatment: When pathogenic bacteria become resistant to antibiotics, common infections can become difficult or impossible to treat. This can invariably lead to prolonged illness, severe infections, increased hospitalisation, and even death.
- Impact on healthcare: AMR can complicate medical procedures like surgeries, cancer therapies, and organ transplants, as the risk of nosocomial infection increases leading to severe post-treatment complications.
- Spread of resistant infections: Resistant bacteria can spread easily within communities and healthcare settings, making it harder to control and confine the outbreaks.
- Economic burden: Treating resistant infections is more expensive and time-consuming.
- Threat to food security: AMR makes it harder to treat infections in livestock, poultry, aquatic animals and plants, potentially leading to food scarcity and inflation.

'ONE-HEALTH' PERSPECTIVE

'One-Health' is an approach that recognises the interconnectedness of human, animal (terrestrial and aquatic), plant and environmental health to address health challenges that affect all species.

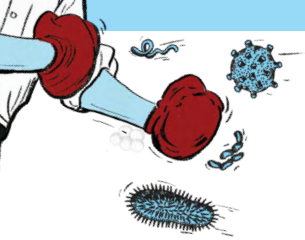
As AMR is a complex, multifaceted issue that arises from the interactions between these different sectors, inadequate communication and coordination between the sectors can further exacerbate the issue.

Addressing AMR through 'One-Health' can implement strategies to reduce antimicrobial use, improve infection prevention, and promote responsible drug use.

ANTIMICROBIAL RESISTANCE AND AQUACULTURE

Aquaculture is the fastest-growing food production sector, producing more than half of the world's fisheries. It offers food and nutritional security by providing a nutritious protein source and reducing the need to catch more wild fish.

It also provides ample employment opportunities and holds environmental benefits like a smaller carbon footprint than other farming sectors and restoration of aquatic biodiversity.



While increased aquaculture production is associated with semi-intensive and intensive farming practices, diseases and subsequent use of antimicrobials are linked to these farming systems.

Antimicrobial use in aquaculture exerts selective pressures, driving the selection of AMR microbes.

In addition to antimicrobial use, the presence of AMR or antimicrobial resistance genes (ARGs) in aquatic systems is linked to many factors, including coastal runoff of AMR bacteria, antimicrobials, pesticides, and heavy metals from terrestrial sources through improper solid waste disposal, agricultural runoff of pesticides, poorly treated hospital effluents and improper wastewater treatment.

For example, Staphylococcus aureus, Escherichia coli and several Vibrio spp. isolated from freshwater and marine farmed fish and shrimp were found to be resistant to antibiotics like cefoxitin, erythromycin, cefpodoxime, and ciprofloxacin at varying levels, whereas, these antibiotics are not used in aquaculture.

Hence, it is pertinent to emphasise that the presence of AMR or ARGs in aquatic ecosystems is not always related to antimicrobial usage in fish farming.

Effective AMR surveillance systems must integrate data across different sectors to identify patterns of resistance and the movement of resistant strains.

Presently, there is limited comprehensive data available on AMR prevalence in the livestock and aquaculture sector of India. Available data are stand-alone reports without Pan-India coverage and with a low sample size.

Accordingly, the Indian Council of Agriculture Research (ICAR) with technical support from FAO (Food and Agriculture Organization) has formed the Indian Network for Fisheries and Animal Antimicrobial Resistance (INFAAR), a network of 31 laboratories across India, to accelerate a structured laboratory-based surveillance of AMR in India's livestock and aquaculture sectors, aiming to identify patterns of resistance and the movement of resistant strains and to quantify the AMR burden in food-producing animals.

WAYS TO MITIGATE AMR IN AQUACULTURE

To address AMR in Indian aquaculture, a multifaceted approach is needed:

- **Responsible antimicrobial use:** These include encouraging aquaculture professionals and farmers to use antibiotics only in necessity and by following the specific guidelines. Presently there are no guidelines for responsible use of drugs in aquaculture. Further, data are lacking on biosafety, withdrawal period, efficacy, and pharmacokinetics of the approved aquaculture drugs on most tropical aquaculture species. The 'All India Network Project on Fish Health', funded by ICAR, aims to develop policy guidelines on responsible antimicrobial use in the Indian aquaculture sector, addressing the research on these lacunae.
- **Alternative to antibiotics:** An immediate strategy in mitigating AMR burden is the application of antimicrobial alternatives, like probiotics, herbal-derived antibacterial agents, phages, etc.
- **Vaccination:** Developing vaccines for the most prevalent and economically significant aquatic pathogens would overcome the occurrence of diseases and thereby application of antimicrobial agents in aquaculture.
- **Improved farm management practices:** Implementing strict biosecurity measures, promoting good farm management practices such as rotational farming, optimal stocking densities, ensuring water quality and regular health monitoring can reduce stress and disease incidences and thus reduce the need for antimicrobials.
- **Improved environmental management practices:** Proper waste management strategies can minimize the spread of antibiotics and AMR microbes into water bodies.
- **Education and training for farmers:** Aquaculture practitioners need training programs and awareness campaigns to educate on AMR and best management practices for immediate AMR containment.

- **Research and innovation:** Encouraging investment in research to develop novel treatments, early disease diagnosis and control methods can offer more alternatives to antibiotics.
- **National and global collaboration:** Collaboration among governments, academia, and industry is crucial for effective AMR prevention and control.

In conclusion, AMR is a complex issue with far-reaching consequences for human, animal, and environmental health. The 'One-Health' approach provides a framework for addressing AMR by recognising the interconnectedness of these sectors.

It is pertinent to emphasise that the presence of AMR or the occurrence of ARGs in aquatic pathogens is not always related to antimicrobial usage in fish farming.

However, implementing responsible antimicrobial use practices, improving biosecurity, farm and environmental management measures, promoting vaccination, and strengthening surveillance and monitoring systems are critical to mitigate the threat of AMR in aquaculture.

S.R. Krupesha Sharma is working as Principal Scientist in the Marine Biotechnology, Fish Nutrition and Health Division, ICAR- CMFRI, Kochi
T.G. Sumithra, is Scientist at ICAR- CMFRI, Kochi.
Joe Kizhakudan is Principal Scientist & Head, ICAR-CMFRI, Visakhapatnam RC
Grinson George is current Director of the ICAR-CMFRI

13. HOW INDIA'S ONE HEALTH APPROACH CAN BE STRENGTHENED TO HELP FIGHT AMR

Investing in biosecurity measures, community-based awareness programmes, sustainable waste management among important measures

Babu Beri

CLICK HERE TO READ ONLINE

ANTIMICROBIAL resistance (AMR) presents a formidable challenge to human and animal health, food safety as well as environmental sustainability. India, like many nations, is grappling with the rapid escalation of AMR due to the overuse and misuse of antibiotics across multiple sectors, including healthcare, animal husbandry and agriculture.

The National Action Plan on AMR (NAP-AMR) provides a framework for addressing AMR through a coordinated approach across human, animal and environmental health sectors, embracing the One Health concept.

However, significant challenges persist in policy formulation, practical implementation, governance, technology and financing.

With the United Nations General Assembly's (UNGA) recent high-level meeting on AMR emphasising prevention, this article explores the challenges faced in implementing India's NAP-AMR across various sectors and outlines potential solutions.

India's regulatory oversight of antibiotic use spans across multiple departments in the ministries of health and family welfare, agriculture and environment. This approach leads to fragmented policy responses.

Harmonising regulations and fostering inter-departmental collaboration are critical to developing a coherent AMR strategy.

AMR surveillance in India is still nascent, with limited data from veterinary, agricultural and environmental sectors. The absence of a centralised, cross-sectoral data repository hinders comprehensive policy development and effective monitoring.

Further, while India has taken strides in regulating human antibiotic use, there is less progress in curbing antibiotic misuse in animal husbandry and agriculture. Establishing stringent guidelines and policies for veterinary and agricultural use of antibiotics is crucial for addressing AMR.There are certain challenges within the healthcare practice itself that exacerbate AMR. Most prominent among them is the antibiotic overprescription in human health and self-medication practices in rural areas. Awareness programmes and strict prescription regulations are necessary to curb misuse at the community level.

Moreover, the excessive use of antibiotics in animal husbandry to promote growth and prevent diseases is also dangerous. Implementing stringent regulations, educating farmers and promoting good livestock management practices are essential steps toward sustainable antibiotic use.

Finally, inadequate AMR training for healthcare and veterinary professionals limits the effective application of NAP-AMR. Tailored training programmes focused on AMR prevention and management are essential for improving practices across sectors.

India's strategy to fight AMR also suffers from limited technological and governance support. Rapid diagnostic tools, for instance, are essential for reducing inappropriate antibiotic use. But

access to such technology is limited, particularly in rural healthcare settings. Investment in affordable diagnostic tools and expanding their availability can significantly impact AMR prevention. Then, the sector also lacks a strong enforcement mechanism, because despite regulations, enforcement remains weak due to limited manpower, resources and decentralised governance. Strengthening regulatory agencies and ensuring accountability in antibiotic use in both human and veterinary sectors is critical.

Moreover, pharmaceutical waste, particularly from healthcare and animal husbandry, contaminates water and soil, contributing to AMR. Effective waste management protocols and robust environmental regulations are needed to mitigate AMR proliferation in the environment.

India's AMR initiatives also see limited funding. Implementing AMR interventions, particularly at a large scale, requires substantial funding. Increased budget allocation toward AMR research, surveillance and public health interventions is essential to sustain the momentum against AMR.

The One Health approach, though crucial, is also often underfunded. Dedicated financial frameworks and public-private partnerships could be leveraged to support coordinated AMR interventions across human, animal and environmental health sectors.

Lack of access is a major impediment for the success of AMR initiatives. Rural healthcare facilities often lack access to essential resources, including diagnostic tools and trained personnel, leading to inappropriate antibiotic use. Improving rural healthcare infrastructure and ensuring equitable access to AMR-related resources is essential for effective implementation.

Further, alternative treatments or preventive measures such as vaccines are limited, especially in the animal health sector. Promoting vaccination and other preventive health measures could reduce reliance on antibiotics and thereby reduce AMR.

WAY FORWARD

The recent high-level meeting on AMR at the United Nations emphasised preventive approaches, acknowledging that prevention should be the cornerstone of AMR strategies. In light of this, India could take the following steps to enhance its NAP-AMR:

1. Strengthen preventive strategies in the animal sector: Investing in biosecurity measures and vaccination programs in animal husbandry can significantly reduce antibiotic reliance. Developing farmer-friendly policies that encourage responsible use of antibiotics could foster a shift toward preventive healthcare.
2. Expand community-based awareness and education programmes: Implementing community-based AMR awareness campaigns can address public misconceptions about antibiotic use. Fostering behavioral changes around antibiotic usage and disposal practices at the grassroots level could further amplify preventive efforts.
3. Adopt advanced surveillance and data analytics: Utilising AI-driven data analytics and electronic health records could improve surveillance of AMR patterns across human and animal health sectors. A centralised AMR database can enable real-time monitoring and better policy responses.
4. Invest in sustainable waste management: Implementing green practices for waste management, particularly pharmaceutical waste, can minimise environmental AMR contamination. Stringent regulations and incentivised initiatives to curb AMR in the environment could align India's efforts with global AMR prevention targets.

India's fight against AMR requires a holistic approach, encompassing robust policies, practical interventions, advanced technology and financial resources, while emphasising prevention across all sectors.

By fostering a preventive approach and promoting the One Health concept, India can make significant strides in combating AMR. With coordinated action and sustained political will, the NAP-AMR has the potential to curb the threat of AMR and safeguard the future of human, animal, and environmental health.

Babu Beri is assistant director (veterinary & animal husbandry), Telangana.

14. FOCUSING ON FARM BIOSECURITY, ENHANCED AWARENESS AND PRUDENT MEDICINAL USAGE CAN MITIGATE ANTIMICROBIAL RESISTANCE IN DAIRY FARMING

Fight against antimicrobial resistance in dairy farms is not solely the responsibility of livestock farmers but requires a collaborative effort across various stakeholders

Pankaj Dhaka

CLICK HERE TO READ ONLINE

ANTIMICROBIAL resistance (AMR) has emerged as a significant global threat, undermining the effectiveness of essential drugs used for treating infections in humans and animals.

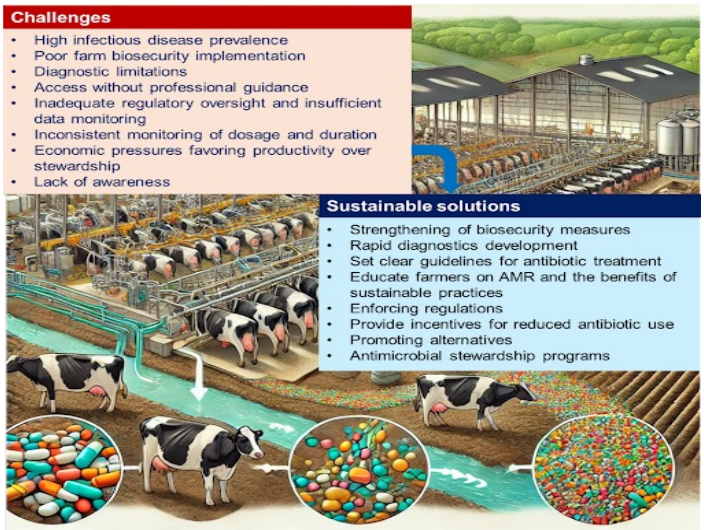
The issue has wide-reaching consequences, not only for public health but also for animal welfare, agricultural productivity and environmental sustainability.

Dairy farming, as a sector that relies on antimicrobials for the prevention and treatment of infectious diseases, plays a significant role in this complex landscape.

It is important to acknowledge the contribution of dairy farms to 'One Health' challenges considering the many factors and pressures the sector faces in maintaining animal health and productivity. This article examines the factors through which dairy farming influences AMR and discusses sustainable solutions, such as farm biosecurity and awareness initiatives to address this escalating issue.

SIGNIFICANCE OF DAIRY FARMS

Antimicrobial resistance is an escalating problem, projected to result in over 10 million annual deaths globally by 2050 if left unchecked. This crisis is particularly severe in low- and middle-income countries (LMICs), where limited regulation and infrastructure heighten the risks associated with antimicrobial use (AMU).



The dairy industry is a consumer of antimicrobials which are mainly used for medical treatment. These drugs are also used, in some cases, for very limited prophylaxis (to prevent disease in healthy animals).

In LMICs, dairy farming is becoming increasingly intensive and organised to achieve greater productivity within the scope of limited inputs. With a growing human population and improved economic conditions, there is a rising demand for animal-based food, including milk, with projections from the Food and Agriculture Organization (FAO) indicating a significant 55 per cent increase in global milk demand by 2050.

This intensification of farming practices with poor management may pose substantial production pressure on dairy animals, contributing to health conditions such as mastitis, metritis, lameness and reproductive disorders, which often necessitate antibiotic treatment. Consequently, the reliance on antimicrobials in dairy farming has surged, heightening the risk of AMR.

Factors such as inadequate animal husbandry infrastructure, the availability of over-the-counter antibiotics and economic pressures to maintain productivity frequently led to suboptimal AMU practices. In many regions, for example, a high incidence of resistant pathogens in dairy settings has been linked to the widespread, often unregulated use of critically important antimicrobials like third-generation cephalosporins. Moreover, the high density of animals in intensive systems and inadequate disease prevention measures often result in increased infections, further exacerbating the reliance on antimicrobials.

This cycle of intensive production and heightened AMU underscores the need for comprehensive strategies to mitigate AMR and protect animal welfare and productivity.

NOT JUST A FARM ISSUE

It is unfair to place the full burden of AMR on dairy farms as multiple actors contribute to this issue. AMR in dairy farming is closely linked to broader systemic challenges, including regulatory gaps, limited access to veterinary services and the economic vulnerability of small-scale farmers Furthermore, many dairy farmers, especially smallholders, have limited knowledge of the long-term risks associated with improper AMU.

They often depend on informal providers for animal health services, leading to inconsistent or under/excessive dosage of antibiotics. Additionally, there is a lack of awareness and implementation of effective biosecurity measures, which means that antimicrobials are often viewed as the only viable solution to manage infections and prevent economic losses.

The issue of waste management is also critical. Dairy farm waste, which often contains remnants of antimicrobials and resistant bacteria, adds to the environmental reservoirs of resistance.

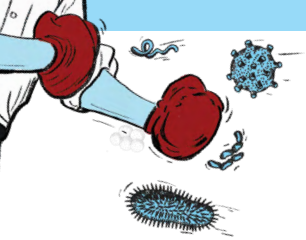
This environmental AMR can move across species barriers, ultimately affecting human populations through water, soil and food contamination. Therefore, AMR is a One Health issue because it directly impacts human, animal and environmental health.

Resistant pathogens from dairy farms pose significant risks, such as the transmission of zoonotic infections and reduced effectiveness of essential antimicrobial drugs. For LMICs, this is especially concerning due to weaker healthcare infrastructure, higher population density and greater dependence on livestock for livelihoods.

SUSTAINABLE SOLUTIONS FOR MITIGATING AMR

To mitigate AMR effectively, a comprehensive and sustainable approach is needed, focusing on farm biosecurity, enhanced awareness and prudent AMU (Figure 1). Here are some key strategies:

Farm biosecurity: Improving biosecurity measures on dairy farms can significantly reduce the need for antimicrobials. Biosecurity protocols—such as controlling animal movement, isolating sick animals, ensuring clean feeding system and maintaining proper hygiene during milking—are crucial for preventing infections. Research evidence has



shown that farms implementing strong biosecurity measures can significantly reduce AMU, thereby decreasing the risk of AMR development.

Awareness and training: Enhancing awareness among dairy farmers regarding AMR and the prudent use of antimicrobials is essential. Farmers should be trained on disease prevention methods that do not rely on antimicrobials, such as vaccination, improved nutrition and better housing. Extension services should also work towards educating farmers on the appropriate use of antibiotics, with an emphasis on using them only under veterinary supervision and understanding the negative environmental impacts of improper farm waste management.

Alternative practices: Alternatives to antimicrobials, such as vaccination, selective dry cow therapy (SDCT) and probiotics, can be instrumental in reducing the reliance on antibiotics. Selective dry cow therapy involves administering antibiotics only to cows with existing infections at the time of drying off, rather than treating all cows, which can significantly reduce antimicrobial usage while maintaining udder health.

Regulatory interventions: The role of regulatory frameworks in managing AMU cannot be overstated. The implementation of stricter regulations for AMU in dairy farming, such as banning over-the-counter sales of antibiotics, enforcing prescription-only use and restricting the use of antimicrobials of human importance, is crucial. This requires close collaboration between governmental agencies, veterinary associations and industry stakeholders. Effective enforcement of these regulations will help ensure that antibiotics are used appropriately and only when necessary.

Integrated One Health approach: A One Health approach is crucial for tackling AMR in dairy farming. This approach emphasises collaboration across the human, animal and environmental sectors. Implementing integrated surveillance programs to monitor AMR trends in dairy farms, coupled with policy initiatives promoting sustainable agricultural practices, is essential for effective AMR mitigation. Moreover, One Health initiatives should focus on building infrastructure and capacity for AMR research, surveillance and control in LMICs, where the burden of AMR is often the highest.

The fight against antimicrobial resistance in dairy farms is not solely the responsibility of livestock farmers but requires a collaborative effort across various stakeholders.

The implementation of farm biosecurity measures, farmer training, alternatives to antimicrobials and strong regulatory frameworks are all key components of a sustainable approach to mitigate AMR. By adopting these strategies, the dairy sector can contribute to the broader goal of reducing AMR, ultimately supporting the One Health vision and ensuring a sustainable future for animal, human and environmental health.

Dr. Pankaj Dhaka is Assistant Professor at Centre for One Health, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, India

15. AS MANY INDIANS AS NETHERLANDS' POPULATION DRINK MILK CONTAINING ANTIBIOTICS. EXPERT PROPOSES SOLUTIONS

There must be stricter regulation of veterinary medicines

Kuldeep Sharma

CLICK HERE TO READ ONLINE

CONTAMINATION in the dairy supply chain can occur at various stages, introducing hazards such as toxins, pesticides, heavy metals, veterinary drugs and organic pollutants into milk.

Antibiotic residues in milk often result from mastitis treatments, injections or contaminated feed. Improper drug use, especially for mastitis control, has been identified as a major source of such residues, leading to antimicrobial resistance, intestinal flora disorders and allergic reactions in humans.

Beyond health concerns, antibiotic residues cause significant issues in dairy processing, including poor curdling in dahi and yogurt, inadequate cheese ripening, reduced flavour in fermented products and diminished activity of starter cultures.

These effects not only compromise product quality but also lead to economic losses for the industry and threaten human health.

The antibiotics used in veterinary medicines belong to six major groups: Beta-lactams (eg: penicillin), aminoglycosides (eg: gentamycin), tetracycline (eg: oxytetracycline), macrolides (eg: erythromycin), quinolones (eg: fluroquinolone) and sulphonamides (eg: trimithropin). Any of the drugs belonging to these groups can appear in milk.

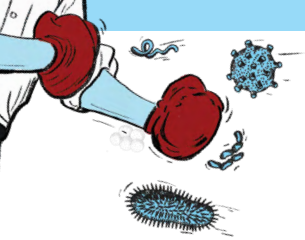
In 2016, this author had the opportunity to collaborate with the Food Safety and Standards Authority of India's (FSSAI) team in designing and implementing the National Milk Adulteration Survey. The scope of the survey expanded in 2018 to include contaminants, reflecting a more comprehensive approach to ensuring milk safety.

The survey showed that 77 (out of 6,432) samples, or 1.2 per cent of the samples, had residues of antibiotics above the permissible limits. Among the top three states with the highest levels of antibiotics residues were Madhya Pradesh (23 out of 335 samples), Maharashtra (9 out of 678 samples) and Uttar Pradesh (8 out of 729 samples). Only one raw milk sample in Kerala was found to contain pesticide residue above the permissible level.

A similar survey was conducted by FSSAI in 12 states / Union territories of India during the post-Covid-19 period in 2022 when the the country was also witnessing a Lumpy Skin Disease outbreak.

The milk samples were tested for all the 26 antibiotics specified in Food Safety and Standards Regulations for milk & 15 as specified for food commodities other than milk, according to the authors of the report. "Only 0.4 per cent (3 / 798) raw milk samples from the two States (two samples from Tamil Nadu and one from Karnataka) were reported to contain antibiotics specified for milk, namely sulfadimidine in one sample and meloxicam in two samples more than the prescribed limit."

Considering a total production of 670 million litres of milk per day in current times, the level of 1.2 per cent contaminated milk with antibiotics accounts for around 8 million litres of milk per day, thety added.



Assuming per capita availability of milk as consumption, around 180 million persons are consuming this milk on a daily basis, which is almost equivalent to the whole of Netherlands. We need to understand this problem and find appropriate solutions to counter the issue.

DRIVING FACTORS

Primary milk production area is the major contributor of contaminants like drug residue or aflatoxin M1. There has not been any direct intervention by the food regulator FSSAI in this part of the dairy value chain since the beginning.

However, after the 2018 survey, a scheme of testing and inspection was introduced by the regulator for all plants involved in processed liquid milk sales.

This intervention introduced the testing protocol with frequency for both raw milk sources as well as finished goods with frequency. The six monthly reports submission to the food regulator also mandated regular testing of contaminants.

There may be three reasons for lack of regular antibiotic testing of raw milk and finished goods: Minimal surveillance and enforcement for contaminant's residues in milk; the perception that this is not a major problem in processed milk sold by commercial dairies in our country and; the cost of testing of these contaminants particularly antibiotics residue is very high due to highly fragmented milk production and collection in India.

The dairy industry follows the principle of prevention through dilution. In India, milk is collected from 80 million small and marginal farmers in small quantities.

The contaminated milk from treated animals would be pooled with very large volumes of uncontaminated milk, resulting in undetectable amounts of antibiotic residues in bulk milk. There are several other reasons for presence of antibiotics in milk.

- Unregulated use of antibiotics by veterinary doctors as well as quacks, including prophylactic use of antibiotics to prevent diseases
- Lack of awareness at the farmers level about usage of antibiotics and their after effects in human beings
- Supply chain issues related to mixing of contaminated milk with clean milk during collection at the aggregator level
- Farmer's losses due to discarded milk of treated animals. No buyer is ready to compensate the farmers for the milk produced from under-treatment animals
- Limited and costlier methodologies for confirmatory tests of complete spectrum of antibiotics across the country

WAY FORWARD

India's regulations for testing antibiotics in milk and dairy products are among the most stringent globally. In some instances, these standards are even more rigorous than those in developed countries.

Indian regulations for commonly used cattle antibiotics, such as tetracycline, sulfadiazine and sulfonamide, are more rigorous than those of the European Union, and in some instances, surpass the standards of Singapore and the FAO-WHO's Codex. However, New Zealand has stricter maximum residual limits for tetracycline compared to India.

Despite the stringent regulations, the issue of antibiotic residues in Indian milk necessitates a paradigm shift through capacity building, access to quality infrastructure, grassroots interventions and alternative treatment strategies for animals.

FSSAI has recently taken steps to register all milk producers. This initiative could serve as a starting point for enrolling them in capacity building programs and raising initial awareness about good farming practices. These practices aim to produce antibiotic-free milk and promote alternative treatments for cattle, such as ethno-veterinary methods or homoeopathy.

Certain proactive steps like doing California Mastitis Test and catching animals at pre-clinical stage have been very helpful in avoiding use of antibiotics for mastitis. In India, a fourth of milk producers are enrolled with around 200,000 primary milk producers cooperative under the

National Dairy Development Board. A national-level program for incentivising farmers for contaminant free milk may be implemented. A large number of states offer milk subsidy from Rs 2-5 per litre. These subsidies may be made to contaminant free milk only as a policy.

The government should promote new-age startups as well as research institutions to develop technologies for low-cost rapid testing of antibiotics in milk and feed. This will simplify decision-making at farmers' level.

Some large multinationals with deep pockets are purchasing antibiotics-free milk at a premium of Rs 1-2 per liter from various members of the dairy value chain. However, handling the problem at its root by eradicating the need for antibiotics at farms through safe practices is a better option.

Finally, there must be stricter regulation of veterinary medicines. Prophylactic use of antibiotics to prevent diseases by doctors must be made illegal and all practicing veterinarian must be asked to keep records of Aadhar cards of cattle on which the antibiotics were used. The regulator to identify hotspots for the usage of these medicines through regional tracking of sale of these medicines.

Establishing regulatory standards and management practices to minimise antibiotic residues is crucial for food safety. Screening milk can prevent contaminated supply from reaching consumers. Many countries have adopted approved tests and implemented good practices on farms to reduce antibiotic residues effectively.

Last but not the least, all stakeholders should come together to solve this problem in an inclusive manner, by safeguarding public health at one hand and farmer's sustainability at the other hand.

Kuldeep Sharma is chief thinking officer at Suruchi Dairy Advisor, an initiative of Suruchi Consultants, Noida.

16. HOW POULTRY PRODUCTION IN INDIA EVOLVED TOWARDS A 'NO ANTIBIOTICS EVER' MODEL

Focus on disease prevention and innovation are reshaping the way we produce safe and affordable chicken and eggs

T Kotaiah

CLICK HERE TO READ ONLINE

POULTRY birds have a short generation interval and their productivity and liveability have improved significantly in recent years. As poultry production grows worldwide, chicken and eggs are becoming key protein sources at a lower cost than other options. However, some consumers worry that harmful substances might be used in poultry farming, posing health risks.

Poultry production in India began to take shape as an industry through commercial-scale operations after 1970. Grandparent stocks were imported from Western countries, bringing with them advanced poultry production technologies, including housing, feed and disease management.

Poultry farming in India was initiated by agricultural farmers, who constructed poultry sheds on their farmland and reared chicks purchased from hatcheries. The hatcheries supported the establishment of new farms and the expansion of existing ones.

With a strong demand for eggs and chicken, farmers profited from low-cost infrastructure. Birds were reared on deep litter, which was cleaned annually. Water was supplied in open troughs and feed was provided in ground mash form. The inclusion of fishmeal and meatmeal enhanced productivity.

At the time, few vaccines were available to protect against viral diseases. The general bacterial load on farms was high, with infections frequently erupting. Western technologists recommended antibiotics for both treatment and regular feeding to reduce bacterial load, which was kept gut bacteria levels low and was found to improve productivity.

Before 2000, there was little discussion about "transmissible antimicrobial resistance" from chicken and eggs to humans. Antibiotics were routinely used as growth promoters. Farmers eventually realised that medication costs were high and that productivity declined once flocks required treatment. Poultry producers began adopting disease prevention methods to reduce medication costs.

Some key prevention strategies that were adopted were:

- Watering systems: Open water basins and nipples were replaced with automatic drinkers. Water sourced from deep wells was stored in overhead tanks and delivered directly to birds, avoiding contamination by human contact or bird excreta.
- Feed processing: On-farm feed mixing was replaced by steaming and pelleting feed in large feed mills, ensuring bacteria were destroyed before the feed left the factory.
- Feed ingredients: Animal-based feed ingredients like fishmeal and meatmeal were eliminated from poultry feed.
- Vaccination and biosecurity: Vaccination and biosecurity were prioritised to prevent viral infections, as bacteria often caused secondary infections following viral outbreaks.
- Cage farming for layers kept birds away from their excreta, ensuring cleaner egg production

During the 1980s, egg consumption rose from single digits to 50 per capita and broiler farming expanded significantly. By 2010, broiler chick producers began rearing their own chicks both on their farms and through contract farming. Despite feed prices tripling, the prices of eggs and chicken did not increase proportionally.

Consequently, transmissible antimicrobial resistance became a critical issue and poultry production could no longer rely on antibiotics or expensive medication. Preventing diseases became the industry's primary focus.

The poultry industry is now moving towards a "No Antibiotics Ever" model, with a greater emphasis on biosecurity measures across structures and management protocols.

Poultry farming has seen significant advancements, particularly in the following areas:

- **Efficient seed material:** Genetic selection has improved seed material, increasing hen egg production from 260 to 325 eggs annually. In broilers, genetic advancements have reduced the time needed to reach the same weight, saving nearly a day each year.
- **Disease-free breeding stock:** Chicks are sourced from tested, disease-free breeding stocks maintained under strict biosecurity, preventing the transmission of diseases like Mycoplasma and Salmonella at the breeding stock level.
- **Clean hatcheries:** Hatcheries now operate under stringent cleanliness standards, similar to those of maternity wards, ensuring a healthy start for chicks.
- **All-In-All-Out rearing system:** This system introduces a gap between batches, allowing residual bacterial load to be naturally eliminated before new birds are introduced.
- **Vaccination improvements:** Effective, non-reactive viral vaccines have been developed to build bird immunity without causing feverish reactions. Killed vaccines for parent birds now offer long-term, high-level protection while passing maternal antibodies to their chicks.
- **Airborne disease prevention:** Farms are strategically located away from existing operations to minimise the spread of airborne diseases.
- **Dedicated personnel:** Farms employ dedicated workers who wear freshly washed uniforms and footwear daily, ensuring better hygiene.
- **Farm-specific equipment:** Vehicles and equipment are exclusive to each farm and not shared, reducing cross-contamination risks.
- **Feed safety:** Large farms, integrators and feed factories now conduct online testing of feed ingredients before unloading. Mechanised feed production and dispensing further minimise disease spread caused by human contact or the reuse of packaging materials.

These measures helped transform poultry farming into a more efficient, biosecure and sustainable industry.

Poultry production in the 2020s has improved and become more organised. Disease management focuses on prevention through clean breeder stocks, maternal vaccinations, clean water and sterilised feed, using a system known as "All in, all out". Mechanisation and improved disease awareness have eliminated the use of antimicrobial drugs in production. Concerns about drug-resistant bacteria originating from poultry products are now a thing of the past, allowing consumers to safely enjoy low-cost, high-quality protein produced by the poultry industry.

Dr Kotaiah is a senior veterinarian and Managing Director, Indbro Research & Breeding Farms Pvt Ltd Hyderabad, India

17. COST-EFFECTIVE, ECO-FRIENDLY TECHNOLOGY TO ELIMINATE ANTIMICROBIALS FROM WASTEWATER IS THE NEED OF THE HOUR

Combating waterborne AMR, its impact on human health needs a comprehensive One Health approach


Shridhar Narayanan


Bakul Piplani


Siva Shanmugam S


Radha K Shandil

CLICK HERE TO READ ONLINE

ANTIMICROBIAL resistance (AMR) occurs when bacterial, viral, fungal, parasitic and other pathogens develop mechanisms to withstand antimicrobials, rendering treatments ineffective. AMR poses a significant global challenge, with several studies providing comprehensive estimates and future forecasts of its burden across countries.

A recent Lancet study estimates that AMR caused more than one million deaths annually between 1990 and 2021. In 2021 alone, an estimated 4.71 million deaths were associated with AMR, including nearly 1.14 million directly attributed to drug-resistant infections. Forecasts suggested that by 2050, deaths associated with AMR could rise by 74.5 per cent to 8.22 million, with nearly 1.91 million directly attributable to AMR — a 67.5 per cent increase from 2021.

This steep rise in AMR could have drastic consequences, with more antimicrobials rendered ineffective, making the discovery of new, effective and safer antimicrobials more critical but highly challenging. Treating drug-resistant infections is already difficult, more expensive and often less safe, with global healthcare costs projected to increase by an additional $1 trillion by 2050.

Moreover, reduced productivity due to disability and loss of life could result in up to $3.4 trillion in gross domestic product (GDP) losses annually by 2030. Estimates from the initiative Investor Action on AMR suggested that the total global costs associated with AMR could reach $100 trillion by 2050, accompanied by a 3.8 per cent decline in global GDP. Clearly, AMR is not merely a global health challenge.

This year marked the second United Nations High-Level Meeting (UNHLM) on AMR, where member countries reviewed progress on global, regional and national efforts since the first UNHLM in 2016. They pledged to invest in sustainable tools and solutions that strengthen and accelerate multisectoral progress through a One Health approach, aiming to achieve global health equity.

Member countries committed to reducing global AMR-related deaths by 10 per cent by 2030, ensuring prudent antimicrobial use and establishing an independent panel for evidence-based action against AMR by 2025.

AMR disproportionately affects low- and lower-middle-income countries (LMICs), with over 80 per cent of AMR-associated deaths occurring in developing countries, making their voices crucial in this global forum. India's initiatives include the establishment of a National Task Force on AMR Containment in 2010, leading to the National Policy on AMR Containment (2011) and the National Programme on AMR Containment (2013).

These culminated in the first five-year National Action Plan on AMR (NAP-AMR 2017–21), launched by the Union Ministry of Health & Family Welfare in alignment with the Global Action

Plan on AMR. This was followed by NAP-AMR 2.0 in 2022, centred on the One Health approach.

Both national and global policy frameworks acknowledge the urgent need for new tools to address AMR. While safer and more effective antimicrobials are essential to improving treatment outcomes, they alone may not suffice. Accurate diagnosis using improved rapid diagnostic tools can guide prudent antimicrobial prescriptions, reducing overuse and misuse.

Vaccines can prevent infections, curbing antimicrobial use and slowing the spread of drug-resistant pathogens. Additionally, alternative therapeutic strategies such as bacteriophage therapy and microbiome-based interventions hold significant promise. Integrating these approaches — novel antimicrobials, diagnostics, vaccines and alternative therapies—offers the most effective means of addressing AMR and preventing its escalation.

While vaccines, diagnostics and new antimicrobials are essential to treat and limit transmission of drug-resistant infections, these tools alone are not sufficient. However, the primary driver of AMR remains the exposure of environmental microorganisms to sub-lethal levels of antimicrobials, fostering the evolution of drug resistance.

Resistant microorganisms can transfer their resistance genes to infectious pathogens, resulting in drug-resistant "superbugs". A notable example is the NDM-1 gene, which encodes a metallo-ß-lactamase capable of degrading last-resort carbapenem antibiotics such as meropenem and imipenem.

Major sources of antimicrobial release include hospital wastewater, pharmaceutical industry effluents and domestic sewage, compounded by indiscriminate use in agriculture and animal husbandry. Inadequate wastewater treatment exacerbates AMR in India and other LMICs. Studies have reported that 95 per cent of Escherichia coli isolates from hospital wastewater in South India and 100 per cent of those from the Cauvery river in Karnataka were resistant to third-generation cephalosporins.

Similarly, 17.4 per cent of Gram-negative pathogen isolates from the Ganga and Yamuna rivers were ß-lactam resistant. Existing wastewater treatment plants (effluent treatment plants, or ETPs and sewage treatment plants, or STP) largely fail to remove antimicrobials and active pharmaceutical ingredients (API). Advanced technologies like nanofiltration, irradiation, oxidation, ozonation and electrocoagulation remain underexplored for real-world utility and are often prohibitively expensive and energy-intensive.

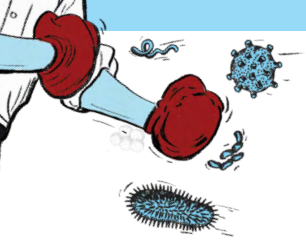
Hence, there is a major unmet need for new cost-effective technologies and solutions that can remove antimicrobials from wastewater, reduce their release into the environment and decelerate the emergence of drug-resistant pathogens.

At the Foundation for Neglected Disease Research (FNDR), we have developed a novel, cost-effective, customisable, eco-friendly and sustainable filtration technology to remove antimicrobials and other APIs, as well as microorganisms, from wastewater. Our technology is amenable to in-line deployment within existing ETPs and STPs, where it can yield antimicrobial- and pathogen-free treated water, safe for environmental release, without additional energy consumption.

Moreover, our technology has the added ability to remove other common water contaminants, such as heavy metals, fluoride, textile dyes, etc, making it a one-step solution that can significantly improve the efficiency of existing ETPs and STPs.

The results from lab-scale proof-of-concept studies suggest that our technology is efficient at removing diverse classes of antimicrobials, including antibiotics, antimycobacterials, antifungals, antivirals, and antimalarials, other pharmaceutical compounds, pathogens such as Escherichia coli, Enterococcus faecalis, and SARS-CoV-2, and noxious water pollutants such as heavy metals, fluoride, ammoniacal nitrogen and industrial dyes.

Subsequent evaluation of the technology in a hospital field trial revealed that it could remove 70-90 per cent of antimicrobials from diverse chemical classes, suggesting a high success rate in the real-world settings. We anticipate that the large-scale deployment of such a solution as an add-on to existing commercial, industrial and municipal wastewater treatment set-ups will help reduce AMR associated morbidity, mortality, and global



socio-economic burden significantly.

The need of the hour is the expedited deployment of newer technologies, such as that developed by the FNDR team and their integration into the global policy frameworks and National Action Plans for AMR. The clock is ticking, and we must act now!

Shridhar Narayanan is a co-founder, chairman and chief executive officer at the Foundation for Neglected Disease Research (FNDR) and scientific advisor to the Indian Pharmaceutical Alliance

Bakul Piplani is a research scientist leading the grants and scientific communications efforts at FNDR

Siva Shanmugam S is a scientist leading the DMPK and Bioanalytical team at FNDR

Radha K Shandil is a co-founder, Director and Chief Scientific Officer at FNDR

18 INDIA CAN PLAY A PIVOTAL ROLE IN GLOBAL RESPONSE TO AMR BY BALANCING REGULATORY COMPLIANCE WITH ECONOMIC VIABILITY

A collaborative environment where regulatory standards are effective and practical is essential

Ashok K Madan

CLICK HERE TO READ ONLINE

ANTIMICROBIAL Resistance (AMR), one of the most urgent health threats facing the world, can jeopardise human health, agricultural productivity, and the environment. Declared by the World Health Organization (WHO) as one of the top 10 global public health threats, AMR could lead to 10 million deaths annually and economic losses of around $100 trillion by 2050 if not addressed.

India, along with China, contributes 80-90 per cent of the world's antibiotic production, positioning itself at the forefront of the global AMR response. However, India's strict adherence to environmental regulations has sometimes put manufacturers at a competitive disadvantage, particularly compared to countries like China, resulting in the Indian Active Pharmaceutical Ingredient (API) industry losing ground to Chinese competitors since the 1990s. Establishing a level playing field through fair regulations is essential for India's competitiveness while safeguarding the environment. Integrating a One Health approach — recognising the interconnected health of humans, animals, and the environment — is crucial for effective AMR containment.

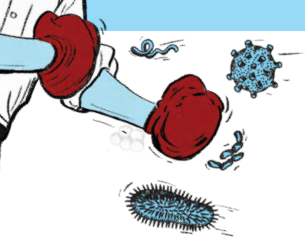
The G20, under India's presidency in 2023, declared AMR a priority area, urging collaborative action among member nations. This commitment, echoed in the 2024 United Nations General Assembly (UNGA) Political Declaration and the latest WHO report on AMR, emphasises the urgent need for global cooperation, regulatory insight, and action.

The One Health approach, endorsed in the UNGA 2024 Declaration, is vital for addressing AMR effectively, particularly in API manufacturing. By minimising environmental pollutants and practicing responsible antibiotic manufacturing, API facilities can help prevent the spread of AMR and protect ecosystems. The recent declarations call for comprehensive national action plans to enhance surveillance, reduce unnecessary antibiotic use, and increase research funding.

The 2024 WHO AMR Report highlights the necessity for regulatory vigilance concerning pharmaceutical pollutants. The WHO's AWARE classification (Access, Watch, and Reserve antibiotics) provides a framework for prioritising effective antibiotics while protecting those reserved for last-line treatments. For API manufacturers, this means monitoring production practices closely, especially for antibiotics in the Watch and Reserve categories, which have a higher resistance potential. Implementing advanced wastewater treatment technologies can significantly reduce AMR spread.

HIGH CAPITAL EXPENDITURE AND PNEC COMPLIANCE

Compliance with Predicted No Effect Concentrations (PNEC) —environmental concentration limits for antibiotics — poses a financial challenge for API manufacturers. Establishing PNEC compliance can require substantial investments, estimated to be



Rs 60-120 crore ($7-15 million) for initial setup and Rs 5-20 crore ($600,000–2.4 million) annually for maintenance. Additionally, individual AMR testing can cost between Rs 15,000-35,000 ($180-420), placing significant financial strain on manufacturing operations, particularly for small and medium enterprises. There is a need for India-specific studies to address antimicrobial residues in effluents under tropical conditions.

Both the G20 and UNGA declarations, along with the WHO report, advocate for financial incentives, such as subsidies and tax breaks, to offset high costs. Government-backed funding to establish advanced wastewater treatment and residue testing facilities is critical for ensuring compliance and maintaining India's competitive edge in the global pharmaceutical market.

IMPLEMENTING ZERO LIQUID DISCHARGE (ZLD)

Implementing ZLD technology is crucial for managing antibiotic residues in wastewater from API facilities. However, the substantial capital and recurring expenses associated with ZLD can be prohibitive for smaller manufacturers. Despite the high costs, ZLD systems align with international environmental targets by reducing the environmental burden and conserving water resources.

Policies like the United Nations Environment Programme's Responsible Antibiotics Manufacturing Programme suggest that ZLD facilities be exempt from bio-assay tests due to their advanced standards. To promote ZLD adoption, government incentives and clear regulatory guidelines distinguishing ZLD from non-ZLD facilities are necessary to ensure compliance without jeopardizing economic viability.

ALIGNING WITH GLOBAL STANDARDS

Recognising the unique scale of API manufacturing in countries like India, the G20, UNGA 2024, and WHO reports highlight the need for tailored standards. Regulatory standards should differentiate between high-output API production and formulation manufacturing to avoid unnecessary financial burdens on smaller facilities. This approach will enable India to lead in AMR containment while preserving its API sector's global standing.

INCENTIVISING R&D AND NATIONAL AMR ALLIANCES

The global antibiotic pipeline has thinned, with only 34 new antibiotics in development—a crisis underscored by the 2024 WHO report. In response, the pharmaceutical industry is creating initiatives like the AMR Action Fund to support new antibiotics. For India's API industry, establishing a national AMR alliance could facilitate pooled resources for R&D and advance research in priority areas.

Funding R&D aligned with the WHO's 40 research areas on AMR can foster innovation and expand treatment options. Developing partnerships for early-stage research into resistant bacteria, fungi, and Mycobacterium tuberculosis would position India as a pivotal player in the global AMR response.

IMPLEMENTING RESPONSIBLE USE AND GREEN PROCUREMENT STANDARDS

Countries like Norway are adopting green procurement policies that prioritise environmental performance over cost. By embracing green standards, Indian manufacturers can attract international clients while minimising AMR spread. These standards include rational antibiotic use and effective residue monitoring, promoting a sustainable pharmaceutical industry in India.

INDIA'S NATIONAL AMR RESPONSE

India's National Guidelines for Infection Prevention and Control and its AMR containment program across 38 state medical colleges support WHO recommendations. As a significant player in antibiotic production, India is well-positioned to combat AMR while ensuring the sustainability of its pharmaceutical sector. By aligning with the G20's AMR prioritization, the UNGA 2024

Political Declaration, and the latest WHO AMR report, Indian API manufacturers can contribute meaningfully to global AMR goals.

A collaborative environment where regulatory standards are effective and practical is essential. This includes supporting sustainable manufacturing practices, adopting advanced waste management solutions, and encouraging research into antibiotic alternatives. By balancing regulatory compliance with economic viability, India can enhance its competitive edge and play a pivotal role in the global response to AMR.

Ashok K Madan is Executive Director of Indian Drug Manufacturers' Association, Delhi

The compendium of articles on the issue of antimicrobial resistance (AMR) is contributed by global and Indian experts in order to mark the World AMR Awareness Week (WAAW) 2024. Under the overarching theme of 'Prevent AMR', this series of invited expert articles cover different aspects such as challenges and solutions vis-à-vis policy, practice, technology, governance, financing, access or implementation of National Action Plan across One Health sectors. The articles were originally published in web version of Down to Earth, CSE's fortnightly magazine during WAAW 2024.

CENTRE FOR SCIENCE AND ENVIRONMENT
41, Tughlakabad Institutional Area, New Delhi – 110 062
Ph: 91 – 11 40616000 Fax: 91 – 11 – 29955879, Email: cse@cseindia.org
Website: www.cseindia.org