BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

IN

ORIGINAL APPLICATION NO No. 497/2024

Suo Motu	::	**Petitioner**
	Vs.	
CPCB & Others	::	**Respondents**

Name of the State: Kerala

REPORT FILED BY THE ENVIRONMENTAL ENGINEER, REGIONAL OFFICE, ERNAKULAM FOR AND ON BEHALF OF THE KERALA STATE POLLUTION CONTROL BOARD

Adv. Jogy Scaria.

ADDITIONAL STANDING COUNSEL FOR THE RESPONDENT:

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

IN

ORIGINAL APPLICATION NO No. 497/2024

Suo Motu	::	**Petitioner**
	Vs.	
CPCB & Others	::	**Respondents**

VOLUME-I

INDEX

Dated this the 14th day of August 2024

Jogy Scaria, Advocate

ADDITIONAL STANDING COUNSEL FOR THE RESPONDENT:

BEFORE THE HON'BLE NATIONAL GREEN TRIBUNAL

PRINCIPAL BENCH, NEW DELHI

IN

ORIGINAL APPLICATION NO No. 497/2024

Suo Motu :: **Petitioner**

Vs.

CPCB & Others :: **Respondents**

REPORT FILED BY THE RESPONDENT IN THE ABOVE CASE

I, Sajeesh Joy, aged 48 years, S/o V. A. Joy, residing at Ernakulam, Environmental Engineer, Kerala State Pollution Control Board, Legal Cell, Ernakulam, do hereby solemnly affirm and state as follows:

A) Compliance with Para 11 of the Order of the Hon'ble NGT dated 06.05.2024 in OA No.497/2024 is reported as follows:

i) There are 11 numbers of pharmaceutical companies in the State. Following is the details of pharmaceutical companies in the State and its compliance status

Sl. No	Name of Unit	District	Category Type	Whether complying with norms (Yes/No)
1	Sanyog Pharma Consultants Indore Private Limited	Thiruvananthapuram	Orange-Pharmaceutical Formulation	Yes

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SAJEESH JOY
ENVIRONMENTAL ENGINEER
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REGIONAL OFFICE

2	Lividus Healthcare Private Limited		Orange-Pharmaceutical Formulation	Yes
3	Bioproducts And Diagnostics (P) Ltd		Red-Pharmaceutical	Yes
4	Capsulation & Pharmaceuticals Pvt. Ltd.	Alappuzha	Orange-Pharmaceutical Formulation	Yes
5	Kerala State Drugs & Pharmaceuticals Ltd		Orange-Pharmaceutical Formulation	Yes
6	Unifier Pharma Chemicals & Scientific Industries Pvt Ltd		Red-Pharmaceutical	Yes
7	Sangrose Laboratories Pvt Ltd		Red-Pharmaceutical	Yes
8	Sance Laboratories Pvt. Ltd. , Vi/51b, P.B.No.2, Kozhuvanal, Pala, Kottayam-686573	Kottayam	Orange-Pharmaceutical Formulation	Yes
9	Southern Union Pharmaceuticals (Kerala) Pvt. Ltd.,Xi/778, Klmno&P,Tr Nair Road, Elamthuruthy, Kalady Junction, Thrissur	Thrissur	Orange-Pharmaceutical Formulation	Yes
10	Megasys Biotek Private Limited, Kinfra Small Industries Park,Kinfra Park P O., Koratty, Thrissur, Kerala	Thrissur	Orange-Pharmaceutical Formulation	Yes
11	Chethana Pharmaceuticals, Ambalakkat Road,Perintalmanna P O	Malappuram	Orange-Pharmaceutical Formulation	Yes

(ii) The industries are regulated based on standards prescribed in Environment (Protection) Rules, 1986

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REGIONAL OFFICE

(iii) Proposed action for prevention of Pharmaceutical Toxicity- The State of Kerala has formulated 'Kerala Antimicrobial Resistance Strategic Action Plan', a copy of which is attached as **Annexure 1**. Based on which the Board has set up Antimicrobial resistance laboratory at Ernakulam in which both antibiotic residue and antimicrobial resistance can be monitored. The Board is carrying out monitoring of antibiotic residue as well as antimicrobial resistance in different sources. The Board also carried out two projects namely efficiency in the removal of antibiotics in wastewater treatment plant as well as on the status of antimicrobial resistance in surface water body through the College of Engineering, Trivandrum and Department of Environmental Science, University of Kerala respectively. It may also be noted that the standards on antibiotic residue and antimicrobial resistance are yet to be notified. "Integrated Antimicrobial Resistance Surveillance Framework for Kerala" focusing on food-animals, food-animal products and environment prepared in 2019 under the guidance of Department of Health & Family Welfare, Centre for Science & Environment with the support from Government Medical College Thiruvananthapuram, Directorate of Animal Husbandry & KSPCB, based on deliberations at the workshop on integrated surveillance framework for antimicrobial resistance for Kerala is attached as **Annexure 2**.

All the facts stated above are true to the best of my knowledge, information and belief.

Dated this the 14th day of August 2024

ENVIRONMENTAL ENGINEER
LEGAL CELL, ERNAKULAM

SAJEESH JOY
ENVIRONMENTAL ENGINEER
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GANDHI NAGAR, KOCHI-682020

KERALA STATE POLLUTION CONTROL BOARD
GANDHI NAGAR
COCHIN-682 020
REGIONAL OFFICE

SALEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

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Suo Motu :: **Petitioner**

Vs.

CPCB & Others :: **Respondents**

VOLUME-II

INDEX

Dated this the 14th day of August 2024

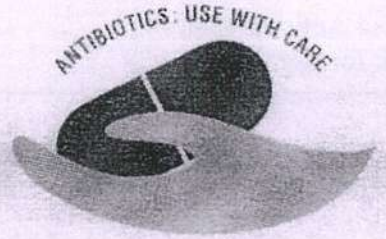
Jogy Scaria, Advocate

ADDITIONAL STANDING COUNSEL FOR THE RESPONDENT:

Annexure-1

Kerala Antimicrobial Resistance Strategic Action Plan

One Health response to AMR Containment



Jointly developed by the Departments of Agriculture Development & Farmers' Welfare, Animal Husbandry, Environment, Fisheries, and Health & Family Welfare

Government of Kerala

Kerala
Antimicrobial Resistance
Strategic Action Plan
(KARSAP)

October 2018

Government of Kerala

Table of Contents

KERALA STATE POLLUTION CONTROL BOARD GANDHI NAGAR COCHIN-682 020 REGIONAL OFFICE

SAJEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

Message from Chief Minister

I am happy to launch the Kerala Antimicrobial Resistance Strategic Action Plan developed by the Department of Agriculture, Animal Husbandry, Fisheries, Environment and Health & Family Welfare of the Government of Kerala in partnership with many other stake holders. This is the first of its kind prepared by any state in India. It recognizes the linkage between different sectors captured in the "One health" policy announced by World Health Organization. I am happy that all the concerned departments under the Government of Kerala have come together in the true spirit of "One Health" and developed this document. I hope that it will become an inspiration and guidance to other states to develop and implement similar Action Plans.

Antimicrobial resistance (AMR) is a global issue and actions are needed at every level to combat it. But action at the State, District, Sub-district and institution level will be critical. The Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) outlines the strategic priorities and activities to achieve the objectives, outputs and outcomes, right from awareness and knowledge, surveillance, optimizing antimicrobial use including antimicrobial stewardship, research to infection prevention and control.

Kerala is considered a consumer State for pharmaceuticals with a total consumption of drugs in the State estimated to be around INR 20,000 crores per annum. Therefore, rational use of pharmaceuticals is very important for Kerala. I believe that the overuse and misuse of antimicrobials can be curtailed with the help of this action plan. I observe that research studies and initiatives are also underway to establish the role of phytochemicals and natural antimicrobial substances as a means to fight antibacterial resistance, and may offer a way forward in AMR containment.

The sustainability of KARSAP depends on the attitude of all the stakeholders in the programme and the extent to which it is implemented. I look forward to the plan being implemented efficiently at all levels where antibiotics are used. I am sure, our State will become a model to the entire nation to develop their own strategies against this global issue.

I wish all success to stakeholders in their endeavour to implement this plan and to minimise Antimicrobial Resistance in Kerala.

Pinarayi Vijayan
Hon'ble Chief Minister

4

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GANDHI NAGAR
COCHIN-682 020
REGIONAL OFFICE

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Message from Health Minister

It is a moment of pleasure and pride to launch the Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP), which is the first of its kind in India, and may be in the South-East Asia Region. Antimicrobial Resistance (AMR) is a serious global public health threat in this century. Major drivers of AMR include inappropriate use of antimicrobials in healthcare as well as in animal husbandry, especially those used for non-therapeutic purpose like growth promotion and in agriculture and fisheries. AMR cannot be completely eradicated however, collaborative and comprehensive action needs to be taken to reduce the prevalence and spread of antimicrobial resistance.

In order to minimize the development of AMR and to maintain the effectiveness of existing antimicrobials, an integrated overarching "One Health" approach is essential in addressing this complex and challenging issue.

The KARSAP has been developed involving multiple sectors and it addresses a wide range of activities required to tackle AMR problem effectively. I am glad to acknowledge the support provided by the World Health Organisation Country Office for India in the development and implementation of KARSAP, which requires commitment and complementary efforts from all related sectors including health professionals – which include doctors, nurses, microbiologists, pharmacologists, researchers – veterinarians, farmers those involved in fisheries and all other related stakeholders.

Educational campaigns and awareness of AMR should also be addressed to all levels of Society. I would like to applaud all the parties involved either directly or indirectly in developing and upraising this action plan including national government and partners like WHO Country Office for India.

I hope that this action plan will provide guidance towards responsible use of antimicrobial agents in the efforts to combat AMR and preserve the efficiency of these precious drugs for the present and the future generation.

K.K. Shailaja Teacher
Hon'ble Minister for Health & Family Welfare

5

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Acknowledgements

The guidance and oversight provided by Shri Pinarayi Vijayan, Hon'ble Chief Minister, Smt. K.K. Shailaja Teacher, Hon'ble Minister for Health, Shri Rajeev Sadanandan, Additional Chief Secretary (Health), Shri MC Dathan, Scientific Advisor to Hon'ble Chief Minister, Shri Lav Agarwal, Joint Secretary, Ministry of Health and Family Welfare, and senior officials from National Centre for Disease Control to develop the Kerala Antimicrobial Resistance Strategic Action Plan is gratefully acknowledged.

This document is based on inputs provided by officials and experts from Kerala's State Departments of Agriculture Development and Farmers Welfare, Animal Husbandry, Environment, Fisheries, Health and Family Welfare.

Active contributors include the experts from Government Medical College Thiruvananthapuram, Rajiv Gandhi Centre for Biotechnology, State Laboratory For Live Stock Marine and Agri Products, State Pollution Control Board, State Drug Controller, Kerala Veterinary and Animal Sciences University, State Public Health Laboratory, Central Institute of Fisheries and Technology Kochi, Amrita Institute of Medical Sciences and Research Centre, Kerala branch of Indian Medical Association, Aster Medicity, Apollo hospital Chennai, ReAct South Asia and state universities and institutions in Kerala.

The following organizations were engaged through a call for partnerships for implementation of KARSAP – Becton Dickinson, Beckman Coulter, bioMerieux, MSD/Merck, DSM Sinochem Pharmaceuticals and Centre for Science and Environment.

Technical coordination and documentation support was provided by World Health Organization Country Office for India.

6

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Preface

The Kerala Government identified antimicrobial resistance (AMR) as a priority few years back. Since then Kerala has been working on its containment through the State AMR committee. A number of activities have been organized for AMR containment in the state including awareness generation, AMR surveillance through laboratory data, infection prevention and control and facilitating pilot research projects for AMR containment.

Since October last year, the approach for AMR containment has been widened, involving stakeholders from animal husbandry, agriculture, food, environment, research and civil society, under the umbrella of a comprehensive One Health approach. This led to a revision of the membership of the State AMR committee and developing a new set of strategies on AMR surveillance, prevention and research.

The Department of Health and Family Welfare is closely monitoring the AMR situation in collaboration with all stakeholders. Focal points for key focus areas have been identified for overall coordination and surveillance, research, infection prevention and control, antimicrobial stewardship and private sector.

The State also formally engaged with the private sector and civil society through a successful call for expression of interest leading to a memorandum of understanding in collaborating with the Government of Kerala for AMR containment in the state. More and more institutions have become partners in regular surveillance and reporting.

Regular meetings of the State AMR committee are being organized to monitor the AMR situation and the activities undertaken for AMR containment in the state and areas identified for research on extent and prevention of AMR.

We realize that with this action plan we are committing ourselves to achieving specific results in an unchartered territory. This will involve calibration of strategies and even their outright revision based on our experience of implementing this action plan. But I hope that this will motivate all the stakeholders to take forward the measures they have committed, to contain the public health threat of AMR in Kerala in the spirit of One Health.

Rajeev Sadanandan
Additional Chief Secretary, Department of Health & Family Welfare

7

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Acronyms and abbreviations

AMR	Antimicrobial Resistance
API	Association of Physicians of India
ASP	Antimicrobial Stewardship Program
DHS	Director Health Services
DME	Director Medical Education
DMO	District Medical Officer
FSSAI	Food Safety and Standards Authority of India
GMCK	Government Medical College Kozhikode
GMCT	Government Medical College Thiruvananthapuram
HAI	healthcare associated infection
IAP	Indian Academy of Pediatrics
ICU	intensive care unit
IEC	information education and communication
IMA	Indian Medical Association
IPC	infection prevention and control
IPHA	Indian Public Health Association
IVRI	Indian Veterinary Research Institute
KAP	knowledge attitude and practice
KARSAP	Kerala Antimicrobial Resistance Strategic Action Plan
KVASU	Kerala Veterinary and Animal Sciences University
LSG	local self government institutions
NABH	National Accreditation Board for Hospitals and Healthcare Providers
NABL	National Accreditation Board for Testing and Calibration Laboratories
NAP-AMR	National Action Plan on Antimicrobial Resistance
OTC	over-the-counter
RGCB	Rajiv Gandhi Centre for Biotechnology
SOP	standard operating procedures
WHO	World Health Organization

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SAJEESH JOY
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REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

Background

Antimicrobial Resistance (AMR) is a global public health problem. Even though there are many drivers of antibiotic resistance, the most dangerous trends contributing to rising AMR apart from the inappropriate use of antibiotics in humans include antibiotic use for growth promotion and disease prevention in animals, horticulture and fisheries. The use of animal manure in soil and inadequate treatment of effluents containing antibiotic residues from pharmaceutical industry, healthcare facilities and farms also contributes to the problem of increasing AMR.

The Government of Kerala is committed to take suitable action to address antimicrobial resistance in the State by involving all stakeholders to develop and implement a State Action Plan on AMR, which will be in alignment with the National Action Plan on Antimicrobial Resistance (NAP-AMR) and the Global Action Plan on Antimicrobial Resistance (GAP-AMR). Inter-sectoral collaboration and a One Health Approach are crucial and hence integrated in the government's approach.

Creating awareness on AMR among cross sectoral stakeholders is important for AMR containment. The Government of Kerala has been involved in creating awareness and developing skills for AMR containment among the medical community in Kerala. Awareness classes have been held at all Government medical colleges in Kerala for faculty and students. The focus of these classes is to emphasize the importance of rational antibiotic use, infection control practices and need to follow institutional antibiotic policy. Participation from private sector and professional bodies, especially Indian Medical Association has been encouraging towards drafting the policy and training the trainers.

Strengthening laboratory capacity for AMR surveillance and collating the data on AMR is essential for assessing baseline AMR burden and providing evidence based information for action. As of now, Kerala has initiated AMR surveillance programme in government teaching hospitals and many tertiary care private hospitals also carry out surveillance. Since food of animal origin also represents

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SAJEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

the major route of human exposure to foodborne pathogens. AMR surveillance in animals and fishes is as critical as it is in human health.

Currently, Government Medical Colleges and General Hospitals are engaged in surveillance of infections of public health importance namely blood stream infection, skin and soft tissue infection, respiratory tract infection, and urinary tract infection and also track six pathogens of public health importance *(E. coli, Klebsiella* spp., *Acinetobacter* spp., *Pseudomonas aeruginosa, Staphylococcus aureus* and *Enterococcus* spp.). Government Medical College Thiruvananthapuram (GMCT) is collating data on AMR surveillance from all teaching hospitals in the State to track AMR trends over time. Government will expand the surveillance to district, secondary and primary level hospitals in order to get more community data to understand the burden of AMR in the community. When the government system is stabilized private hospitals will also be invited to join the data collection system

Application of good infection prevention and control (IPC) measures across human health, animal health and agriculture also helps to prevent infections and limit use of antibiotics. Steps have been taken to tackle AMR at all government medical colleges in Kerala, which include scaling up of infection control program to prevent spread of antibiotic resistant organisms. Healthcare associated infection (HAI) rates with respect to ventilator associated pneumonia, catheter associated blood stream infection, catheter associated urinary tract infections and surgical site infections are being calculated in 20 intensive care units (ICU) and 8 high dependency units at Medical College Hospital Thiruvananthapuram in addition to the NABH accredited institutions in the State who submit data on healthcare associated infections (HAIs) each month to NABH for the national database. HAI rate calculation is going to be extended to the remaining 14 ICUs and 8 high dependency units at Medical College Hospital Thiruvananthapuram. Infection control nurses and link nurses have been identified and trained in all the government medical colleges in Kerala and soon HAI rates will be calculated in all medical colleges. It is proposed to establish a hub of infection surveillance in the state, with Department of Microbiology at GMCT as the nodal centre. All the surveillance data from various government medical colleges will be

10

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SAJEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

forwarded to Department of Microbiology at GMCT, where the trends and rates of infections and AMR will be collated and analysed.

Application of good IPC measures to animal husbandry is important to reduce antimicrobial residues in environment. Kerala State Pollution Control Board recommends adherence to good farm management practices for infection control among flocks. IPC measures also include issuance of improved biosecurity guidelines by Central Poultry Development Organisation for farm implementation and promotion of antibiotic alternatives (such as vaccination). The threat of action under phytosanitary conditionalities by fish importing countries has led to fisheries department to monitor the use of antibiotics in fish hatcheries and farms.

Kerala is considered as a consumer State for pharmaceuticals with a total consumption of drugs in the state at around 20,000 crores per annum, with antibiotics making up 20% of the total drugs consumed annually in the state. Poultry farmers in Kerala also use a variety of antibiotics either as growth promoters or for controlling infections. Many prescription medications used for human and animal health ultimately find their way into the environment and can affect the health and behaviour of animals. Drugs Control Department has a very significant role to play by way of regulatory action for optimizing the use of antibiotics, preventing sale of spurious and not-of-standard-quality (NSQ) drugs, and over-the-counter (OTC) sale, and adherence to the Red line campaign of Government of India. GMCT has also initiated Antibiotic Stewardship Program (ASP) to ensure that the right drug gets prescribed at the right time, in the right dose, for right duration for the right patient at all government medical colleges in Kerala. For that purpose antibiotic stewardship committees have been started at all government medical colleges in Kerala. Antibiotic prescription audit has been started in all government medical colleges under department of pharmacology. General Hospital Ernakulam (accredited by the National Accreditation Board for Hospitals and Healthcare Providers [NABH]) has been running a very effective ASP for the last two years. All the NABH accredited corporate hospitals in the state have good AMR surveillance as well as ASP programs which have demonstrated decrease in consumption of high end antibiotics, reduction in length of stay, mortality and cost of care.

11

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SAJEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

The importance of research and innovations cannot be over emphasized. As the world is running out of effective antibiotics to fight even simple infections, alternate strategies and new molecules need to be discovered at the earliest. RGCB is the research partner for AMR containment activities in the State.

Research is also underway to establish the role of phytochemicals and natural antimicrobial substances as a means to fight antibacterial resistance. Rajiv Gandhi Centre for Biotechnology (RGCB), Thiruvananthapuram, Kerala (www.rgcb.res.in), a premier national research institute, is exclusively devoted to research in molecular biology and biotechnology.

Various challenges in development and implementation of Kerala State Action Plan on AMR may include human resources (numbers and skills), standardisation of evidence based medicine practise across all healthcare organisations, standardisation of microbiology laboratories, role of anthropogenic activities in contaminating the natural water bodies, OTC sale of antibiotics, absence of antibiotic residue control program, and traceability problems with food of animal origin. However, despite these challenges the Government of Kerala is extremely committed and supportive of activities and proposals of all relevant stakeholders. Besides, strong collaborations and commitment of stakeholders across human health, animal health, food/agriculture and environment gives a positive direction to success ahead if these efforts are sustained over the coming years.

12

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State Workshop on Antimicrobial Resistance

The Kerala State Workshop on Antimicrobial Resistance was organized by the Department of Health and Family Welfare, Government of Kerala at the State Health Systems Resource Centre in Thiruvananthapuram on 17 October 2017.

The aim of the workshop was to share information on AMR and its containment in Kerala and brainstorming to initiate development of the Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP), in alignment with the NAP-AMR. The workshop brought together stakeholders from human health, animal health, agriculture, environment and research, to discuss the importance of a 'One Health' approach in containing AMR and development of KARSAP.

Following an information sharing session, the participants were segregated into teams based on their domain of expertise to reflect on strategic activities for collaborative containment of AMR, with a One Health approach. The groups reflected on the following priority areas:

(1) Awareness and understanding – communications and training
(2) Knowledge and evidence – laboratories and surveillance
(3) Infection prevention and control – human health, animal/food and community
(4) Optimizing use of antibiotics – regulations and antibiotic consumption, antimicrobial stewardship in humans and animals
(5) Research and innovations
(6) Collaborations

The workshop had active engagement of all stakeholders and the key takeaway messages and follow-up action points from the workshop include the following:

- RGCB volunteered to host a meeting to define the research priorities under Kerala's State Action Plan on AMR, and to lead development of research proposals by January 2018.
- Prioritization of AMR surveillance activities

13

KERALA STATE POLLUTION CONTROL BOARD * REGIONAL OFFICE * GANDHI NAGAR, COCHIN-682 020

SAJEESH JOY
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REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

- Private colleges and laboratories accredited by the National Accreditation Board for Testing and Calibration Laboratories (NABL), to feed their AMR data into State level
- WHONET to be used for data entry on AMR across human health, veterinary sector and food laboratories
- The Department of Microbiology GMCT to collate the data sent in by laboratories participating in the surveillance

- Hospital Infection Control programs to be mainstreamed at all levels
- Review need for microbiology laboratories' automation to guide clinical use of antibiotics
- Regulatory bodies to control use of antibiotics
  - State Drug Controller to suggest a mechanism
  - Review use of electronic prescriptions (similar to National Health Service, UK)
- World Health Organization Country Office for India was requested to provide technical support for development and implementation of State Action Plan on AMR in Kerala
- A multi-disciplinary working group to be formed for AMR containment in Kerala with representatives from all key stakeholders, including health department, animal husbandry, fisheries, agriculture, pollution control board, drug regulator, food safety, science & technology, Ayurveda Yoga Unani Siddha Homeopathy (AYUSH), research institutes, private sector, etc.
- Suggestion to create an operational team (core working group or secretariat) was proposed to carry out routine day to day operational activities towards development and successful implementation of the AMR action plan in Kerala

The next section describes the focus areas, objectives, activities and key stakeholders, as proposed by the participants for each strategic priority, at the Kerala State Workshop on Antimicrobial Resistance.

14

KERALA STATE POLLUTION CONTROL BOARD GANDHI NAGAR COCHIN-682 020 REGIONAL OFFICE

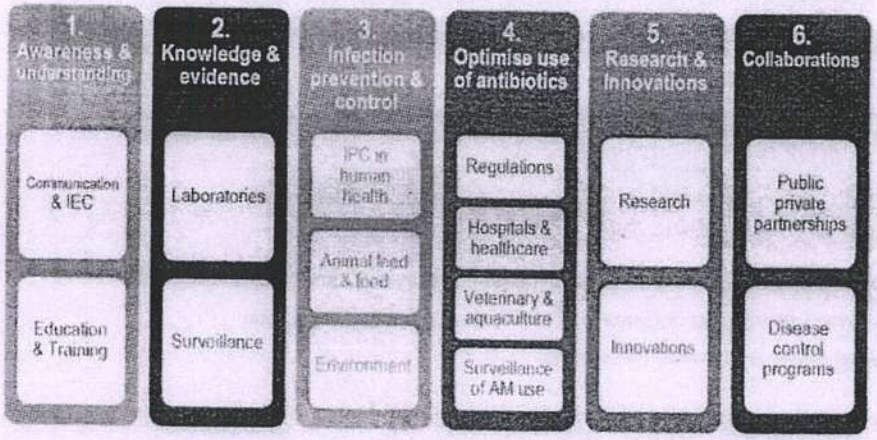
SAJEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

Kerala Antimicrobial Resistance Strategic Action Plan

The Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) has 6 strategic priorities:

1. Awareness and understanding
2. Knowledge and evidence
3. Infection prevention and control
4. Optimizing use of antibiotics
5. Research and innovations
6. Collaborations

The following are the focus areas of the strategic priorities under KARSAP:



15

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GANDHI NAGAR, KOCHI-682020

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Strategic priority 1 – Awareness and Understanding

Aim: Improve awareness and understanding of AMR through effective communication, education and training

Focus area: Communications and IEC

Objective: To improve the awareness among general public on antibiotic abuse, antimicrobial resistance, antibiotics in food, labelling of food derived from animals and the One Health approach using standardized information, education and communication (IEC) material like short videos, pamphlets, animations, booklets, posters articles in media etc.

1.1. Create a framework for engagement using social media (Department of Health and Family Welfare, Department of Electronics & Information Technology, Kerala State Information Technology Mission, State Council of Educational Research and Training) Timeline: 3 years

1.2. Organize awareness raising events to celebrate the World Antibiotic Awareness Week

1.3. Ensure consumer awareness on antibiotics in food and AMR, labelling of food from animals raised with/without antibiotics and responsible use of antimicrobials

1.4. Create tools facilitating thorough risk communication in the areas of livestock production, aquaculture and food hygiene.

1.5. Launch an online platform/framework to communicate information on One health approach to AMR

Objective: To improve the awareness among school children about antibiotic abuse, infection prevention and antimicrobial resistance using tailored educational material integrated into school curricula

1.6. Develop and integrate educational resources on AMR into school curriculum (Department of Community Medicine at medical

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REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

colleges, Department of General Education, civil society groups, WHO) Timeline: 1 year

1.7. Celebrate antibiotic awareness week in schools, colleges and all healthcare organisations in the State (**Department of Health and Family Welfare**, Department of General Education and universities) Timeline: 3 years

Objective: To organize mass sensitization programmes in schools and colleges, using already existing engagement platforms like National Service Scheme, National Cadet Corps, etc.

1.8. Formulate and pilot IEC material on antibiotic use and AMR (**Department of Community Medicine** at medical colleges, mass media, local self-government institutions, *Kudumbashree*) Timeline: 3-6 months

Focus area: Education and Training

Objective: To formulate a system of tailored training programmes on AMR and IPC for doctors at all levels of the health care delivery system.

1.9. Formulate offline and online training programmes for doctors at all levels (**Director Medical Education** [DME], **Director Health Services** [DHS], Kerala University of Health Sciences (KUHS), National Informatics Centre Kerala, ReAct, Kerala state branches of Indian Medical Association [IMA], Indian Public Health Association [IPHA]) Timeline: 3 years

1.10. Study/research on changes in knowledge, attitude and practice (KAP), following implementation (**Department of Community Medicine** at medical colleges, Department of Health and Family Welfare) Timeline: 5 years

Objective: To plan and implement university level training programmes for undergraduate and postgraduate level students, house-surgeons and faculty, under the aegis of Kerala University of Health Sciences (KUHS)

17

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REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

1.11. Formulate and implement customised training programmes for undergraduate and postgraduate students (Kerala University of Health Sciences [KUHS], Department of Microbiology at medical colleges, WHO) Timeline: 5 years

1.12. Study/Research on changes in KAP among undergraduate & postgraduate students and faculty, following implementation of training programs (Department of Community Medicine at medical colleges, Department of Health and Family Welfare) Timeline: 5 years

Objective: To train all the pharmacists, nurses and supporting staff, in antibiotic protocols, antibiotic abuse and antibiotic resistance

1.13. Training programme for pharmacists, nurses and support staff (State Drug Controllers, Pharmacy and Nursing colleges, Kerala Government Pharmacists' Association, other pharmacists' associations, Nursing association) Timeline: 3 years

1.14. Study/Research on changes in KAP among pharmacists, nurses and support staff, following implementation of training programs (Department of Community Medicine at medical colleges, Department of Health and Family Welfare) Timeline: 5 years

Objective: To devise a system for training other users of antibiotics, like food animal farmers, veterinary doctors (and students), farmers (of food animal) and fisheries professionals

1.15. Targeted training programme for farmers, veterinarians (and veterinary students), and fisheries professionals (Agriculture Development & Farmers' Welfare Department, Fisheries Department, Animal Husbandry Directorate, Department of Health and Family Welfare, Central Institute of Fisheries Technology (CIFT), Kerala Veterinary and Animal Sciences University [KVASU], Kerala University of Fisheries and Ocean Studies) Timeline: 5 years

1.16. Incorporate AMR education in curriculum and develop continuing education/training programs related to AMR for professionals in veterinary medicine, fisheries and agriculture (Agriculture

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REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

Development & Farmers Welfare Department, Fisheries Department, Animal Husbandry Directorate, Department of Health and Family Welfare, Kerala Veterinary and Animal Sciences University [KVASU], Kerala University of Fisheries and Ocean Studies) Timeline: 5 years

1.17. **Study/Research on changes in KAP among farmers, veterinarians, and fisheries professionals, following implementation of training program (Department of Community Medicine** at medical colleges, Department of Health and Family Welfare) Timeline: 5 years

Objective: To build capacity among those working in environment and allied agencies, for surveillance of antibiotic residues and antimicrobial resistance in the environment

1.18. **Capacity building workshops for personnel from Environment and Pollution Control Board and allied agencies for surveillance of antibiotic residues and AMR in the environment (Department of Environment**, Department of Health and Family Welfare, Department of Community Medicine at medical colleges, Central Institute of Fisheries Technology (CIFT), Kerala State Pollution Control Board) Timeline: 3 years

1.19. **Study/Research on changes in KAP among those working in environment, pollution control board and allied agencies, following implementation of training program (Department of Community Medicine** at medical colleges, Department of Environment, Department of Health and Family Welfare) Timeline: 5 years

Key stakeholders:

Department of Health and Family Welfare, Department of Agriculture Development & Farmers' Welfare, Animal Husbandry Directorate, Fisheries Department, Department of Environment, Director Health Services [DHS], Director Medical Education [DME], General Education Department, State Drugs Control Department, Electronics & Information Technology Department, Kerala State Pollution Control Board, National Informatics Centre Kerala, Department of Community Medicine at medical colleges, Department of Microbiology at medical colleges, Kerala University of Health Sciences, Indian Public Health Association [IPHA], Kerala state branch/chapter of Indian Medical

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SAJEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

Association [IMA], private sector hospitals, Kerala State Information Technology Mission, Central Institute of Fisheries Technology (CIFT), Kerala University of Fisheries and Ocean Studies, Kerala Veterinary and Animal Sciences University [KVASU], Kerala Government Pharmacists' Association, other pharmacists' associations, State Council of Educational Research and Training Kerala, *Kudumbashree*, local self-government institutions, mass media, universities, ReAct, WHO, civil society groups working on AMR...

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GANDHI NAGAR, KOCHI-682020

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Strategic priority 2 – Knowledge and Evidence

Aim: Strengthen knowledge and evidence for containment of AMR through surveillance

Focus area: Laboratories

Objective: Strengthening of microbiology laboratories to detect antimicrobial resistance

2.1. Establish and standardize microbiology laboratories in all district hospitals with medical microbiologists (MD); with all laboratories enrolled in External Quality Assurance Scheme (**DME, DHS,** State Health Mission) Timeline: 1 year

2.2. Standardized laboratories in veterinary sector in every district (**Animal Husbandry Directorate**) Timeline: 1year

2.3. State level standard operating procedures (SOP) for collection, storage, transportation, processing and quality assurance (**DME, DHS**) Timeline: 1 year

2.4. Establish data collection and collaboration at district levels (**DME, DHS,** Department of Microbiology GMCT) Timeline: 1 year

2.5. Upgradation of microbiology laboratories at medical colleges and districts - automated systems for identification and antimicrobial sensitivity testing (**DME, DHS**) Timeline: 1 year

2.6. Strengthen human resources for laboratories in human and veterinary sectors (**DHS. Animal Husbandry Directorate**)

Focus area: Surveillance

Objective: Standardize and strengthen AMR surveillance in Kerala

2.7. Establish state referral laboratory at Department of Microbiology GMCT

2.8. State Public Health Laboratory Thiruvananthapuram and General Hospital Ernakulam identified as two regional centres for AMR surveillance in district/general hospitals; all laboratories in the

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GANDHI NAGAR, KOCHI-682020

network to be assessed using a standard questionnaire followed by a site visit.

2.9. AMR surveillance to be initiated at all levels for 6 pathogens (*E. coli*, *Klebsiella* spp., *Acinetobacter* spp., *Pseudomonas aeruginosa*, *Staphylococcus aureus* and *Enterococcus* spp) in 4 samples – blood, urine, pus/exudate, respiratory specimens

2.10. Animal surveillance for sample-bug-drug combinations as per guidelines issued by the Food and Agriculture Organization of the United Nations (Chief Disease Investigation Office, Palode, Thiruvananthapuram; four apex laboratories at Palode, Thiruvalla, Ernakulam and Palakkad; KVASU, Wayanad and Ernakulam laboratory shall collate, analyse and share data with Director Animal Husbandry)

2.11. Surveillance in food animals and their products for sample-bug-drug combinations (State Laboratory for Livestock Marine and Animal Products, Maradu, Ernakulam)

2.12. Surveillance in fisheries for sample-bug-drug combinations (Central Institute of Fisheries Technology [CIFT], Kochi)

2.13. Surveillance in dairy products and food for sample-bug-drug combinations (Council for Food Research and Development laboratory at Konni)

2.14. Develop and implement standards for antibiotic residues in food (from animals), and in waste (Department of Agriculture, Central Institute of Fisheries Technology, State Pollution Control Board)

2.15. Strengthen the state antibiotic residue control plan in animal products by Animal Husbandry Directorate

2.16. Strengthen the state antibiotic residue control plan in food by Food Safety and Standards Authority of India (FSSAI)

2.17. Surveillance and monitoring of AMR in aquatic and terrestrial environments (all relevant stakeholders including Central Institute of Fisheries Technology)

2.18. Develop and adopt standards for antibiotic residues in waste generated from farms, factories, human health care, veterinary care

22

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GANDHI NAGAR, KOCHI-682020

and fisheries settings (all relevant stakeholders including Central Institute of Fisheries Technology)

2.19. Strengthen the state antibiotic residue control plan in environment done by Kerala State Pollution Control Board

2.20. Identify nodal persons in all sectors. State level inter-sectoral committee will meet under chairmanship of Directorate of Health Services in every quarter

2.21. Establish separate AMR databases for human, animal, food and environment

2.22. Strengthen resources for surveillance of AMR and antibiotics/residues in all sectors – human, veterinary, agriculture, crops, food, fisheries, and environment

2.23. Establish and implement a comprehensive One Health AMR surveillance system

Key stakeholders:

Director Health Services [DHS], Director Medical Education [DME], Animal Husbandry Directorate, Department of Microbiology GMCT, State Public Health Laboratory Thiruvananthapuram, General Hospital Ernakulam, Chief Disease Investigation Office Palode, apex laboratories (Palode, Thiruvalla, Ernakulam, Palakad), Kerala Veterinary and Animal Sciences University (KVASU), State Laboratory for Livestock Marine and Agri Products Ernakulam, Central Institute of Fisheries Technology (CIFT) Kochi, Council for Food Research and Development laboratory Konni, Kerala State Pollution Control Board, Food Safety and Standards Authority of India, State Health Mission…

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Strategic priority 3 – Infection Prevention and Control

Aim: Reduce the incidence of infection through effective infection prevention and control (IPC)

Focus area: Infection Prevention and Control in human health

Objective: Reduction of healthcare associated infections (HAI) rates by 20% of the existing rate by one year and 50% by three year and attaining international benchmark by five years

3.1. Develop and implement IPC programme, with standard operating procedures (SOP)

3.2. Ensure appropriate facilities for isolation and supplies for standard precautions (individual institutions)

3.3. Strengthen medical and surgical asepsis (Hospital Infection Control Department)

3.4. Strengthen sterilization & disinfection (Hospital Infection Control Committee & Central Supply Sterilization Department)

3.5. Strengthen immunization coverage/programme

3.6. Establish policy for occupational exposures including sharps and blood/body fluids exposure

3.7. Ensure administrative oversight of IPC activities (Hospital Infection Control Committee, Infection Control Team, Rapid Response Team, Scientific Advisory Panel)

Objective: Hand hygiene compliance 80% by one year and 100% by three years

3.8. Strengthen and improve hand hygiene in hospitals (Infection Control Team, HICC)

Objective: Adherence to Antibiotic Policy and Antimicrobial Stewardship Programme

3.9. Ensure appropriate antibiotic prophylaxis and use (Hospital Antimicrobial Stewardship Committees/Teams)

24

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Objective: Ensure HAI surveillance and regular monitoring through an evaluation framework for IPC

3.10. Establish surveillance of common healthcare associated infections (**Hospital Infection Control Committees**)

3.11. Monitor the IPC programme (Department of Health)

Objective: Reducing environmental contamination with multi-drug resistant pathogens & antimicrobial residues

3.12. Identify environmental sources of infection (**Kerala State Pollution Control Board**, LSG)

3.13. Improve housekeeping and environment management (Housekeeping department and engineering department at hospitals)

3.14. Ensure appropriate bio-medical waste management (**individual institutions**)

3.15. Strengthen facility infrastructure including environment controls and sewage treatment plant (**Kerala State Pollution Control Board**, health institutions)

Focus area: Animal feed & food

Objective: Reducing incidence of infection through effective infection prevention and control in animals

3.16. Ensure compliance to routine immunization and biosecurity measures

3.17. Ensure compliance to sterilization & disinfection practices

3.18. Ensure compliance to IPC practices during production/processing of food & food storage

3.19. Establish statutory regulatory body for animal health

3.20. Develop standard operating procedures (SOP)

3.21. Develop and implement infection prevention and control programs in veterinary settings and animal husbandry.

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SAJEESH JOY
ENVIRONMENTAL ENGINEER
KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

Focus area: Environment

Objective: Reducing incidence of infection through effective infection prevention and control in environment

3.22. Identify sources of AMR (Kerala State Pollution Control Board, LSG)

3.23. Collect baseline data (Kerala State Pollution Control Board, LSG)

3.24. Ensure routine monitoring and surveillance

3.25. Trace source of infection in the environment to prevent contamination of environment

3.26. Establish statutory regulatory body (State Government)

3.27. Develop standard operating procedures (SOP)

3.28. Develop policy on registration and licensing of farms, factories, slaughter houses, fish/meat/dairy processing units, animal feed manufacturing units, health care facilities and veterinary care units

3.29. Develop appropriate biosecurity guidelines, siting guidelines and Standard Operating Procedures (SOPs) on waste management for farms, feed manufacturers, slaughter houses, food processing units, health and veterinary care facilities, sewage treatment plants and good manufacturing practices (GMPs) for fish/meat/dairy processing units

3.30. Adopt less risky litter/manure management approaches such as biogas generation (in-house plants or common plants), proper composting for treatment of litter/manure under supervision

Key stakeholders:

Hospital Infection Control Department (Infection Control Committee, Infection Control Team), Hospital Antimicrobial Stewardship Committees/Teams, housekeeping department and engineering department at hospitals, Central Supply Sterilization Department, Kerala State Pollution Control Board, Central Institute of Fisheries Technology (CIFT), local self-government institutions (LSG), individual institutions, health institutes, Government...

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Strategic priority 4 – Optimising Use of Antibiotics

Aim: Optimize the use of antimicrobial agents in health, animals and food

Focus area: Regulations

Objective: Stepwise introduction to reduce OTC sale of drugs

4.1. Announce, notify and issue circulars to pharmacies

4.2. Prepare training modules/IEC and conduct awareness/skill development campaign for regulators, custom officials, distributors, pharmacists, licensees and pharmacy students (State Drugs Control Department, Kerala State Pharmacy Council)

4.3. Conduct education sessions (Kerala State Pharmacy Council, pharmacists associations, IMA, Association of Physicians of India [API], Indian Academy of Paediatrics [IAP])

4.4. Ensure compulsory attendance at 6-monthly educational sessions (Kerala State Pharmacy Council)

4.5. Conduct public awareness activities targeted at consumers and community, including social media (in alignment with activity 1.1)

4.6. Ensure proper disposal measures of antibiotics – by pharmaceutical distributors with accountability to manufacturer

4.7. Implement and monitor sale of antibiotics as per state and national guidelines – centralised database of import, distribution and sales

4.8. Conduct centralised prescription audits (State Drugs Control Department)

4.9. Monitor the quality of antimicrobials (State Drugs Control Department)

4.10. Monitor for presence of antibiotics in feeds used in veterinary sector and aquaculture

4.11. Develop and implement drug/antibiotic take back programmes

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GANDHI NAGAR, KOCHI-682020

Focus area: Hospitals and healthcare institutions

Objective: Optimize the use of antimicrobials in hospitals and healthcare institutions

4.12. Prepare institutional antibiogram for empiric use of antibiotics

4.13. Formulate antibiotic policy based on institutional antibiograms and establish antimicrobial stewardship committee at all the hospitals in the state, including private sector

4.14. Ensure formulary restriction (pre-authorization) and de-escalation with respect to high-end antibiotics like tigecycline, minocycline, colistin, polymyxin B and fosfomycin, etc.; carbapenems and linezolid to be included after 6 months into the list of drugs requiring pre-authorization

4.15. Conduct antibiotic stewardship training for all doctors, MBBS students and dentists

4.16. Compliance to surgical prophylaxis policy at all hospitals

4.17. Train/sensitize pharmacologists in clinical pharmacology (proposal submitted to DME for establishing clinical pharmacology departments in all government medical colleges)

4.18. Review legislation on electronic prescriptions, followed by training on its use, implementation and monitoring

4.19. Create and use mobile apps for antimicrobial stewardship, based on institutional antibiograms

4.20. Develop and share report on KARSAP implementation to state AMR committee (all members of state AMR committee, under chairmanship of ACS Health)

4.21. Develop training modules for medical, pharmacy, lab technology and nursing students

4.22. Conduct educational sessions for private practitioners (IMA, IAP, API, DMO)

4.23. Conduct prescription audits in healthcare facilities

Focus area: Veterinary and aquaculture

Objective: Optimize the use of antimicrobials in veterinary and aquaculture

4.24. Steps to be taken to prevent use of 'antibiotics for human use' as 'antibiotics for growth promotion in veterinary and aquaculture' (State Drugs Control Department, State Veterinary Council, Indian Veterinary Research Institute [IVRI], Coastal Aquaculture Authority, Fisheries Department, FSSAI)

4.25. Ban the use of colistin as a growth promotor

4.26. Adopt measures to rationalize antibiotic usage in veterinary practice, treatment and prophylaxis (Agriculture Development & Farmers' Welfare Department, Fisheries Department, Animal Husbandry Directorate, State Drugs Control Department, State Veterinary Council, IVRI)

4.27. Ban/phase off non-therapeutic use of antimicrobials for disease prevention and growth promotion in livestock and fisheries

4.28. Restrict the use of critically important antimicrobials (for humans) in food-animal farming

4.29. Develop/adopt regulations to monitor antibiotic use in animal feed/feed premix including their sale, labelling, registration, prescription and import

4.30. Develop/adopt appropriate labelling laws for feed, feed premix, antibiotics used in animals

4.31. Promote use of alternatives such as herbal drugs, animal vaccines, probiotics for use in food animals

Focus area: Surveillance of antimicrobial use

Objective: Establish the surveillance system for antimicrobial use at health facilities, manufacturer, distributor, seller, user and import level in humans, animals, agriculture and food sectors

4.32. Use AMC tool to measure consumption of antibiotics at health care facilities

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GANDHI NAGAR, KOCHI-682020

4.33. **Standardise tools to measure total consumption of antibiotics at the state level (in human and animal health, food and agriculture)**

Key stakeholders:

State Drugs Control Department, Kerala State Pharmacy Council, Director Health Services (DHS), Director Medical Education (DME), principals of medical colleges, private health sector, pharmacists' associations, Agriculture Development & Farmers' Welfare Department, Fisheries Department, Animal Husbandry Directorate, State Veterinary Council, Indian Veterinary Research Institute (IVRI), Coastal Aquaculture Authority, Food Safety and Standards Authority of India (FSSAI), Kerala state branch/chapter of Indian Medical Association (IMA), Indian Public Health Association (IPHA), Association of Physicians of India (API), Indian Academy of Pediatrics (IAP) ...

Strategic priority 5 – Research and Innovations

Aim: Promote research and innovations for AMR containment

Focus area: Research on AMR

Objective: To compile the research activities on AMR in Kerala

5.1. Conduct literature review (**RGCB**, KVASU, Government Medical College Kozhikode [GMCK], GMCT, Government Ayurveda College Thiruvananthapuram, Animal Husbandry Directorate, Indian System of Medicine Kerala) Timeline: 1 year

Objective: To identify potential research institutes/university departments working on AMR

5.2. Compile list of institutes and relevant investigators (**RGCB**, KVASU, GMCK, GMCT, Government Ayurveda College Thiruvananthapuram, Animal Husbandry Directorate, Indian System of Medicine Kerala) Timeline: 1 year

Objective: Define research priorities on AMR in Kerala

5.3. Define research priorities for veterinary aspects (**KVASU**, Animal Husbandry Directorate) Timeline: 1 year

5.4. Define research priorities for human aspects (**GMCT**, GMCK, RGCB) Timeline: 1 year

5.5. Define research priorities for ayurvedic aspects (Government Ayurveda College Thiruvananthapuram, Indian System of Medicine Kerala) Timeline: 1 year

5.6. Encourage research on cytokine response – resistant/susceptible bacteria (**RGCB**, Infectious Disease Department GMCT) Timeline: 3 years

5.7. Identify sources of AMR in hospitals, and in environment especially in water bodies, and conduct operational research on best options for containment measures/system (**RGCB**, Kerala State Pollution Control Board, CIFT, CSE)

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GANDHI NAGAR, KOCHI-682020

5.8. Surveillance study on antimicrobial resistance in the community in Thiruvananthapuram and Kollam districts of Kerala. (Kerala Health Services Department, State Public Health and Clinical Laboratory & RGCB) Timeline: 1 year

Objective: *Research for special attention on zoonotic bacteria – Campylobacter spp., EHEC, Salmonella enteritidis, S. typhimurium*

5.9. Isolate, identify & conduct antibiogram profiling of the above organisms from animals and their products (**KVASU**, Animal Husbandry Directorate) Timeline: 3 years

5.10. Isolate, identify & conduct antibiogram profiling and global surveillance of bacterial pathogens from humans using whole genome sequencing – *E. coli, Klebsiella* sp., *Acinetobacter* spp., *Pseudomonas aeruginosa, Staphylococcus aureus, Enterococcus* spp. (**GMCK**, GMCT, RGCB) Timeline: 3 years

5.11. Organise "Research Day on AMR" in institutions to showcase their research and to establish collaborations (all institutions)

Focus area: Innovations

Objective: *Alternate strategies for combating AMR - screening of phytochemicals/herbal extracts*

5.12. Herbal drug research and development (**Government Ayurveda College Thiruvananthapuram**, Indian System of Medicine Kerala, KVASU) Timeline: 3 years

5.13. Promote research on biofilm inhibition (**RGCB**, Government Ayurveda College Thiruvananthapuram, Indian System of Medicine Kerala) Timeline: 3 years

5.14. Research on development of probiotics of human origin (**RGCB**, Government Ayurveda College Thiruvananthapuram, Indian System of Medicine Kerala) Timeline: 3 years

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Objective: Development of new diagnostics

5.15. Promote research for rapid bacterial diagnostic kits (RGCB, GMCT) Timeline: 3 years

Objective: Innovations using information technology

5.16. Introduce information technology for tracking and analysing AMR & HAI surveillance trends for real time feedback and action (GMCT) Timeline: 3 years

Key stakeholders:

Rajiv Gandhi Centre for Biotechnology (RGCB), Kerala Veterinary and Animal Sciences University (KVASU), Government Medical College Thiruvananthapuram, Government Medical College Kozhikode, Central Institute of Fisheries Technology (CIFT), Government Ayurveda College Thiruvananthapuram, Indian System of Medicine Kerala, Animal Husbandry Directorate, Kerala State Pollution Control Board, CSE, Health Services Department, State Public Health and Clinical Laboratory

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Strategic priority 6 – Collaborations

Aim: Partnership with private sector and civil society organizations for AMR containment

Focus area: Public private partnership

Objective: Co-opting private hospitals into the AMR programme

6.1. Develop partnership with private hospital groups and individual hospitals on AMR & HAI surveillance, research and capacity building (IMA, Qualified Private Medical Practitioners Association, Catholic Health Association of India, Christian Medical Association of India)
Time line: 2 years

6.2. Provide space for private firms in Infection Prevention Programme and AMR surveillance programme (DHS, DME, Kerala State Public Health Laboratory, Kerala Medical Services Corporation Limited)
Time line: 2 years

Focus area: State disease control programmes

Objective: Ensure information sharing on drug resistance in State disease control programmes

6.3. Establish regular sharing of information on AMR in State disease control programmes on TB, influenza, malaria, HIV/STI and leprosy

Key stakeholders:

Kerala state branch/chapter of Indian Medical Association (IMA), Qualified Private Medical Practitioners Association, Catholic Health Association of India, Christian Medical Association of India, Director Health Services (DHS), Director Medical Education (DME), Kerala State Public Health Laboratory, Kerala Medical Services Corporation Limited, State disease control programmes on TB, Influenza, malaria, HIV, leprosy and gonococcus

Monitoring and Evaluation framework

Priority indicators	Input (basic resources)	Process (activities)	Outputs (results at programme level)	Outcomes (results at population level)
1. Awareness and Understanding	IEC materials for relevant groups (public, farmers, professionals in health, agriculture and environment sectors) developed	AMR awareness campaign organized Awareness activities for media at State, District and sub-district level AMR module developed for CME/CPD for relevant professional groups	Number of print articles covering AMR Inclusion of AMR in curricula of professional Universities [KUHS, KVASU] Inclusion of AMR in curricula at school and college level	AMR awareness levels in target populations, e.g. % of population who know that it is inappropriate to use antibiotics for common cold or viral infections Knowledge, attitudes and practices of health workers and vets on AMR and its implications for antimicrobial use and misuse (via standard online survey)
2. Knowledge and Evidence	State Coordinating Centre for AMR surveillance established with clear terms of reference Operational plan developed for AMR surveillance	Number of hospitals -/laboratories participating in quality assurance programme SOPs established for AMR surveillance in animals, aquaculture and environment AMR data received from all sectors	Surveillance system for AMR in animals, food and environment established Report on AMR (humans, animals/food/aquaculture and environment) and AM residues in food and environment	Reduced levels and trends of resistance in *E. coli*, *Klebsiella*, *Pseudomonas*, *Acinetobacter*, MRSA and *Enterococcus*
3. Infection Prevention and Control	State nodal institution identified for IPC	% hospitals with functioning IPC committee % hospitals with adequate IPC nurses AMR issues incorporated in biosecurity guidance for farms and slaughterhouses	Hib/rotavirus/typhoid, PCV vaccine coverage across the state Proportion of acute health care facilities with IPC program in place (including monitoring of hand hygiene) Number of health facilities with new or refurbished WASH facilities Number of commercial farms compliant with infection prevention guidelines and good practices	Average hand hygiene compliance rates in hospitals and primary care centres. Percentage of health facilities with functional water, sanitation and hygiene under Kayakalp/SBM Number of pharmaceutical companies manufacturing antibiotics having effluent treatment plants

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KERALA STATE POLLUTION CONTROL BOARD
REGIONAL OFFICE
GANDHI NAGAR, KOCHI-682020

Priority indicators	Input (basic resources)	Process (activities)	Outputs (results at programme level)	Outcomes (results at population level)
4. Optimising Use of Antibiotics	State nodal institution identified for antimicrobial stewardship	Treatment guidelines reviewed and updated considering patterns of resistance and use Monitoring antimicrobial use (AMU) /consumption at facility level Legislation approved, banning sales of antibiotics incorporated in animal food Vets involved in drug control in the state Methodology developed for calculating antimicrobial use at state level	Numbers of hospitals with updated AB guidelines based on local AMR pattern Percentage of tertiary care hospitals with AB stewardship programme Percentage of medical colleges/hospitals with AB stewardship programme Implementation of ban/restrictions on antibiotic premixed food in animal husbandry and aquaculture	Total consumption of antibiotics monitored (state level) % of antibiotics tested by State Drug Controller with acceptable quality
5. Research and Innovations		State AMR research agenda established Collaboration between Rajiv Gandhi Centre and stakeholders for AMR research	Financing sources for KARSAP identified Monitoring indicators at state level (% major hospitals and labs reporting to government)	Proportion of KARSAP activities (1) With identified funds (2) Adequately funded and implemented
6. Collaborations	State AMR monitoring cell established	State AMR monitoring cell functional Number of AMR projects under PPP	State AMR forum established and functional	Data/information from KARSAP to be reported to State and Central Government**

** Responsibility for assimilating data and reporting on M&E indicators shall sit with State AMR Coordinating Institution (GMCT); data and information will be collated and shared by GMCT with State Government and Central Government (NCDC and MoHFW).

KERALA STATE POLLUTION CONTROL BOARD * REGIONAL OFFICE * GANDHI NAGAR COCHIN-682 020

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Annexure-2

Integrated Antimicrobial Resistance Surveillance Framework for Kerala

focussing on food-animals, food-animal products and environment

Based on deliberations at the
Workshop on Integrated Surveillance Framework for Antimicrobial Resistance for Kerala
Kochi, Kerala

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Contents

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List of abbreviations

AMR	Antimicrobial Resistance
AR	Antibiotic Residue
ARG	Antibiotic Resistant Gene
AST	Antimicrobial Susceptibility Testing
CIFT	Central Institute of Fisheries Technology
CLSI	Clinical and Laboratory Standards Institute
CSE	Centre for Science and Environment
ELISA	Enzyme-Linked Immunosorbent Assay
ESBL	Extended Spectrum Beta Lactamase
HPLC	High Performance Liquid Chromatography
KARSAP	Kerala Antimicrobial Resistance Strategic Action Plan
KSPCB	Kerala State Pollution Control Board
KUFOS	Kerala University of Fisheries and Ocean Studies
LCMS	Liquid Chromatography–Mass Spectrometry
MIC	Minimum Inhibitory Concentration
NAP	National Action Plan
STP	Sewage Treatment Plant

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1. Introduction

Antimicrobial resistance (AMR), particularly antibiotic resistance, is recognized as a global public health threat today. It arises when microorganisms are able to survive exposure to a drug that could normally inhibit their growth or kill them. When AMR arises and spreads in infection-causing bacteria, treating common infections and managing surgical procedures becomes difficult, resulting in prolonged hospital stays, expensive treatments and high economic burden. AMR is estimated to claim more than 10 million lives per year by 2050[1] and result in lost outputs worth US $100 trillion, if not contained timely. It can also potentially impact food safety, nutrition security, livelihood and attainment of Sustainable Development Goals.

AMR has been recognized as a 'One Health' issue owing to its significant linkages with the health of humans, animals and environment. Antibiotic misuse and overuse in animals – particularly food-animals and in crops is an important driver of AMR. The environment also has a key role in the emergence and spread of AMR. Waste from drug manufacturing units, healthcare settings (human and veterinary), food production systems (such as farms, slaughter-houses, processing units), and community are considered as key contributors of AMR causing determinants such as resistant bacteria, antibiotic residues and resistance conferring genes in the environment. The environment is thus a large pool of these determinants. However, in terms of AMR containment, the human health side of AMR problem has received the most attention, followed by the animal side. The environmental aspects of AMR have received limited attention in comparison.

Responding to the global call on AMR containment, India released its multi-sectoral National Action Plan (NAP) on AMR[2] along with the Delhi Declaration on AMR[3]. The Indian NAP-AMR called for states in India to develop their own State Action Plans (SAP) on AMR to facilitate action on the ground, up to district and sub-district levels. Kerala became the first Indian state to develop its own SAP-AMR. The Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP)[4] was formally released by the Hon'ble Chief Minister of Kerala, Shri Pinarayi Vijayan in October 2018.

Of the six key strategic priorities of the KARSAP, the second strategic priority outlines the need for surveillance of AMR in order to generate more knowledge and evidence. The KARSAP acknowledges that in addition to human health, surveillance in animals, fisheries and agriculture is equally critical. The KARSAP emphasizes on surveillance of AMR and antibiotic residues in food-animals, food-animal products, and environment.

The Centre for Science and Environment (CSE) has been engaging with the Department of Health, Kerala to contribute towards containment of AMR in the state. CSE is also an implementation partner to the KARSAP. As part of this engagement, CSE organized a workshop in Kerala to develop an integrated AMR surveillance plan for the state. The workshop was organized in Kochi in collaboration with the State Department of Health and Family Welfare and the Kerala State Pollution Control Board (KSPCB). An integrated surveillance encompassing all sectors would not only be useful for knowing present AMR trends in the state, but also help generate necessary evidence to guide future AMR containment policy and practice.

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The workshop included representation from the various stakeholders from Kerala such as the state departments of Health, Animal Husbandry, Fisheries, Drug Control, along with the KSPCB, Kerala University of Fisheries and Ocean Studies, Kerala University, All Kerala Chemist and Druggist Association, Central Institute of Fisheries Technology, Centrient Pharmaceuticals, Meat Products of India, Government Medical College (Ernakulum and Trivandrum) and Aster Medicity. The framework for integrated surveillance of AMR in food-animals, food-animal products and environment has been developed based on the deliberations held in this workshop.

2. Surveillance framework for antimicrobial resistance in food-animals, food-animal products and environment for Kerala

With an aim to build a comprehensive surveillance framework for Kerala in the workshop, the expert group (*see List of expert contributors*) collectively finalized three sectors where surveillance would be carried out – livestock (poultry and cattle), fisheries and environment. The framework looks at surveillance of resistant bacteria, antimicrobial residues (AR) and antimicrobial resistance genes (ARGs). The framework is divided into two sections:

(a) Sampling framework: Across each sector, districts, sampling locations, sample sizes, sample types, frequency of sampling etc. has been identified.

(b) Key bacteria, antibiotics, genes, standard methods, data analysis and reporting: This section focuses on which bacteria, antibiotics or genes would be monitored, which standardized laboratory methods would be adopted, how data would be analyzed and reported.

The expert group also prioritized a phased approach for surveillance. The surveillance framework is intended to provide a five-year roadmap for carrying out AMR surveillance. Over a span of these five years, surveillance would be carried out in two phases – Phase 1 (1-3 years) and Phase 2 (4-5 years). The framework may be suitably adapted by other states with similar geographic and socioeconomic features.

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5

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2.1. Sampling framework

2.1.1. Poultry

A sampling framework for AMR surveillance in poultry sector of Kerala is provided in Table 1. The focus has been broiler poultry over layers, since poultry meat is the most consumed meat product in Kerala. Eggs from layer poultry are usually procured from other states. Two key stakeholders are involved in this surveillance - the Animal Husbandry Department and Food Safety Department. In Phase 1, sampling is to be done from only three districts. In Phase 2, sampling would be expanded to cover the remaining 11 districts so that all 14 districts are included in the surveillance exercise in the long run. Key sampling sites include broiler poultry farms and retail markets, wherein antimicrobial susceptibility testing (AST) would be done in cloacal swab samples (by the Animal Husbandry Department) and retail meat samples (by the Food Safety Department) respectively. For each sample type (e.g., cloacal swab or meat), the framework proposes testing of 30 samples per district per quarter in Phase 1 in three districts. These districts should continue with similar sampling strategy and surveillance in Phase 2 as well. Sampling for the remaining 11 districts in Phase 2 would include about 40 samples per district every year. A smaller sample size and lesser frequency for 11 districts in Phase 2 is proposed taking due consideration of the collective load on laboratories in the district. However, if the district has capacity to scale up in the long run, then sample size and frequency could be expanded for better understanding of district wise trends. For e.g., each district could consider expanding sample size from 40 to 120 samples in a year and increase sampling frequency from bi-annual to quarterly. Apart from AST, residue monitoring is to be carried out in all retail products by the Food Safety Department following a similar approach. This will help identify whether unapproved antibiotic has been misused or appropriate withdrawal periods have been followed or not.

Table 1: Sampling framework for poultry sector

	Districts	Sampling locations	Sample types	No. of sampling locations per district*	No. of samples per site	Samples per district	Sampling frequency	Samples per year per district	AMR, AR	Stakeholder
Phase 1 and 2	Ernakulam Kozhikkode Trivandrum	Broiler farms	Cloacal swab in healthy birds#	10	3	30	Quarterly	120	AMR	Animal Husbandry Department
		Retail outlets	Meat	10	3	30	Quarterly	120	AMR, AR	Food Safety Department
Phase 2	Alappuzha Idukki Kannur Kasaragod Kollam Kottayam Malappuram Palakkad Pathanamthitta Thrissur Wayanad	Broiler farms	Cloacal swab in healthy birds#	10	2	20	Biannual	40	AMR	Animal Husbandry Department
		Retail outlets	Meat	10	2	20	Biannual	40	AMR, AR	Food Safety Department

#Liver or heart blood samples may be taken from farms with diseased animals. This is not a part of routine monitoring.
*Rotation of sites sampled should be considered. For example, in each district, different sets of 10 sites should be sampled in different quarters. The first set of sites could be revisited again in year 2 and likewise.
Note: Presently, the Animal Husbandry Department has a state disease diagnostic laboratory, four regional disease diagnostic laboratories and 14 clinical laboratories across districts[5]. In the long term, these should be strengthened and capacitated to execute the proposed framework across all districts.

2.1.2. Cattle for milk

Table 2 shows sampling framework for dairy sector (cattle for milk) in Kerala. This includes milk (raw and processed) as well as milk products such as cheese, curd, yoghurt etc. While the framework is largely similar to that of the poultry sector, an additional sampling location has been identified in this case which is cooperative societies. The Animal Husbandry Department will carry out surveillance of samples collected from the farms and cooperative societies, while those from retail markets will be carried out by the Food Safety Department. Other than processed milk, raw milk sold at market places or delivered at households for consumption could also be tested by the Food Safety Department.

Table 2: Sampling framework for cattle for milk

	Districts	Sampling locations	Sample types	No. of sampling locations per district *	No. of samples per site	Total samples per district	Sampling frequency	Samples per year per district	AMR, AR	Stakeholder
Phase 1 and Phase 2	Ernakulam Kozhikkode Trivandrum	Farms	Milk[a]	5	2	10	Quarterly	40	AMR	Animal Husbandry Department
		Cooperative society	Milk and milk products	2	5 (2 milk, and 3 milk products, if any)	10	Quarterly	40	AMR	Animal Husbandry Department
		Retail outlets	Milk and milk products	5	2 (1 milk, and 1 milk product, if any)	10	Quarterly	40	AMR in all samples , AR in milk	Food Safety Department
Phase 2	Alappuzha Idukki Kannur Kasaragod Kollam Kottayam Malappuram Palakkad Pathanamthitta Thrissur Wayanad	Farms	Milk[a]	5	2	10	Biannual	20	AMR	Animal Husbandry Department
		Cooperative society	Milk and milk products	2	5 (2 milk, and 3 milk products, if any)	10	Biannual	20	AMR	Animal Husbandry Department
		Retail outlets	Milk and milk products	5	2 (1 milk, and 1 milk products, if any)	10	Biannual	20	AMR in all samples , AR in milk	Food Safety Department

[a]Mastitis pus samples may be taken from farms with diseased animals. This is not a part of routine monitoring.

*Rotation of sites sampled should be considered. For example, in each district, different sets of 5 sites should be sampled in different quarters. The first set of sites could be revisited again in year 2 and likewise.

Note: Presently, the Animal Husbandry Department has a state disease diagnostic laboratory, four regional disease diagnostic laboratories and 14 clinical laboratories across districts[5]. In the long term, these should be strengthened and capacitated to execute the proposed framework across all districts.

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2.1.3. Cattle for meat

Beef, after poultry, is the most consumed meat product in Kerala. This section presents the sampling framework for cattle (for meat) in Kerala (Table 3). The framework is designed in line with the dairy and poultry sector. In this case, slaughterhouses have been introduced as a new sampling site. The Animal Husbandry Department would conduct AST in rectal samples collected from farms and meat samples from slaughterhouses. The Food Safety Department will carry out AST and residue monitoring in meat samples from retail outlets.

Table 3: Sampling framework for cattle for meat

	Districts	Sampling locations	Sample types	No. of sampling locations per district*	No. of samples per site	Total samples per district	Sampling frequency	Samples per year per district	AMR, AR	Stakeholder
Phase 1 and Phase 2	Ernakulam Kozhikkode Trivandrum	Farms	Rectal samples	10	3	30	Quarterly	120	AMR	Animal Husbandry Department
		Slaughter houses	Meat	5	3	15	Quarterly	60	AMR	Animal Husbandry Department
		Retail outlets	Meat	5	3	15	Quarterly	60	AMR, AR	Food Safety Department
Phase 2	Alappuzha Idukki Kannur Kasaragod Kollam Kottayam Malappuram Palakkad Pathanamthitta Thrissur Wayanad	Farms	Rectal samples	10	2	20	Biannual	40	AMR	Animal Husbandry Department
		Slaughter houses	Meat	5	2	10	Biannual	20	AMR	Animal Husbandry Department
		Retail outlets	Meat	5	2	10	Biannual	20	AMR, AR	Food Safety Department

*Rotation of sites sampled should be considered. For example, in each district, different sets of 5 sites should be sampled in different quarters. The first set of sites could be revisited again in year 2 and likewise.

Note: Presently, the Animal Husbandry Department has a state disease diagnostic laboratory, four regional disease diagnostic laboratories and 14 clinical laboratories across districts[5]. In the long term, these should be strengthened and capacitated to execute the proposed framework across all districts.

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2.1.4. Sampling framework for surveillance in fisheries sector

This section discusses the sampling framework for fisheries sector in Kerala (Table 4). To begin with, AMR surveillance will be done in two key fish-producing districts of Kerala in Phase 1 across farms, landing centres and wholesale markets. Surveillance will subsequently expand to cover all five major fish-producing districts of the state in Phase 2, and include retail market as an additional sampling site. The framework suggests monitoring of not just fish meat, but also of environmental samples like soil, water and feed, particularly from fish farms. Frequency of sampling from farms is based on culture period, unlike other cases where samples are to be collected quarterly. The State Fisheries Department and the Food Safety Department would be the key stakeholders. The State Fisheries Department will initially be required to be supported by the resources and infrastructure from the Central Institute of Fisheries Technology and the Kerala University of Fisheries and Ocean Studies.

Table 4: Sampling framework for fisheries

	Districts	Sampling locations	Sample types	No. of sampling locations per district**	No. of samples per site	Total samples per district	Sampling frequency	Samples per year per district	AMR, AR	Stakeholder
Phase 1	Ernakulum Kollam	Farms*	Soil, water, feed, fish meat	2% of total farms	At least 2 per type	Based on no. of farms sampled	Twice during culture period	Based on no. of farms sampled	AMR in all samples, AR in fish meat	State Fisheries Department
		Landing centres#	Fish meat	2-3	At least 2	Based on variety of marine captures	Quarterly	Based on variety of marine captures	AMR, AR	
		Wholesale markets	Fish meat	10% of total markets	At least 2	Based on no. of markets sampled	Quarterly	Based on no. of markets sampled	AMR, AR	
Phase 2	Aliepy Ernakulum Kannur Kollam Palakkad	Farms*	Soil, water, feed, fish meat	2% of total farms	At least 2 per type	Based on no. of farms sampled	Twice during culture period	Based on no. of farms sampled	AMR in all samples, AR in fish meat	State Fisheries Department
		Landing centres#	Fish meat	2-3	At least 2	Based on variety of marine captures	Quarterly	Based on variety of marine captures	AMR, AR	
		Wholesale markets	Fish meat	10% of total markets	At least 2	Based on no. of markets sampled	Quarterly	Based on no. of markets sampled	AMR, AR	
		Retail markets	Fish meat	10% of total markets	At least 2	Based on no. of markets sampled	Quarterly	Based on no. of markets sampled	AMR, AR	Food Safety Department

*Farms include freshwater and brackish water farms; #Landing centres for marine capture; **Rotation of sites sampled should be considered.

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2.1.5. Sampling framework for surveillance in environment sector

The broad structure of the environment sector w.r.t. AMR has been categorized into point sources and non-point sources. Point sources refer to a single pollution source that could contribute AMR determinants through waste from these sources. These include factories, healthcare settings, farms and the community. AMR determinants may then directly, or after treatment, reach the larger external environment. Non-point sources are part of this larger environment, which include rivers, lakes, ponds, oceans, groundwater and soil. These act as sinks of AMR determinants contributed by point sources. In addition, they also act as sources since AMR determinants can find their way back into humans, animals and the food chain from the larger environment.

The sampling framework for surveillance across point and non-point sources in environment sector in Kerala is shown in Table 5 and 6 respectively. Sampling will expand from three districts in Phase 1 to all districts in Phase 2. For point sources, effluent samples will mostly be monitored, except in case of municipal solid waste dump sites, where soil and water will be monitored. For non-point sources, seasonal sampling (i.e., before, during and after monsoon) of surface or ground water samples will be done and monitored for resistant bacteria only. The key stakeholder involved would be the KSPCB. The KSPCB could initially seek technical and capacity building support from the other stakeholders in the state such as the state Animal Husbandry Department, Fisheries Department, Central Institute of Fisheries Technology etc. In the meantime, laboratories of the KSPCB could be strengthened and resources trained w.r.t. microbiology, analytical chemistry and molecular biology in order to conduct AMR surveillance independently.

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Table 5: Sampling framework for point sources in environment

	Districts	Sampling locations	No. of sampling locations per district	Sample types	No. of samples per site	Total samples per district	Sampling frequency	Samples per year per district	AMR, AR	Stakeholder
Phase 1	Kozhikkode Ernakulum Trivandrum	Sewage Treatment Plant (STP)	1 modern plant at Muttathara, Trivandrum	Effluent	3 (inlet, midpoint, outlet)	3	Quarterly	12	AMR, AR	KSPCB
		Residential STPs in high rise buildings	5 (initial pilot in Trivandrum)	Effluent	1	5	Quarterly	20	AMR, AR	
		Hospital	1 each of general hospital, medical college, corporate hospital, veterinary hospital, polyclinic (5 sites)	Effluent	1	5	Quarterly	20	AMR, AR	
		Slaughter houses	2	Effluent	1	2	Quarterly	8	AMR, AR	
		Biomedical waste treatment plant	Only 1 present in Palakkad	Effluent	1	1	Quarterly	4	AMR, AR	
		Farms (poultry, dairy, aquaculture)	5 (consider 5-10% of farms selected for surveillance in livestock/fisheries)	Effluent	1	5	Quarterly	20	AMR, AR	
		Municipal solid waste dump sites	2	Soil, water	2 per sample type	8	Quarterly	32	AMR, AR	
Phase 2	Alappuzha Ernakulam Idukki Kannur Kasaragod Kollam Kottayam Kozhikkode Malappuram Palakkad Pathanamthitta Thrissur Trivandrum Wayanad	STP	1 modern plant at Muttathara, Trivandrum	Effluent	3 (inlet, midpoint, outlet)	3	Quarterly	12	AMR, AR	KSPCB
		Residential STPs in high rise buildings	5 (initial pilot in Trivandrum)	Effluent	1	5	Quarterly	20	AMR, AR	
		Hospital	1 each of general hospital, medical college, corporate hospital, veterinary hospital, polyclinic (5 sites)	Effluent	1	5	Quarterly	20	AMR, AR	
		Slaughter houses	2	Effluent	1	2	Quarterly	8	AMR, AR	
		Biomedical waste treatment plant	Only 1 present in Palakkad	Effluent	1	1	Quarterly	4	AMR, AR	
		Aquaculture farms, poultry farms, dairy farms	5 (consider 5-10% of farms selected for surveillance in livestock/fisheries)	Effluent	1	5	Quarterly	20	AMR, AR	
		Municipal solid waste dump sites	2	Soil, water	2 per sample type	8	Quarterly	32	AMR, AR	

Note: Based on learning from Phase 1, number of sampling locations will be expanded for other point sources. Antibiotic residue testing could be done on 1/3rd of samples collected for AMR surveillance and involve qualitative testing before quantitative estimation.

11

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Table 6: Sampling framework for non-point sources in environment

	Districts	Sampling locations	No. of sampling locations per district	Sample types	No. of samples persite	Total samples per district	Sampling frequency*	Samples per year per district	AMR, AR	Stakeholder
Phase 1	Ernakulum Kozhikkode Trivandrum	Rivers and Lakes#	At least 5	Water	3 (at different points along a river)	15	Seasonal	45	AMR	KSPCB
		Open wells	10	Ground water	1	10	Seasonal	30	AMR	
		Estuaries	5	Water	1	5	Seasonal	15	AMR	
		Coast line	5	Sea water	1	5	Seasonal	15	AMR	
Phase 2	Alappuzha Ernakulam Idukki Kannur Kasaragod Kollam Kottayam Kozhikkode Malappuram Palakkad Pathanamthitta Thrissur Trivandrum Wayanad	Rivers and Lakes#	At least 5	Water	3 (at different points along a river)	15	Seasonal	45	AMR	KSPCB
		Open wells	10	Ground water	1	10	Seasonal	30	AMR	
		Estuaries	5	Water	1	5	Seasonal	15	AMR	
		Coast line	5	Sea water	1	5	Seasonal	15	AMR	

#Examples: Pamba, Periyar rivers, Ramsar sites e.g. Vembanad lake, Ashthamudi lake (brackishwater lake), Sashthamkotta Lake (freshwater lake); *Seasonal sampling could be carried out pre-monsoon, monsoon, post-monsoon.

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2.2. Key bacteria, antibiotics, genes, standard methods, data analysis and reporting

	Poultry (Broiler)	Cattle for milk and meat	Fisheries	Environment
Key bacteria (for AST)	*Escherichia coli* *Salmonella* spp. *Klebsiella* spp.	*Escherichia coli* *Staphylococcus aureus*	*Escherichia coli* *Vibrio parahaemplyticus* *Aeromonas* spp.	Phase 1: *Escherichia coli* (focus on ESBL producing *E. coli*) Phase 2: *Escherichia coli* *Enterococcus* spp. *Klebseilla* spp.
Key antibiotics (for AST)	*Escherichia coli and Klebsiella* spp. • Tetracyclines • Sulfonamides (e.g. suphaquinoxaline) • Fluoroquinolones (e.g. enrofloxacin) • Third generation cephalosporins (e.g. ceftriaxone) *Salmonella* spp. • Beta lactams (e.g. ampicillin) • Chloramphenicol • Sulfonamides (e..g. cotrimoxazole)	*Escherichia coli* • Tetracycline • Beta lactams • Third generation cephalosporins (e.g. ceftriaxone) • Fluoroquinolones (e.g. ciprofloxacin) • Carbapenems (e.g. imipenem) • Aminoglycosides (e.g. gentamicin) *Staphylococcus aureus* • Tetracyclines • Beta lactams (e.g. oxacillin) • Macrolides	• Tetracyclines • Cephalosporins • Quinolones	• Carbapenems (e.g. imipenem) • Fluoroquinolones (e.g. ciprofloxacin) • Beta Lactams and Beta Lactamase Inhibitor
Method for bacterial isolation, identification, characterization	Biochemical identification system (ViTEK)	Biochemical identification system (VITEK)	Biochemical identification system (VITEK)	Selective media and biochemical analysis
Method for AST*	Kirby Baeur Disc Diffusion, MIC and interpretation using CLSI			
Key antibiotics (for residue monitoring)	• Tetracyclines • Fluoroquinolones (e.g. enrofloxacin) • Third generation cephalosporins (e.g. Ceftriaxone) • Sulfonamides (e.g. suphaquinoxaline)	• Tetracyclines • Beta lactams (e.g. penicillin, ampicillin, amoxicillin, cloxacillin) • 3rd generation cephalosporins • Fluoroquinolones (e.g. enrofloxacin, ciprofloxacin) • Aminoglycosides (e.g. gentamicin)	• Tetracyclines • Nitrofurans	Antibiotics to be tested will be site-specific and also depend on its concentration and rate of breakdown (only for point sources)
Method for residue testing	ELISA; 10% of ELISA positive samples to be further validated using HPLC/LCMS			
Genetic markers**	• ESBL genes (blaCTX-M, blaSHV, blaTEM etc.) • Tetracycline resistance genes (tet-A, tet-B, tet-M, tet-O, tet-S etc.) • Sulfonamide resistance genes (sul1-3 etc.) • Quinolone resistance genes (*qnrA, qnrB, qnrS* etc.)	• ESBL genes (blaCTX-M, blaSHV, blaTEM etc.) • Tetracycline resistance genes (tet-A, tet-B, tet-M, tet-O, tet-S etc.) • Macrolide resistance genes (err, mef, msr, ere etc.)	• Tetracycline resistance genes (tet-A, tet-B, tet-M, tet-O, tet-S etc.)	• ESBL genes (blaCTX-M, blaSHV, blaTEM etc.)
Data harmonization and reporting	WHONET; Annual reporting			

*Minimum Inhibitory Concentration (MIC) method is ideal and recommended for large antibiotic molecules. Laboratories with necessary infrastructure may prefer MIC (if required in Phase 2); **Along with resistant bacteria and residues, presence of genetic markers responsible for AMR in bacteria should also be tested. This could however be initiated in Phase 2 of surveillance.

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