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Antimicrobial Resistance and Antibiotics use in Livestock Contribution to Pollution: A Case study of India

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Abstract: The mortality and economic costs associated with antimicrobial resistance (AMR) are still amajor concern. Several countries' health agencies, including India's, have devised plans to stop the spreadof the disease. Humans, animals, food, and the environment must all be considered in the fight againstAMR. The many components of the Indian take on the One Health movement are covered in thiscomprehensive examination. Antimicrobial resistance (AMR) is a major problem that threatens animal andhuman health, food safety, ecosystems, and the long-term viability of animal protein production, all ofwhich are negatively impacted by the widespread use of antibiotics in animal feed. Consequences of theintense and widespread usage of antibiotics in cattle production are discussed. Resistant organisms ortheir genes have also been found in the environment, particularly in water sources. Two major factorscontributing to antimicrobial resistance in India are the improper usage of these drugs and inadequateway in which waste water is handled. While there is information available for other nations, India ismissing information about the factors that contribute to AMR, such as the use of sludge in agriculture,the inappropriate dispose of livestock animals, and the aquaculture business. While the Indian healthauthorities have begun taking steps to combat AMR, these efforts are in their infancy. In this review, wefocus on how the creation of antibiotic alternatives in the post-antibiotic age can help ameliorate AMRissues. Here, we focus on how the creation of antibiotic alternatives in the post-antibiotic age can helpameliorate AMR issues. The future is suggested with the difficulties that India faces in mind.

Keywords: Antimicrobial resistance (AMR), Antibiotics , Mortality , Health Authorities, Aquaculture Business , Post-Antibiotic Age

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INTRODUCTION

Antimicrobial resistance (AMR) already claims the lives of 700,000 people every year, with an additional 10 million expected to perish by 2050. This makes AMR the third leading cause of death, after cancer and automobile accidents. By 2050, AMR is predicted to reduce global GDP by 2-3.5 percent, with a corresponding drop in livestock of 3-8 percent, costing the global economy an estimated USD100 trillion. The World Health Organization (WHO) and other interested parties are paying attention to the spread of antimicrobial resistance (AMR) around the world. With the World Health Organization designating antimicrobial resistance as a top priority area3, and numerous European heads of state formulating plans to rein in the spread of AMR, it is clear that action must be taken. There is little doubt that genuine attempts are being made to combat this shared foe. Additionally, India has developed its own AMR National Action Plan (NAP).

It has been estimated that the majority (about 80%) of all antibiotics sold in the United States are used in animal agriculture to promote growth and prevent illnesses [3]. Sales data for antimicrobials from 41 countries also suggests an increase of 11.5% from 2017's estimated 93,309 tonnes to 2030's projected

104,079 tonnes [4]. The "One Health" strategy and other forms of multi-disciplinary integration are necessary for addressing the AMR problem and mitigating the hazards associated with the widespread use of antimicrobials in animal farming.

To attain optimal health and well-being results, "One Health" emphasises the linkages among humans, non-human animals and plants, and their shared ecosystem and environment at the local, regional, national, and global levels . Recent instances of zoonotic diseases that have spread from animals to humans include swine flu, Ebola, and the horrific current Covid-19 pandemic. Fortunately, many nations, including India , have made steps to limit the use of antimicrobials in livestock farming. The Indian government has been working on reducing the overuse of antibiotics since 2016, when they initiated a countrywide pilot programme to accompany new rules. Due to the multifaceted nature of the AMR issue, a simple solution is not possible. A prohibition on antibiotic feed additives will obviously have negative effects on livestock disease resistance and normal growth cycles, which will have a knock-on effect on investment costs for livestock and poultry. India's NAP on AMR was recently framed in April 201, outlining the country's planned actions over the next five years. This paper describes the current state of antimicrobial resistance in India, along with the specific difficulties experienced there and the environmental factors that contribute to the spread of AMR.

PREVALENCE OF AMR IN INDIA, AS REPORTED: A STATEMENT OF THE PROBLEM

Because of their interconnectedness, human, animal, and environmental factors are all considered in the One Health approach to AMR control. Similar trends may be seen in India, where AMR rates have been increasing at an alarming rate across all three industries throughout the past decade or so. Lack of adequate research and data also hinders accurate evaluation of the rise and scope of AMR in India and precludes a nationwide comparison. Just under half (48.3%) of the 1,252 AMR studies published by Indian institutes focused on human subjects, with the remaining 3.3% focusing on animals, 4.2% on the environment, and 0.5% on One Health. The remaining 11 were founded on novel agents, diagnostics, editorials, and other non-canonical sources.

ANIMAL MANURE: A SOURCE OF ANTIBIOTICS AND ANTIBIOTIC RESISTANCE GENES

Antibiotics and the ecotoxicological consequences they have on the environment have emerged as a pressing global issue [1-4], with antibiotic misuse in the cattle and poultry sector standing out as a particularly pressing area of study [5-8] and [9]. According to research, only a fraction of antibiotics given to animals really enter the animals' metabolic pathways and are utilised by the animals. Urine and faeces are the primary routes for the excretion of both ingested antibiotics and the antimicrobial resistance genes they produce in animals [10, 12]. In many cases, farmers use untreated faeces as an organic fertiliser, despite the fact that it contains antibiotics and/or AMR genes. This practise has serious environmental, food safety, and ecological toxicity consequences because it puts stress on the resistance of soil microorganisms and induces additional antibiotic resistance genes. There has been widespread detection of AMR genes in animal waste [15–18]. In cattle breeding, tetracycline resistance genes and sulfonamide resistance genes are the most common forms of resistance genes [19,20]. Eight tetracycline resistance genes expressing resistance were discovered in septic tanks and groundwater samples near pig farms by Chee-Sanford et al.; they were tetracycline O (tet (O)), tetracycline Q (tet (Q)), tetracycline W (tet (W)), tetracycline M (tet (M)), tetracycline This study demonstrated that the release of livestock manure without proper treatment poses a significant threat to the local water and soil quality due to the spread of AMR gene pollution. India's cattle and poultry breeding business has shifted from decentralised to intensive farming during the past few decades. Antibiotics are widely utilised, and antibiotic-related contamination from animal and poultry waste is a major problem .The waste from our animal companions has developed into a massive reservoir of antibiotic-resistant genes.

The scale of the problem as it currently exists in India is as follows:

Malaria in humans More than 70% of Escherichia coli, Klebsiella pneumoniae, and Acinetobacter baumannii isolates, and nearly 50% of Pseudomonas aeruginosa isolates, were resistant to fluoroquinolones and third-generation cephalosporins, according to the'scoping report on antimicrobial resistance in India (2017), which was commissioned by the government of India. There was still 35% resistance to the piperacillin-tazobactum medication combination among E. coli and P. aeruginosa, while 66% of K. pneumoniae were resistant due to the existence of several resistance genes, including carbapenemases. Rising A. baumannii carbapenem resistance rates of 71% have necessitated the use of colistin as a last-resort antimicrobial. There is now evidence of colistin resistance in India. High mortality of 70% was linked to colistin-resistant K. pneumoniae, despite the low rate of colistin resistance (1%, except for 4.1% reported by Gandra et al.). Staphylococcus aureus accounted for 42.6% of methicillin-resistant S. aureus and Enterococcus faecium for 10.5% of vancomycin-resistant E. faecium among Gram-positive organisms. Rates of resistance to ciprofloxacin were 28% and 82% for Salmonella Typhi and Shigella species, respectively; rates of resistance to ceftriaxone were 6% and 12%, and rates of resistance to co-trimoxazole were 2% and 80%, respectively. Vibrio cholerae tetracycline resistance ranged from 17% to 75% across the country in 2011.

Agriculturally-Relevant Animal-Transmitted Disease : In 2015, India surpassed China as the world's greatest milk producer and ranked second in fish production, according to statistics. And between 2000 and 2030, poultry consumption in India is projected to increase by a whopping 577 percent. Since the potential of the food animal sector is so great, antimicrobial drugs are employed extensively to maximise output. The states of Uttar Pradesh (17.6%), Rajasthan (10.0%), and Andhra Pradesh (9.4%) were responsible for a large portion of India's total milk production in 2013-2014, which amounted to 137,685.8 103 tonnes. 15. Fourty-eight percent of Gram-negative bacilli found in cow and buffalo milk were extended-spectrum -lactamases (ESBL) producers (West Bengal), and 47.5% were resistant to oxytetracycline, according to analysis of milk samples used to estimate AMR in livestock (Gujarat) 16. Vancomycin resistance was found in 2.4% of S. aureus (West Bengal)17 among the Gram-positive organisms isolated from these milk samples; methicillin resistance was found in 21.4% of S. aureus and 5.6% of coagulase-negative Staphylococci (Karnataka) 18. With an annual output of 9579103 tonnes of fish15, India is rapidly becoming a global leader in the aquaculture sector. Fourty-eight percent of the Enterobacteriaceae isolated from the stomach of the common Tilapia fish found in Maharashtra's lakes were ESBL producers. 19. Shrimp, shellfish, and crabs sold in Kerala's retail markets tested positive for Vibrio cholera and Vibrio parahaemolyticus and were found to be 100% resistant to ampicillin and 100% susceptible to chloramphenicol, with ceftazidime resistance ranging from 67% to 96%. 20. The states of Haryana (18.4%), West Bengal (17.1%), and Uttar Pradesh (14.1%)15 account for most of India's annual broiler meat production of 1,916 103 tonnes. Three of the seven existing studies on AMR in poultry11 focused on ESBL-producing Enterobacteriaceae and found that the rate of ESBL producers varied from 9.4% in Odisha to 33.5 % in Madhya Pradesh to 87% in Punjab. Salmonella species were found in broilers at a rate of 3.3% in Uttar Pradesh and a rate of 23.7% in Bihar, with 100% of isolates in Bihar and West Bengal being resistant to ciprofloxacin, gentamicin, and tetracycline. 11.

Contaminant-Mediated Reactions in the Natural World It has been observed that several water sources in India include bacteria and their genes that are resistant to antimicrobials. Hospital effluents and pharmaceutical wastewaters are two important contributors, both of which are often discharged untreated into neighbouring water sources. When the treatment facility received only residential water, only domestic waste, or only hospital effluent as input, the rate of E. coli isolates resistant to the third generation of cephalosporin varied from 25% to 95%, depending on the source of the input21.

THE DIFFICULTIES OF ANTIMICROBIAL RESISTANCE IN INDIA

Many people consider India to be "the AMR capital of the world". India faces a double bind: on the one hand, the country is fighting more drug-resistant strains of long-standing foes like tuberculosis, malaria, and cholera; on the other hand, new MDR organisms are emerging, creating new diagnostic and treatment hurdles. Poverty, illiteracy, crowding, and malnutrition all contribute to the problem30. The general population's lack of knowledge about infectious diseases and their lack of access to healthcare often prevent people from seeking medical advice. As a result, people often try to treat themselves with antibiotics without first consulting a doctor to determine the proper dosage and length of treatment. Due to a lack of appropriate diagnostic techniques, many patients who seek medical attention wind up taking broad-spectrum, high-end antimicrobials. The spread of multidrug-resistant (MDR) organisms in hospitals is facilitated by factors like low doctor to patient and nurse to patient ratios and a lack of infection prevention and control (IPC) guidelines. The accessibility of OTC medications also contributes to antimicrobial resistance.

As the pharmaceutical industry has grown, so too has the amount of trash it produces. This waste finds its way into water bodies and is a constant source of AMR in the environment despite the lack of stringent regulatory and legislative actions. The use of antimicrobial agents like pesticides and insecticides in the agricultural industry could be a problem, but there is not enough evidence to make that claim at this time. As it is, India's farmers must contend with a variety of environmental challenges, including arid climates, mountainous terrain, and frequent natural disasters on the country's enormous agricultural fields. Without giving any thought to the long-term effects, they give in to the temptation of employing antimicrobial agents to safeguard their field from pests and rodents. Rains and floods wash this massive stockpile of antimicrobials into nearby bodies of water, creating ideal conditions for the spread of MDR infections. Framing and implementing policies on the control of AMR are hampered by the lack of data on the degree of AMR, especially in animals and the environment.

ANTIBIOTICS AND GENES FOR RESISTANCE TO THEM DISPERSED

THROUGH WATER, SOIL, AND PLANTS

Antibiotics, either as their parent chemicals or as their major metabolites, are estimated to make up 30-90% of what is discarded in animal faeces and urine . Antibiotics found in large quantities in livestock manure can pollute the environment by leaching into the land and water (Figure 1). Animal dung and urine fertilisation can introduce antibiotic residues into the soil, where they can accumulate and have negative effects on plant health. Soil microbial communities and activities are impacted by antibiotic residues, which also promote the emergence and dissemination of bacteria with resistance genes. Soil's adsorption and degradation capacities vary depending on the type of antibiotic present, with tetracyclines having the highest relative rate, followed by fluoroquinolones, macrolides, and finally sulfonamides. Water contamination occurs when antibiotics in manure seep into groundwater through infiltration or runoff with soil leaching after being applied to crops. Furthermore, wastewater discharged from animal farms or rains will damage surface water due to the leftover antibiotics in livestock and poultry excrement.

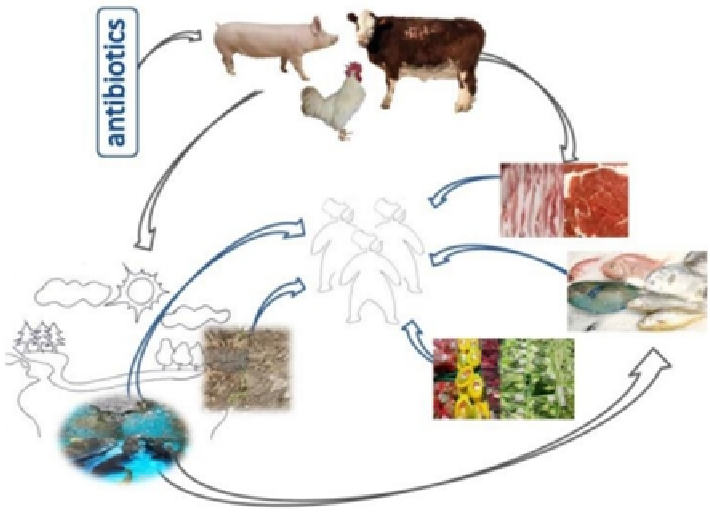

Figure 1 shows the prevalence of the use of veterinary antibiotics in the livestock and poultry production industry for the purposes of both promoting healthy growth and curing existing disorders. Because of this, AMR and ARGs have spread widely from animals to humans, other animals, plants, the ecosystem, and the environment (soil and water pollution), as seen in the diagram below.

THE PRESENCE OF ANTIBIOTICS AND ANTIBIOTIC RESISTANCE GENES (ARGS) IN WATER, VERSION

Aquaculture effluent, whether treated or not, is a major contributor to antibiotic and ARG pollution in rivers. Nine regularly used veterinary medications were tracked by Xu et al. in the Pearl River during the high and low water seasons. These medicines included ofloxacin, norfloxacin, and amoxicillin. In the flood season, antibiotic concentrations ranged from 11 to 67 µg/L, whereas in the low water season, they reached a maximum of 460 µg/L. Only amoxicillin was not detected. From 0.44 to 169 g/L and 0.44 to 4.66 g/L, respectively , nine antibiotics were found in the wastewater of livestock farms in the northern, central, and southern regions of Jiangsu Province. Average amounts of ofloxacin, norfloxacin, roxithromycin, erythromycin, and sulfamethoxazole in the Yellow River and its tributaries ranged from 25 µg/L to 240µ/L in some rivers .Antibiotics including ofloxacin and enrofloxacin, among others, were found in the water of Baiyangdian Lake by Li et al. .Antibiotics have also been discovered in the groundwater of greenhouses that utilise animal dung as organic fertiliser to grow vegetables.

Many ARGs were found in the river, and antibiotics were found there as well. Examples include the high detection rate (100%) and abundance (sul1 and sul2) of sulfonamide resistance genes (sul1 and sul2) in the Tianjin Haihe River , and the presence of tetracycline resistance genes (tet A and tet B2; 43 and 40 percent, respectively) in the water of the Pearl River .Two sulfonamide resistance genes, nine tetracycline resistance genes, and one β- lactam resistance gene were discovered by Jiang et al. in Shanghai's Huangpu River and a drinking water reservoir. There is a risk that ingesting water from these waters, which has been contaminated with germs that are resistant to antibiotics, could be harmful to human health.

Antibiotics have recently come under scrutiny due to the potential harm they pose to the environment through water pollution. Aquatic species eventually absorb or consume antibiotics that have been identified in water. When antimicrobials are employed in aquaculture to raise seafood, those antimicrobial-resistant (AMR) genes can make their way up the food chain and into humans. Long-term effects on human health and the development of drug resistance would be particularly devastating for the young, the old, and those with compromised immune systems.

Furthermore, some bacteria and fungi may develop multi-drug resistance and eventually produce "superbugs" as a result of the long-term enrichment of antimicrobials in water. Superbug infections pose a serious risk to human and animal health around the world. These infections can cause not only death, but also a significant financial burden on the healthcare industry (www.who.int (accessed on 30 March 2021).

THE CONSEQUENCES OF MISUSING ANTIBIOTICS

Immune System Deficiency in Livestock and Poultry

When a significant dose of antibiotics is taken orally, the drugs travel through the bloodstream to reach all of the body's tissues and organs that need them .This includes the lymph nodes, kidneys, liver, spleen, thymus, lungs, and bones. The animals' ability to fight off sickness will diminish with time, and the prevalence of chronic conditions will rise. Antibiotics can also reduce antigen quality, which negatively impacts the immunological process and, in turn, vaccination .

Affect Livestock and Poultry by Causing Dysbacteriosis, Disease, or Secondary Infection

Antibiotics inhibit harmful microorganisms and also disrupt the mutual restriction pattern of microbial populations or communities, despite each antibiotic having its own antibacterial range. As a result, the microecology becomes unbalanced, and either resident bacteria or passing bacteria proliferate at an abnormally high rate, resulting in either a secondary infection or an infection from within .In particular, widespread and long-term antibiotic usage disrupts the body's natural flora, creating an environment where pathogenic bacteria might flourish and cause an inside infection .Exogenous infection can occur when drug-resistant bacteria from the outside of the body are able to invade a susceptible host due to antibiotic-induced microbial vacancy.

Environmental Impacts of Animal Product Residues

The use of antibiotics in animal feed has been met with some criticism due to concerns about drug residue. Antibiotics, once ingested, travel throughout the body, with the liver being a particular target. Antibiotics are mostly eliminated in the urine, faeces, and bile. Drug residues in the environment can be the result of the long-term stability of some antibiotics that are excreted into the environment. A huge number of drug-resistant strains, decreased resistance to specific diseases, or toxic effects on the body due to a large accumulation can emerge from the delayed buildup of these leftover pharmaceuticals in the human body and plants via animal products and the environment [7].

ANTIBIOTIC RESISTANCE IN BACTERIA AND OTHER ILLNESS-CAUSING MICROORGANISMS

Antibiotic resistance among infectious diseases is a worldwide concern. Antibiotic-resistant infections have virtually eliminated all available treatment options. To be more specific, prolonged use of antibiotics in animals at dosages below the therapeutic dose (such as preventative doses and growth promoting doses) can hasten the development of antibiotic-resistant bacteria. Antibiotic-resistant bacteria (ARGs) can transfer from animal to animal once they are created, turning the animals housed in intensive breeding facilities into a vast reservoir of ARGs.

Table 1 : Classification of Antibiotic Substitutes

Category	Plant Active Substances		Phages	Vaccines	Probiotics	Antimicrobial Peptides
	Essential oil	Condensed tannins				
Classification composition	Carvacrol, citronellol, geraniol, eugenol, thymol	Oligomeric or polymerized flavonoids consisting of flavane-3-ol. Mainly includes catechin		Heat inactivated bacteria, viruses, active modified and purified components	Lactic acid bacteria, yeast, Lactobacillus, etc.	Polypeptides
Function	Antibacterial, antifungal, anti-virus, anti-inflammatory, increase feed palatability	Antibacterial, antiparasitic, antioxidant, immunomodulatory activities	Predate on bacteria	Prevention of virus and bacterial infection	Inhibit pathogens, change microbial metabolism and regulate immunity	Broad antibacterial spectrum, immune function, promoting growth, not easy to produce drug resistance

Adverse Reactions to Antibiotics and Other Resistance Genes (ARGs) and Their Effects on Human Health

Antibiotics like penicillin, streptomycin, sulfonamides, and others have been linked to an increased risk of allergic reactions; the use of chloramphenicol has been linked to regenerative, dysfunctional, and hemolytic anaemia; thrombocytopenia; and liver injury; tetracyclines have been linked to photosensitivity and gastrointestinal reaction; olaquindox is a gene inducer; furazolidone has been linked to induced animal carcinogenesis.

DRIVERS OF ENVIRONMENTAL AMR IN INDIA

Antimicrobial overuse and abuse Antimicrobial resistance (AMR) is exacerbated by human intake of antibiotics; India has the highest per capita usage of antibiotics worldwide. Consumption of antibiotics in India in 2010 was 12.9 109 units, or 10.7 units per person. Retail sales of antibiotics increased by 23% between 2000 and 2010. Since then, it has been assumed that the consumption rate has been growing. Although alarming, these numbers should come as no surprise in a country like India, where antibiotics are utilised on a daily basis (39,40). Widespread availability of illicit antimicrobials demonstrates deficiency in the functioning of health authorities, while the lack of understanding among medical practitioners about the judicious use of antibiotics, especially fixed-drug combinations, 41 highlights this problem. Kelesidis and Falagas reviewed the prevalence of substandard and counterfeit antimicrobial agents and found that 39% of the tested agents were substandard, making India the leading country in both production and use.

Antimicrobial resistance (AMR), which is exacerbated by animal usage of antibiotics: There is an anticipated 31.2% increase in the global market for meat, meat products, and farmed seafood produced in India by 2030–14. Antimicrobials play an important role in preventing illnesses in these farmed animals and in boosting productivity45. After China, the United States, and Brazil, India is the world's fourth-largest user of antimicrobials for use in animals. According to Bayesian forecasts, between 2010 and 2030, India would be responsible for the greatest relative growth in antimicrobial use for use in cattle. Chicken meat and milk, for example, have both been shown to contain traces of antibiotics in reports from India

Biocide-induced antimicrobial resistance : A biocide is any agent whose primary purpose is to eliminate the offending microorganism or pathogen. Insecticides, pesticides, fertilisers, and disinfectants are all part of this category. Exposure to biocides, even at sub-lethal quantities, can boost the population of resistant organisms in the environment. Soil nitrogen depletion through the use of nitrogen-based fertilisers has been linked to the elimination of the vanA gene, which in turn has been linked to an increase in clinical vancomycin resistance. The co-selection of biocides and antimicrobials is aided by the fact that they share resistance mechanisms. Due to their shared position on plasmid, S. aureus bacteria are resistant to the biocide benzalkonium chloride and also have an eight-fold higher tolerance to the antibiotic oxacillin.

Sewage sludge from the city: Due to the fact that 30–90% of all antimicrobials are excreted unchanged in human faeces and urine, sewage sludge provides a prime breeding ground for resistant microorganisms and genes. Only about 20%-30% of municipal waste water is handled at treatment plants, and even that is not enough to get rid of the resistant organisms, according to a study published in Environmental Health Perspectives. 'AMR-rich' municipal waste water is released into the local water supply. It has been found that domestic and municipal sewage waste is the primary source of antibiotic-resistant genes in the Mutha River that flows through Pune, India, with a concentration 30 times greater in the sediments close to the city. Enterococci, a common gut commensal, could be isolated from rivers in a few locations, but the rate of vancomycin-resistant enterococci on the banks of the Indian river Gomti varied widely, from 22 percent to 100 percent.

Sewage from medical facilities: Antimicrobial waste is generated in large quantities in hospitals and other healthcare institutions, either indirectly through patient secretions or directly as wasted discarded drugs. Concerning levels of fluoroquinilone, sulphonamide, and tinidazole residues were detected from an Indian hospital wastewater, as reported by Mutiyar and Mittal57. Because of the huge volume of antimicrobials used in healthcare settings, the effluent waters from these facilities are likely to be particularly rich in resistant bacteria and their genes. There were sufficient antibiotic concentrations in the effluent plants of Indian hospitals to trigger genotoxic changes and thus alter bacterial strain.

STEPS TAKEN TO CURB AMR IN THE ENVIRONMENT

Dedications to politics

(i) Cooperation on a global scale: The World Health Organization (WHO) first identified AMR as a major public health risk in 20113. Multiple meetings were held by the South East Asian Regional Office (SEARO) to discuss and decide upon strategies for combating antimicrobial resistance (AMR) in the region. In 2011, the Health Ministers of all Member nations, including India, met in Jaipur, India, and pledged to embrace the Jaipur Declaration by enacting stringent measures on AMR. In the 2014 WHO Report, the alarmingly high rates of AMR in India were highlighted. This Report prompted collaborative efforts between India and the World Health Organization. The World Health Organization has designated antimicrobial resistance (AMR) as a Flagship Priority issue for SEARO8, and in response, the Indian Medical Association has begun an awareness programme to educate medical professionals and the public. To combat antimicrobial resistance (AMR), the 68th World Health Assembly in 2015 adopted the idea of "One Health" and launched the first iteration of the Global Action Plan (GAP74). Members, including India, committed to developing national action plans (NAPs) to combat AMR by the end of 2017.

(ii) National efforts: To create India's NAP, the government established a Core Working Group on AMR. NAP has outlined six strategy targets, all of which include some sort of environmental consideration for AMR. In addition, a timeframe for the following five years is outlined for the completion of each strategic priority's identified interventions, actions, and outcomes. Despite its potential, the NAP has not yet been implemented fully in any of the Indian States. The Central Drugs Standard Control Organization of India introduced Schedule H1 in 2014 to reduce the widespread illegality of over-the-counter drug sales. However, it includes only a subset of antimicrobials, specifically groups. The Food Safety and Standards Authority of India (FSSAI) released a list of acceptable amounts of antimicrobial residue in animal, poultry, and fish products in June 2017.

Indian health care institutions Both the Indian Council of Medical Research and the National Center for Disease Control launched AMR surveillance networks in 2013 and 2014, respectively, to better understand the epidemic's scope. With funding from the United States' Centers for Disease Control and Prevention (CDC), these two groups began conducting a comprehensive review of current IPC practises in India in 2015, with the ultimate goal of developing updated recommendations for reducing the prevalence of healthcare-associated infections in hospitals. However, these initiatives primarily address AMR in healthcare settings and do not make any unique accommodations for AMR in the natural world. Similarly, the National Health Systems Resource Centre and the National Accreditation Board of the National Health Mission focus on infection prevention and control (IPC) methods and the fortification of laboratories and hospitals rather than AMR in the environment per se30. National health authorities have only recently come to terms with the environmental significance of AMR, and the National Health Policy 201775 calls for "a rapid standardisation of guidelines regarding antibiotic use," as well as "limiting the use of antibiotics as OTC medications," "banning or restricting the use of antibiotics as growth promoters in animal livestock," and "pharmacovigilance including prescription audits inclusive of antibiotic usage - in the hospital and community."

Conceptual leaps : The Swachh Bharat Abhiyan78, also known as the Clean India Mission, was launched by the National Health Mission of India to promote better sanitation and hygiene across the country. This large initiative included a media-based campaign to raise awareness about the risks of defecating in the open. Statistics compiled by UNICEF reveal that India is home to 60% of the world's one billion people who practise open defecation. It is also stated that this is a cultural issue, as other countries in Africa and Southeast Asia who are also experiencing economic hardship do not have the same level of open defecation as India. In India, novel approaches and the power of the media are required to tackle such complex social and cultural problems. The following are some suggestions on how India can better control AMR in the future.

CONCLUSIONS

Environmental AMR in India has been mostly ignored. The risk of AMR in India's environment is rising, thus quick action is needed to limit its spread. To solve this issue, we need to bring together experts from different fields and coordinate their work under one set of watchful eyes. With its vast livestock and aquaculture industries, India is also a major player in the global market for veterinary antibiotics. There is no denying the significance of veterinary antibiotics in the production of cattle and poultry, in the prevention and control of animal diseases, in the enhancement of the efficiency of breeding, and in the effective guarantee of a steady supply of these foods. However, the residues of veterinary drugs and pesticides in animals exacerbate the toxic and side effects of veterinary antibacterial drugs; the long-term irrational use of veterinary antibiotics in animal husbandry production has increased the antibiotic resistance rate of bacteria derived from animals and led to the emergence of "super-bacteria." The leftover pharmaceuticals are released into the environment, contaminating the ground and water supplies. The security of public health, ecological environments, and the production and quality of livestock and aquatic products are all jeopardised as a result of this.

As a result, India has taken strong and effective action to prohibit the use of growth-promoting feed medication additives. Basic and advanced medical education and training on the causes of the AMR problem, as well as solutions to reduce and control AM, are essential, and will play a pivotal role in the effective management of AMR globally . Raising public awareness of the AMR threat and encouraging public engagement in preventing the spread of AMR are also crucial.

From a public health standpoint, we should also focus on preventing the spread of antibiotic resistance. We need upstream and downstream connection systems, constant monitoring, and an assessment of antibiotic risk that takes into account change. Furthermore, in order to maximise the effectiveness of the connection mechanism, regulatory departments involved in ecological environment management must keep tabs on antibiotic production, use, and disposal. Increased spending on prevention and control measures, hastened development of novel materials and technologies, a focus on education and the spread of antibiotic knowledge, and better sewage and wastewater treatment equipment are all required .

Antibiotic overuse and resistance are global problems that necessitate ongoing study and the creation of viable antibiotic alternatives. International cooperation is, thus, growing in significance. To deal with the problems that may arise in the post-antibiotic age, India needs to collaborate with other nations to create new antibiotics or antibiotic alternatives while also carefully regulating antibiotic use. The effective control and sustainable use of antibiotics is seen to be possible with the cooperation of nations around the world.

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