Department of Health & Family Welfare
Government of Kerala

Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP)

One Health response to AMR Containment

KERALA .HEALTH

KARSAP- 2026

Foreword

Antimicrobial resistance (AMR) has emerged as one of the most formidable public health threats of the twenty-first century, undermining decades of progress in the prevention and treatment of infectious diseases. Resistant pathogens increasingly compromise the effectiveness of life-saving antimicrobials, resulting in prolonged illness, increased healthcare costs, therapeutic failures, and higher mortality rates. Globally, bacterial AMR was directly responsible for an estimated 1.27 million deaths in 2019 and contributed to nearly 5 million deaths, highlighting the magnitude of this growing crisis. The consequences extend beyond infectious diseases, threatening the safety of routine surgical procedures, chemotherapy, organ transplantation, and intensive care interventions that rely on effective antimicrobial therapy. In this context, a robust surveillance systems and evidence-based antimicrobial stewardship have become indispensable components to respond against AMR.

Kerala is the first state to formulate a strategic action plan. The department started implementing the same from 2019. As the implementation gained momentum by taking ambitious campaign of making Kerala Antibiotic literate, the world faced the Covid pandemic and it impacted momentum. Kerala took another strategic initiative of implementing ONE HEALTH in 2021 by drawing lessons from the pandemic. AMR became an integral part of ONE HEALTH drive undertaken in the state. Subsequently at the state level, district level structures and processes were formed and capacity building was done. This was done by keeping people and peoples' representatives at the grassroots on the forefront. The social determinants of health – empowerment of women and women participation, strong panchayath for local governance and leadership, literacy and very vigilant social as well as public scrutiny strengthened the program. It has gone from strength-to-strength in phases and now aspiring to declare Kerala as antibiotic literate within 9 to 12 months.

Kerala is the only State in India to release an annual state antibiograms from 2021 onwards and the Kerala State Antibiogram 2026 represents a critical milestone in the State's ongoing efforts to monitor resistance trends, guide empirical therapy, strengthen infection prevention and control practices, and inform public health policy. By consolidating susceptibility data generated through the Kerala Antimicrobial Resistance Surveillance Network (KARS-Net), this report provides clinicians, microbiologists, hospital administrators, and policymakers with actionable insights into the evolving landscape. As Kerala continues to advance its One Health approach to combat AMR, the findings presented in this antibiogram will serve as an essential resource for preserving the effectiveness of existing antimicrobials and safeguarding the health of future generations.

It is worth mentioning here that the KARSNET annual report of 2026 depicts AMR trends from 55 surveillance centres across the state capturing and analyzing data from 65,849 unique patient isolates . This publication is the product of coordinated collaboration between the Department of Health and Family Welfare, public and private hospital laboratories, academic institutions, and civil society partners. I commend the dedication of microbiologists, clinicians, epidemiologists, laboratory technicians, data managers, and administrative staff whose meticulous work made this report possible. Their combined efforts exemplify the multisectoral response requirements that AMR demands.

The movement is built with the ONE HEALTH approach ensuring involvement of line departments. The next step would be to have an antibiogram of Animal Husbandry and other line departments too. These various researched reports later to be analysed from geography and

sector specific perspectives so that the departments, organizations and the stakeholders shall be able to take informed interventions and bring changes on the supply and demand side too. Such approach will require a long-term commitment and interventions necessarily involving the primary stakeholders- people.

Kerala has taken the initiative of making the state Antibiotic literate. We hope by this financial year it will be achieved. It will be a strong foundation upon which the AMR program can be further strengthened. Kerala Health has introduced an accreditation system to declare Hospitals/ Panchayath as Antibiotic Smart.This initiative involves service providers i.e. Doctors and paramedics, Pharmacists, other sector specific functionaries and people including political executives of Panchayaths. This initiative would build a movement to reach to the goal of an Antibiotic Literate State. We have made the information available on www.health.kerala.gov.in portal for easy access to all students and researchers. It informs district and panchyath wise their Antibiotic Smart status. In order to facilitate the reporting, monitoring, evaluation and analytics a well thought out AMR Management System software has been developed in partnership with the Digital University of Kerala. This system will open up new opportunities to use advanced technological tools to conduct analytics and take specific interventions.

While data is indispensable, it alone is not sufficient. The antibiogram must inform action: stewardship teams must use it to update empiric therapy guidelines; hospital administrators must prioritise infection prevention and diagnostic stewardship; policy makers must support sustained investments in laboratory capacity, surveillance systems, workforce training, and research; and communities must be engaged to promote judicious antibiotic use. Together with these measures it will form a resilient approach that preserves antimicrobial efficacy for future generations. The health fraternity has to abide by the standard treatment protocols. The combination of efforts on the supply side as well as the demand side will bring the desired results of minimizing antimicrobial resistance.

I congratulate all the field teams, nodal officers of the line departments, Dr Saritha and Dr Aravind for their committed efforts and all state level and field officers of all the line departments and organizations for their invaluable contribution to strengthen the AMR program in the state.

With best wishes

Dr Rajan N Khobragade, IAS
Additional Chief Secretary
Health and Family Welfare

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Executive summary

The *Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP)* represents a pioneering, state-led response to the growing global threat of antimicrobial resistance (AMR). Since its formal launch on October 25, 2018 by Honourable Chief Minister of Kerala Shri Pinarayi Vijayan in the presence of WHO representative to India Dr. Henk Bekedam, KARSAP has evolved into a comprehensive, multi-sectoral framework that integrates human health, animal health, agriculture, and environmental perspectives under a One Health approach.

This book documents the journey of the first State level AMR action plan in India KARSAP from its inception through 2026, capturing the strategic vision, coordinated actions, and measurable progress achieved over nearly a decade. It highlights how Kerala translated global and national commitments such as the WHO Global Action Plan on AMR and NAP-AMR into localized, context-specific time sensitive interventions.

Foundational Phase (2017–2020):

KARSAP began with the establishment of governance structures, technical working groups, and baseline assessments. Early efforts focused on strengthening surveillance systems, promoting antimicrobial stewardship in healthcare settings, and building awareness among healthcare professionals and the public. The development of Kerala Antimicrobial resistance surveillance Network [KARSNET] and infection prevention and control (IPC) protocols marked critical early milestones.

Expansion, Decentralization and Integration (2020–2026):

During this phase, KARSAP expanded its reach across sectors. Antibiotic literate Kerala campaign was launched to create awareness on AMR across all sections of society. Surveillance networks were strengthened through laboratory capacity building and digital reporting systems. Annual Kerala state Antibiograms have been published from November 2022 onwards thereby becoming the first State in India to do so. AMR committees were established in all Districts and Health blocks, and AMR surveillance hubs were established in all districts. Unique Hub and spoke model of AMR surveillance was initiated in all districts in Kerala thereby capturing AMR trends in primary and secondary tiers of health care as well. Antimicrobial Stewardship institutionalized in public and private healthcare facilities got strengthened by the release of district level antibiograms. Parallel initiatives in veterinary practices, fisheries and aquaculture, drugs control department emphasized rational antimicrobial use, while environmental monitoring began addressing pharmaceutical waste and effluents. Capacity building, training programs, and academic collaborations played a central role in sustaining momentum. Community engagement initiatives and behavioral change campaigns were further strengthened by the launch of the unique Antibiotic smart hospital initiative [ASHI] and Antibiotic literate local self Government initiatives. Another unique step

was launch of Operation AMRITH [Antimicrobial Resistance Intervention for Total Health] in January 2024, which banned OTC sale of antibiotics without prescription in Kerala

LookingAhead:
As KARSAP moves beyond 2026, the focus shifts toward sustainability, scaling innovations, and aligning with emerging global priorities such as pandemic preparedness and climate-health linkages. The Kerala experience underscores the importance of decentralized leadership, evidence based policymaking, and collaborative action in combating AMR. This book serves not only as a chronicle of KARSAP's achievements and challenges but also as a practical guide and inspiration for other regions of Global South seeking to implement effective AMR strategies.

Background

AMR -A Global Public Health Threat-Antimicrobial resistance (AMR) has been recognized as one of the biggest public health challenges by the World Health Organization (WHO). On September 21, 2016 United Nations (UN) General assembly met to discuss AMR. It was only the fourth time that a health-related problem had been discussed in UN General assembly.[1] Although AMR is a natural phenomenon, it is being propagated by misuse of antimicrobial medicines, inadequate or inexistent programs for infection prevention and control (IPC), poor-quality medicines, weak laboratory capacity, inadequate surveillance and insufficient regulation of the use of antimicrobial medicines. AMR has become a core political, social, and economic problem of our time.

Global Burden of AMR-It is predicted that if AMR continues unabated, it will lead to one crore deaths by 2050.[2] This is infact more than the number of people who are expected to die due to cancer or road traffic accident. AMR is also expected to impact the global economy by 100 trillion dollars, by 2050. [2]The Lancet estimates that 1.27 million deaths were directly attributable to AMR in 2019, and 4.95 million deaths were associated with AMR.[3] AMR is a global health threat, and low- and middle-income countries (LMICs) are expected to be impacted more than the developed countries. AMR contributes to deaths across a range of different types of infections – not just those typically thought to be serious like pneumonia and sepsis, but also simple treatable illnesses like urinary tract infections or infected wounds.

Economic consequences of AMR-The economic consequences of AMR are equally severe. The World Bank estimates that by 2050, the world could face an additional US$ 1 trillion in healthcare costs, and GDP losses between US $1 trillion and $3.4 trillion annually by 2030 due to AMR . Therefore, addressing AMR requires coordinated global and national efforts, such as improving infection prevention, expanding access to quality diagnosis and treatment, and fostering innovation in the development of new vaccines and antimicrobials.

Drivers and determinants of AMR-AMR is driven by a complex interplay of biological, behavioral, and systemic factors at both global and national scales. Globally, excessive and inappropriate use of antibiotics in human medicine such as overprescription, self-medication, and incomplete treatment courses creates strong selection pressure that accelerates the emergence of resistant strains. This is compounded by widespread antibiotic use in livestock and agriculture for growth promotion and disease prevention, facilitating transmission of resistant pathogens through food chain and the environment. Weak regulatory frameworks, limited surveillance systems, and poor infection prevention and control practices in many low and middle income countries further amplify the problem. International travel and trade also enable rapid cross-border dissemination of resistant organisms. In the Indian context, these global drivers are intensified by high population density, variable access to healthcare, over-the-counter availability of antibiotics, and gaps in sanitation and wastewater management that allow resistant genes to circulate widely in communities. Additionally, challenges such as inadequate antimicrobial stewardship, heterogeneous healthcare infrastructure, and limited diagnostic capacity contribute to empirical and often inappropriate antibiotic use.

Global Response to AMR-As AMR threatens the very core of modern medicine, on May 2015 World Health Assembly adopted a global action plan on AMR. The United Nations General

Assembly High-Level Meeting on Antimicrobial Resistance marked a turning point in the global response to antimicrobial resistance (AMR). Held in September 2016, it was only the fourth time the United Nations General Assembly addressed a health issue at this level, highlighting the seriousness of AMR . During the meeting, world leaders committed to a coordinated, multi-sectoral response and adopted a political declaration recognizing AMR as a fundamental threat to global health, food security, and development. The declaration called for stronger national action plans, improved surveillance, regulation of antimicrobial use in humans and animals, and increased investment in research and development. It also reinforced the "One Health" approach, bringing together sectors such as healthcare, agriculture, and the environment. The meeting ultimately helped elevate AMR from a technical public health issue to a major political priority, encouraging sustained international collaboration.

AMR was discussed again during the 79th UN General Assembly meeting on AMR, held on 26 September 2024, global leaders approved a political declarations related to AMR[4].These included committing to a clear set of targets and actions like reducing the estimated 4.95 million human deaths associated with bacterial AMR annually by 10% by 2030.The declaration also calls for sustainable national financing and US$100 million in catalytic funding to support funded national action plans on AMR. The declaration also sets an ambitious target that at least 70% of antibiotics used for human health globally should belong to the WHO Access group, basic water, sanitation, hygiene and waste management services in all health care facilities and 90% of countries meeting WHO's minimum requirements for IPC program by 2030.[4] There are also commitments on investments to facilitate equitable access to and appropriate use of antimicrobials, antimicrobial use surveillance and AMR across sectors including agriculture and animal health, through a holistic, multi-stakeholder, One Health approach. AMR mitigation efforts require a whole-of-society approach with strong political will and commitment to ensure that all stake holders work in unison and implement local, context specific solutions. [4]

National Response to AMR-The Global Action Plan on AMR (GAP-AMR) was endorsed by all WHO Member States in 2015 [5].India's National Action plan on AMR (NAP-AMR) was launched on 19th April 2017. Development of State Action Plans for Containment of AMR (SAPCAR) is a key priority under the NAP-AMR. Kerala became the first state in India to develop its state action plan Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) which was launched by Honourable Chief Minister of Kerala, Shri Pinarayi Vijayan launched on 25 October 2018[6.7] .Till date only 20% of State's in India have drafted SAPCAR.NAP-AMR 2.0 launched on November 18, 2025 is based on a five year [2025-2029] strategic framework based on a One Health approach.

Kerala State Response to AMR-KARSAP is conceptualized and implemented as a One Health response to AMR, and was jointly drafted by departments of Health, Animal husbandry, Environment, Fisheries and Agriculture.The highlight of KARSAP is that the policy makers of the state considering AMR as a crisis, take lead and support the technical experts for the execution. Another unique aspect is the measures taken for AMR mitigation which is based on participatory antimicrobial stewardship (AMS), whereby through district and block level AMR committees and public participation, a whole of society approach is ensured. [6,8].

There were 4 main objectives of KARSAP when it was launched in 2018. These were to create AMR surveillance systems in Kerala, develop multisectoral strategies to reduce AMR, periodically review the AMR surveillance data to plan future actions, review the inputs from working group on research and incorporate them to prevention and management strategies. In line with Global and National Action plan, KARSAP has six strategic priorities . In 2022, a time sensitive monitoring and evaluation framework was conceptualized to coordinate and augment AMR mitigation strategies in human side, animal husbandry, fisheries, aquaculture, environment and other sectors.[8].

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KARSAP-Kerala State's Strategic Response to containment of AMR

The Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) is a comprehensive public health framework developed by the Government of Kerala in 2018 to combat the growing threat of antimicrobial resistance (AMR). It represents India's first sub-national action plan aligned with the World Health Organization Global Action Plan (2015) and the National Action Plan on AMR (2017). Conceptualized using a "One Health" approach, KARSAP integrates human health, animal husbandry, agriculture, fisheries, and environmental sectors to address the multifactorial drivers of resistance. Its primary objectives include establishing robust AMR surveillance systems, reducing antimicrobial misuse, periodically evaluating resistance trends, and incorporating findings into prevention and treatment strategies.

KARSAP is structured around six strategic priority areas: improving awareness and education, strengthening knowledge and evidence through surveillance, enhancing infection prevention and control, optimizing antimicrobial use, promoting research and innovation, and fostering

intersectoral collaboration. These priorities are operationalized through initiatives such as antimicrobial stewardship programmes in hospitals, expansion of laboratory diagnostic capacity, integrated surveillance networks like KARS-NET, and regulatory measures to control over-the-counter antibiotic sales. Additionally, the plan emphasizes training healthcare professionals, educating the public, and monitoring antimicrobial usage across human and animal sectors, thereby ensuring a coordinated and evidence-based response to AMR.

A defining feature of KARSAP is its time-bound, multi-level implementation strategy supported by monitoring and evaluation frameworks through which phased targets such as district-level and block level AMR committees, establishment of AMR surveillance networks using a hub-and-spoke model in all districts, and AMR surveillance labs in all districts have already been accomplished. KARSAP also incorporates environmental measures like regulating pharmaceutical effluent discharge and promoting safe disposal of unused medicines. Through sustained policy support and multisectoral coordination, KARSAP has contributed to measurable outcomes, including improved surveillance coverage and reductions in inappropriate antibiotic use, positioning Kerala as a model for AMR mitigation at both national and global levels. Many innovative steps like Antibiotic smart hospital initiative [ASHI], AMS compliant hospitals , Antibiotic literate LSGI etc are unique contributions made by Kerala Health to AMR containment efforts in Global south.

On October 19, 2023, the World Health Organization (WHO) issued guidelines with regard to the importance of having a people-centred approach to addressing antimicrobial resistance in human health an approach described as participatory stewardship. It puts people and their needs at the centre of the AMR response and guides policymakers in taking programmatic and comprehensive actions to mitigate AMR in line with a proposed package of core interventions.

These interventions are based on a review of four pillars and two foundational steps that are critical to overcome barriers faced by people and health systems in addressing AMR. The four pillars are: (1) prevention of infections; (2) access to essential health services; (3) timely, accurate diagnosis; and (4) appropriate, quality-assured treatment.

The pillars are supported by the two foundational steps: Effective governance, awareness and education; and strategic information through surveillance and research.

The Government of Kerala realised the importance of participatory stewardship in AMR much earlier and hence during the November 2019 annual review of Kerala Antimicrobial Resistance Strategic Action Plan (KARSAP) activities by the health minister, it was decided to make Kerala an antibiotic literate / aware state .

KARSAP GOVERNANCE STRUCTURE

In 18/12/2017 through a Government Order a high level committee was constituted under Additional Chief secretary Health and family welfare to co-ordinate activities under KARSAP. Other members of the committee are Director of Health Services, Director of Medical Education, Director Indian Systems of Medicine, Director Homeopathy, Director of Animal Husbandary, Director Fisheries department, Director State Public Health laboratory, Commissioner of food safety, Chairman Kerala State Pollution control Board, Registrar Kerala Veterinary and Animal sciences University [KVASU], Registrar Kerala University of Fisheries and Ocean studies [KUFOS], Nodal officer KARSAP [Head of Microbiology at GMC Thiruvananthapuram], Nominee of Indian Medical Association, Nominee of department of Science and Technology and Nominee of Director of Rajiv Gandhi centre for Biotechnology. This committee is now working as core committee of KARSAP.

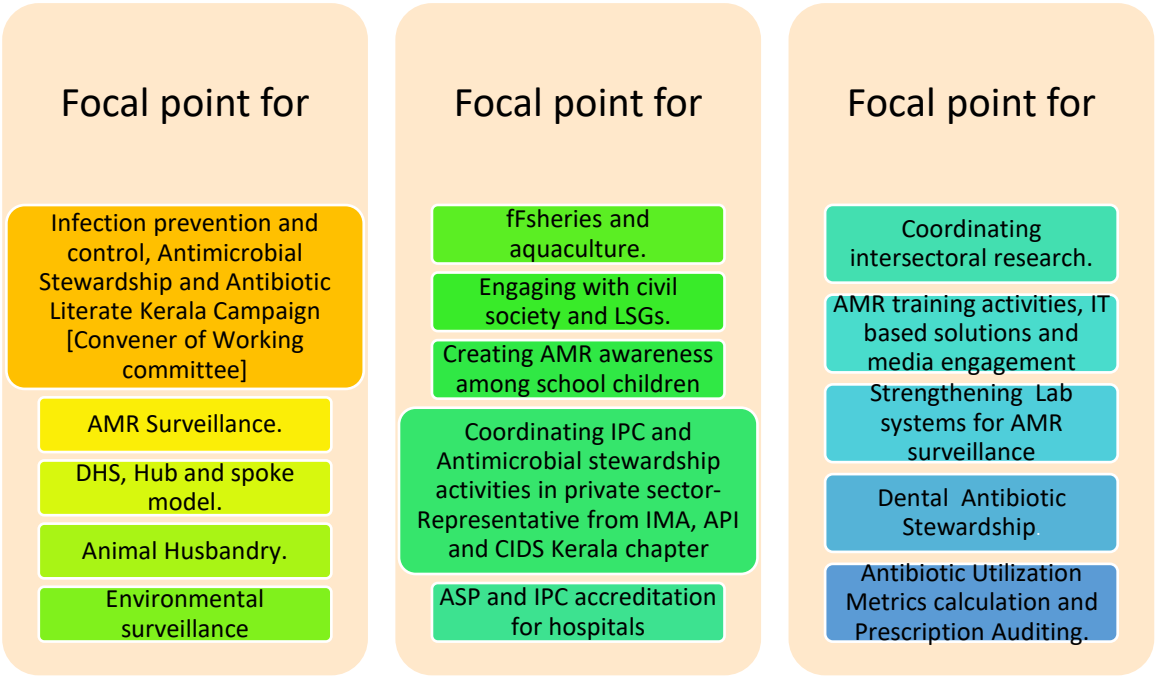
KARSAP working committee

Inorder to streamline activities of KARSAP under various domains, a Government order was issued on 11/2/2022 to constitute working committee of KARSAP. This committee was again reconstituted in 22/06/2024 by another GO to include representatives from API, CIDS, IDA and for including a nodal point from pharmacology for co-ordinating antibiotic utilization metrics calculation.
Nodal officer of KARSAP is the Head of department of Microbiology at Government Medical College Thiruvananthapuram

The KARSAP working committee has the following objectives:

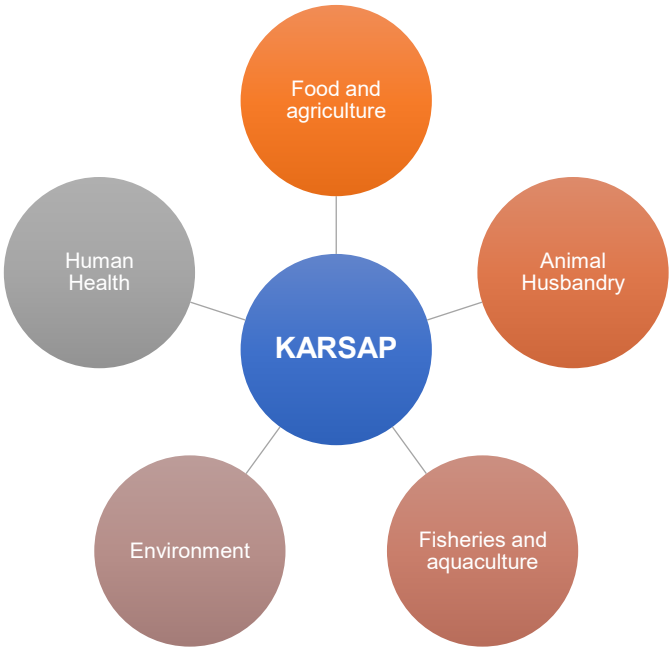
- Create AMR surveillance systems in Kerala to assess trend of AMR.
- Develop multisectoral strategies to reduce AMR in Kerala.
- Periodically review AMR surveillance data and to monitor prevention and management strategies.
- Review the inputs from working group on research and incorporate them to prevention and management strategies.

Focal Points in KARSAP Working Committee

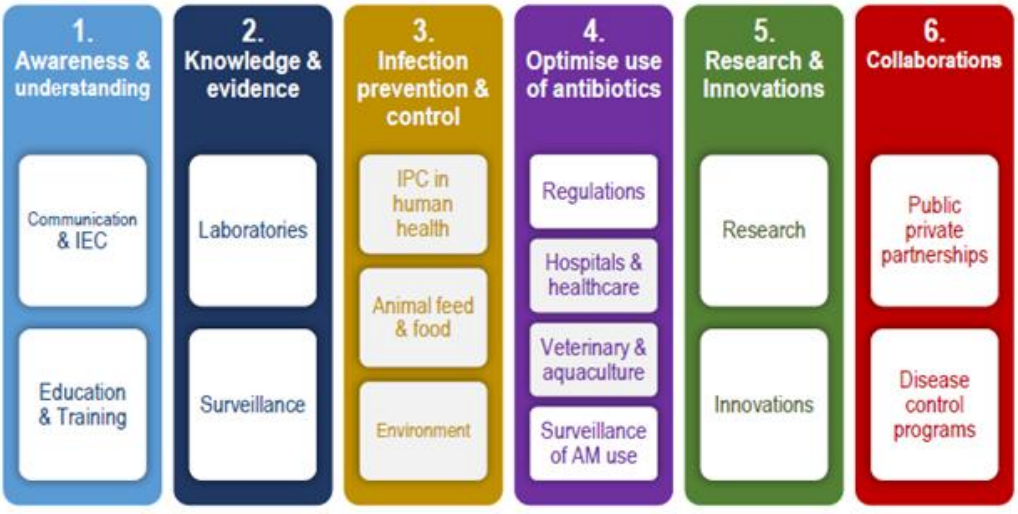


Additional Director of Health Services, Medical and Public Health as well as Nodal officer of KARSAP should attend all working committee meetings. Activities under DHS should be supervised by ADHS Medical. The working committee should report to Nodal officer of KARSAP and core committee of KARSAP.

THE KEY ONE HEALTH STAKEHOLDERS OF KARSAP



KARSAP – strategic priorities



KARSAP strategic priorities are aligned with those of Global action plan on AMR and National Action plan on AMR. The **Global Action Plan on AMR**, adopted by the World Health Organization in 2015, provides a coordinated international framework to combat AMR . Its overarching goal is to ensure continued access to effective, safe, and quality-assured

antimicrobial medicines while minimizing resistance. The plan follows a **"One Health" approach**, integrating human health, animal health, agriculture, and environmental sectors.

Strategic priority one is focussed on improving Awareness and Understanding- This objective focuses on enhancing knowledge about AMR through **education, communication, and training**. It aims to change behavior among healthcare providers, patients, farmers, and the public.Through this focus is on promoting rational antimicrobial use in all sectors and to reduce the misuse of antimicrobials by improving awareness.

Strategic priority two is focussed on strengthening Knowledge and evidence through Surveillance -This involves building robust systems for **data collection, monitoring, and research** on antimicrobial use and resistance patterns. This data helps in evidence based policymaking and in detection of AMR trends in the state and districts.

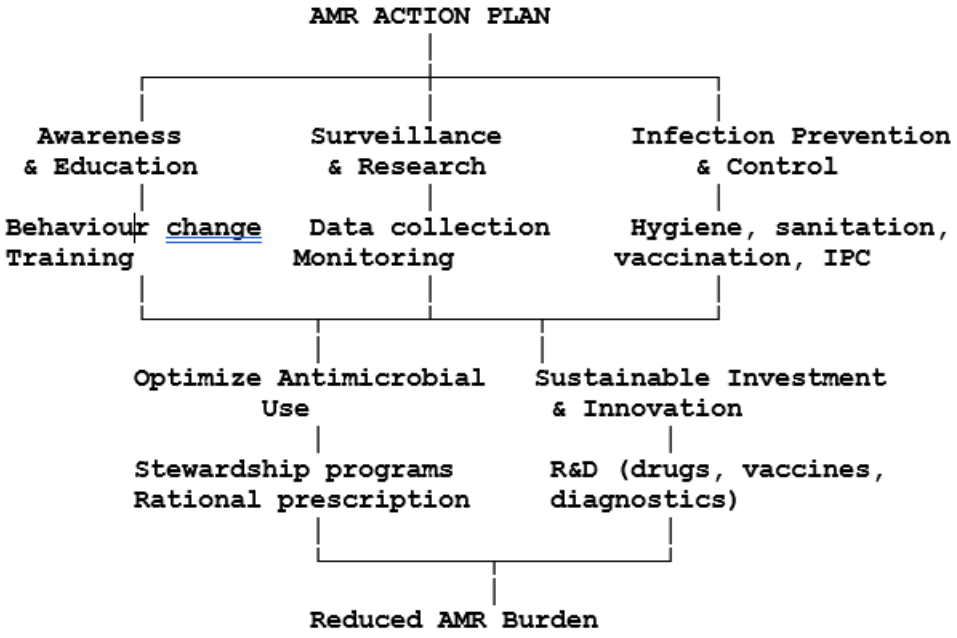
Strategic Priority Three is focussed on Infection Prevention and control -This priority emphasizes **infection prevention and control (IPC)** measures such as sanitation, hygiene, vaccination, and hospital infection control to reduce incidence of infections. By preventing infections, need for antimicrobials can be reduced thereby reducing selection pressure and genesis of AMR.

Strategic priority Four is focussed on optimizing the Use of Antimicrobial Agents-with the aim of **antimicrobial stewardship** in human and animal health to ensure appropriate prescription, dosage, and duration. This helps in minimizing selection pressure and thereby development of AMR.Regulatory framework like banning OTC sale of antibiotics etc also will come under this priority. Reducing non-therapeutic use of antimicrobials in livestock , and monitoring antimicrobial use in food production comes under this priority.

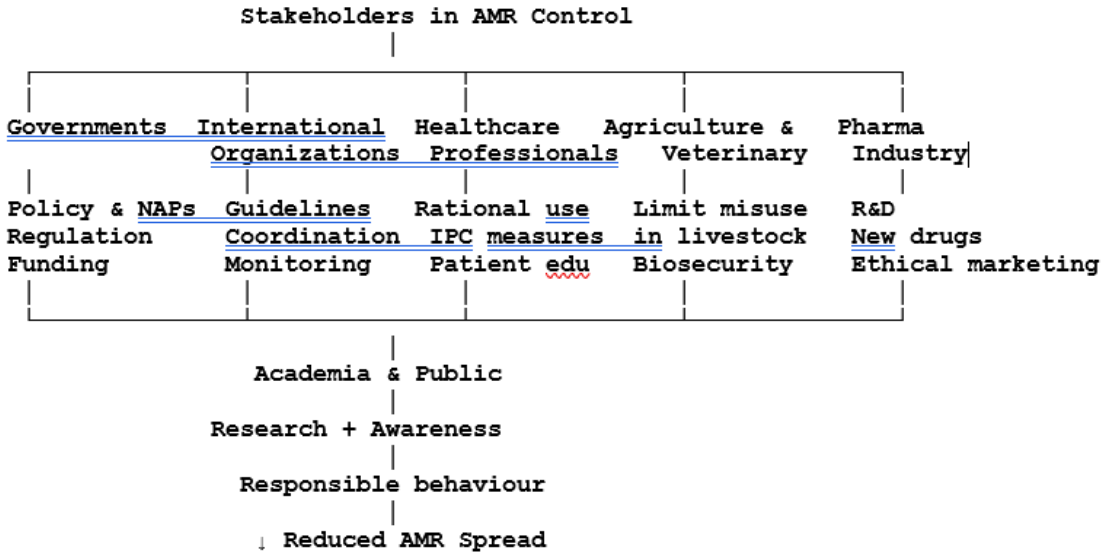
Strategic Priority Five is focussed on Research and Innovations- this includes promoting research into new antimicrobials, diagnostics, and vaccines. Research into newer molecules is essential to address the declining pipeline of new drugs and also to develop long term AMR containment strategies.

Strategic Priority Six focusses on collaborations-public-private partnership is essential to address AMR.

FLOW CHART DEPICTING STRATEGIC PRIORITIES



FLOW CHART DEPICTING STAKEHOLDERS AND ROLES



KARSAP has a monitoring and evaluation framework, which is time sensitive for strategic priorities 1 to 4 in human health, animal husbandry, fisheries/aquaculture and the environment.

KARSAP targets and time frame set in 2022

Targets	One year	Three years	Five years	Current status
District level AMR committees to be established	√			Achieved 2023
Block level AMR committees to be established	√			Achieved 2023
Awareness generation on AMR among school students	√			Ongoing
AMR to be included in school curriculum		√		Not yet
Hub and spoke model of AMR surveillance in all districts		√		Achieved 2025
Accreditation for all tertiary care institutions		√		Going on
Accreditation for all primary and secondary care institutions			√	**ongoing**
Zero effluent discharge policy in hospitals, farms, pharma industry			√	**ongoing**
Expansion of PROUD to all districts in Kerala		√		ongoing
Converting all PHCs to Antibiotic smart PHCs	√			ongoing
WHO AWaRe Target to be attained		√		2030 target
Antimicrobial utilization metrics calculated in all hospitals		√		Ongoing
50% reduction in carbapenem resistant Gram-negative infections		√		Ongoing

Review of KARSAP objectives and activities

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

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

1.7. Celebrate antibiotic awareness week in schools, colleges and all healthcare organisations in the State

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

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

1.10. Study/research on changes in knowledge, attitude and practice (KAP), following implementation

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)

1.11. Formulate and implement customised training programmes for undergraduate and postgraduate students

1.12. Study/research on changes in knowledge, attitude and practices (KAP) among undergraduate & postgraduate students and faculty, following implementation of training programs

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

1.14. Study/research on changes in KAP among pharmacists, nurses and support staff, following implementation of training programs

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

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

1.17. Study/research on changes in KAP among farmers, veterinarians, and fisheries professionals, following implementation of training program

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

1.19. Study on changes in KAP among those working in environment, pollution control board and allied agencies, following implementation of training program

Participatory Antimicrobial Stewardship – Antibiotic Literate Kerala Campaign (ALKC)

Fostering patient and public engagement (PPE) to mitigate AMR is termed as the participatory antimicrobial stewardship (AMS) and puts people and their needs at the centre of the AMR response. PPE has been adopted as an important target only in few national AMR policies. The importance of having a people-centered approach to tackle AMR was acknowledged by WHO and issued guidelines on 19 October 2023. These core interventions are based on four pillars and two foundational steps that are critical to overcome barriers faced by people and health systems in addressing AMR.

The four pillars are:

(1) prevention of infections;

(2) access to essential health services;

(3) timely, accurate diagnosis; and

(4) appropriate, quality-assured treatment.

The pillars are supported by the two foundational steps which are

(1) effective governance, awareness and education; and

(2) strategic information through surveillance and research.

Government of Kerala realized the importance of PPE in AMR as early as 2019. During November 2019 annual review of KARSAP activities by the honourable Health Minister of GoK, it was decided to make Kerala an antibiotic literate state. Under KARSAP, Antibiotic Literate Kerala Campaign (ALKC) was launched in 2019 with the aim of making all citizens of Kerala aware about the judicious use of antibiotics in all sectors through participatory AMS program. Due to COVID-19 pandemic, activities of ALKC came to a standstill in 2020 and 2021. From 2022 onwards public measures under ALKC has gained momentum.

Antibiotic literate Kerala Campaign - Target 2025

The broad objectives envisaged under antibiotic literate Kerala campaign are:

- Universal awareness about the importance of having access to antibiotic free food and water.
- Universal awareness about the importance of consuming antibiotics only on doctor's prescription.
- Universal awareness about importance of safely disposing unused or date expired antibiotics. [For this Kerala have started a unique campaign termed PROUD [Program on removal of unused drugs] which is a joint venture of Kerala State Drugs Control Department and All Kerala Chemists and Druggists Association]
- Awareness among school students of the threat posed by AMR.

In order to make Kerala an antibiotic literate state, several initiatives have been launched by the GoK which include preparation of online training modules on AMS for doctors, school and college students, public, grassroot level healthcare workers, pharmacists and farmers. AMR awareness messages in regional language (Malayalam) for public, farmers and students have been prepared, collated and released as an AMR flip book and information, education, communication (IEC) dossier for ready reference. Public engagement through visual and print medium is routinely done. Departments of animal husbandry, fisheries, aquaculture, environment, food and agriculture are also part of ALKC and messages in Malayalam for farmers have been formulated.

For implementation of ALKC, a decentralized approach was planned through creation of district and block level AMR committees. In 2023, Kerala achieved a significant milestone by becoming the first state in India to establish AMR committees in all districts and 190 health blocks. The AMR committees at district and block level are truly One Health based and have representatives from the departments of health, animal husbandry, fisheries, agriculture, and environment. ALKC is implemented through block AMR committees and is monitored by district and state AMR committees. These block AMR committees are the subdistrict bodies to disseminate the mandates on AMR programs in the field and among health care professionals and monitors the AMS activities in each local self-government departments (LSGD) under the block, against the mandates of KARSAP and its goals. Monitoring and evaluation framework and standard operating procedures (SOP) for block and district AMR committees have been issued as Government Orders (GO) by the GoK.

Key initiatives:

- Messages in Malayalam for farmers have been formulated by departments of animal husbandry, and fisheries and aquaculture.
- IEC dossier and AMR flip book in Malayalam has been released.
- Multi-lingual posters on AMR have been prepared for guest worker education.
- Online training modules on antimicrobial stewardship are available on State training site from 2021 onwards.
- To disseminate these messages to the public, District level AMR [Antimicrobial resistance] committees have been constituted in all districts in Kerala. It is for the first time that district level AMR committees have been constituted in India. Taking it forward Block level AMR committees have been constituted in all 190 health blocks. SOP for block level AMR committees have been released, and all hospitals will become "Antibiotic smart hospitals" in a time sensitive manner.
- During World AMR Awareness Week (WAAW) celebrations in 2023, FHC Kakodi was declared as first Antibiotic smart hospital in the State. During WAAW 2023 AMR IEC activities were conducted in all districts in Kerala. On Jan 1,2024 FHC Ozhlapathy in Palakkad was declared as antibiotic smart.
- To convert all panchayats/municipalities/towns to antibiotic literate, volunteers trained

as part of One Health, ASHA workers, NSS students etc are being used c to disseminate the customized messages in Malayalam to everyone in the Panchayat/municipalities/townships. The community volunteers act in co-ordination with FHCs/Block AMR committees. More than 3.5 lakh houses have been covered.

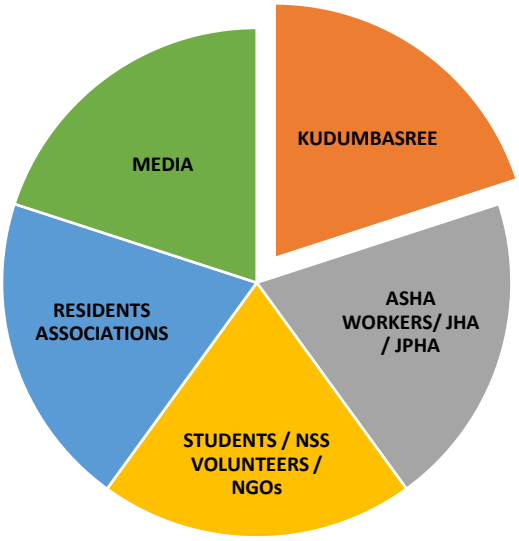
- The community volunteers are being trained to identify AMR hotspots in each panchayat like poultry farms, dairy farms, aquaculture, butcher shops, pharmaceutical industries, hospital effluents etc. All the identified AMR hotspots are being tagged geospatially, and focussed IEC interventions are being delivered. -Short term Goal.
- Drugs control department has launched "Student Programme on Antimicrobial Awareness Kerala (SPAARK)- with 'Sokhyam Sada' where trained students do house to house campaign.
- All district AMR committees have crafted customized action plans to reach antibiotic literate status by 2025.
- During World AMR Awareness Week (WAAW) celebrations in 2023, IEC activities were conducted in all districts in Kerala. Activities conducted during WAAW 2023 across the state was compiled and released as a book.
- During WAAW 2024, IEC activities were intensified across the state at the district and block level and the activity book was compiled and released.
- During WAAW 2024, 395 Local Self-Government Institutions [LSGI], 734 Government Hospitals, 437 Ayush Hospitals, and 404 Private Hospitals conducted AMR related IEC activities covering more than one lakh participants across Kerala. *Janakeeya Arogya Kendrams* [JAK] conducted 5,710 AMR awareness activities including public functions, awareness sessions, pledge, rallies, quizzes, poster competitions etc. Field staff from Jak conducted 8,339 community level activities. WAAW activities were conducted in 2,238 educational institutions covering 100,985 students. House-to-house visit was conducted by 12,465 volunteers, who visited 327,257 houses and distributed IEC materials. As part of WAAW 1,530 pharmacies visibly exhibited IEC on AMR statutory warning to have valid prescription for antibiotic dispensing. During WAAW 2024, in total 55,550 IEC materials were prepared, 2,004 social media IEC materials were used, and 316 audio/video IEC materials were released.
- During WAAW 2025, activities were intensified to accelerate Antibiotic literate Kerala campaign based on an augmented plan of action.Messages in Malayalam were customized to " 10 commandments on AMR" with tagline " Entekeralam Antibiotic sakshara keralam" [My Kerala, Antibiotic Literate Kerala".Radio jingles on the same theme were made. Questionnaire based Awareness assessment among public was done in all districts regarding antimicrobial resistance [AMR] and the optimal use of antibiotics.This questionnaire was administered to public coming to all FHCs/ CHCs/ UHCs/ Secondary care centres / tertiary care centres both Government and Private hospitals . Same questionnaire was administered to high school and college students under purview of block and District AMR committees.Micro action plans were made by all district AMR committees to ensure coverage of all marginalized population like

a) Guest Workers b) Orphanages c) Tribal population d) Palliative care etc.

IEC messages in regional languages were used for guest worker education on AMR.

For Student /Youth engagement- Antibiotic literacy based competitions quiz, essay writing, painting, elocution etc. for schools/colleges etc. at district level were conducted. Reels making competition on AMR was also organized in many districts. •

To reach 95 lakh households in the State, pro-active engagement with women self-help groups like Kudumbasree, residents associations, NGOs, NSS volunteers, students etc. are being done. For this customized messages are used to ensure uniformity.



All Districts have coordinated with the District Mission Coordinators of Kudumbasree to sensitize all CDS chair persons at the district level, all ADS chairpersons at the Grama Panchayat/ Municipal Levels. Sensitization of all Kudmbasree members have been conducted at NHG Levels. Health staff (Health Inspectors. PHNs, JHIs, JPHNs, MSP were the resource persons in the sensitizations sessions so conducted.

AMR footprint in visual, electronic, social media, FM radio etc was ensured.The core messages published in AMR IEC dossier have been conveyed to ensure uniformity.

IEC Activities using students etc. were performed in congregation places like bus stands, railway stations, fairs etc.

CRITERIA FOR ASESSMENT OF ANTIBIOTIC LITERATE STATUS

90% of respondents from public, students, farmers should get atleast 80% score based on assessment questionnaire	√
During WAAW 2025 AMR activities should be conducted with involvement of all hospitals – public and private, LSGIs and pharmacies in the state	√
Random checks to assess adherence to ban on OTC sale of antibiotics without prescription [desirable target > 80%]	√

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

2.2. Standardized laboratories in veterinary sector in every district

2.3. State level standard operating procedures (SOP) for collection, storage, transportation, processing and quality assurance

2.4. Establish data collection and collaboration at district levels

2.5. Upgradation of microbiology laboratories at medical colleges and districts - automated systems for identification and antimicrobial sensitivity testing

2.6. Strengthen human resources for laboratories in human and veterinary sectors

Focus area: Surveillance

Objective: Standardize and strengthen AMR surveillance in Kerala

2.7. Establish state referral laboratory at Department of Microbiology GMCT, 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 network to be assessed using a standard questionnaire followed by a site visit.

2.8. 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

2.9. Animal surveillance for sample-bug-drug combinations as per guidelines issued by the Food and Agriculture Organization of the United Nations

2.10. Surveillance in food animals and their products for sample-bug-drug combinations

2.11. Surveillance in fisheries for sample-bug-drug combinations

2.12. Surveillance in dairy products and food for sample-bug-drug combinations

2.13. Develop and implement standards for antibiotic residues in food (from animals), and in waste

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

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

2.16. Surveillance and monitoring of AMR in aquatic and terrestrial environments

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

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

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

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

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

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

KARS-NET (Kerala Antimicrobial Resistance Surveillance Network) was established in 2018 with the help of WHO Country Office for India and National Centre for Disease Control (NCDC). To get representative data from private hospitals, primary and secondary care institutions, KARS-NET has expanded to include 59 satellite centres with GMC Thiruvananthapuram as the coordinating centre. Also 185 spokes (secondary tier hospitals are also part of surveillance system).

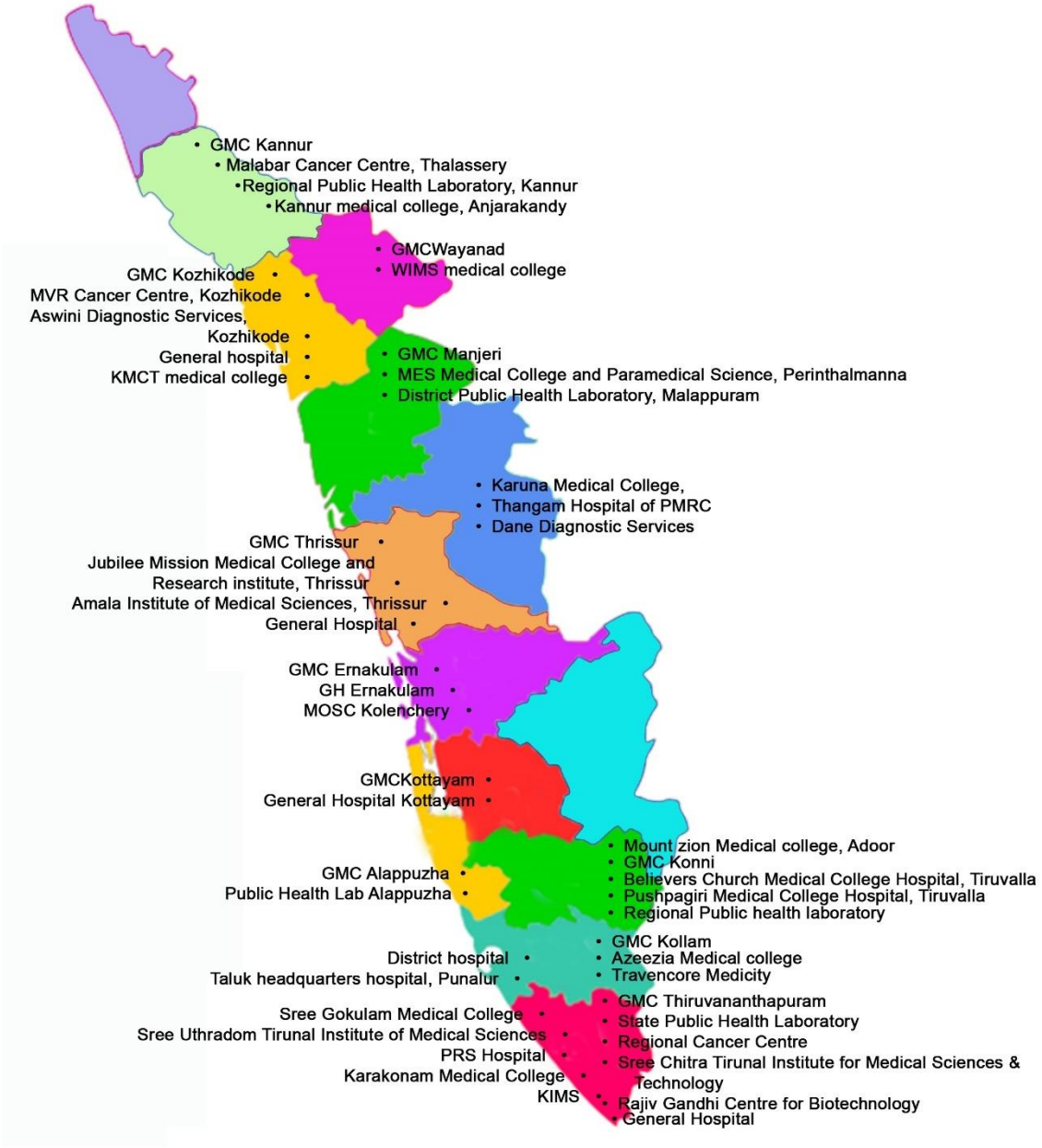
Objectives of KARS-Net:

- Foster standardization, strengthening and expansion of AMR surveillance in Kerala
- Analyse and report KARS-Net data to State Government and NCDC on regular basis
- Contribute towards the estimation of extent, burden, and monitoring of AMR in Kerala
- Detect emerging resistance and its spread in Kerala

KARSNET surveillance data for 2021-2024 has been released and indicates the level of AMR among priority pathogens in Kerala.

Hub and spoke model of AMR surveillance have been initiated in all 14 districts to get surveillance data from secondary care hospitals. [First such initiative in India].Surveillance data shows significant difference in ESBL and carbapenem resistance rates between isolates from tertiary care and secondary care hospitals necessitating the need for tier specific antibiotic guidelines.

KARS-NET AMR SURVEILLANCE SITES



All the participating network sites report the monthly AMR data of the nine priority pathogens to the Department of Microbiology, Government Medical College, Thiruvananthapuram. The feedback regarding the quality and completeness of AMR data is provided to the network sites on monthly basis. The network sites are mandated to implement internal quality control as an essential component of quality assurance in antimicrobial susceptibility testing and also participate in the External Quality Assessment Scheme (EQAS). Continuous support is provided to the programme sites to improve specimen collection, bacterial culture, identification of pathogens and their antimicrobial susceptibility testing (AST) which includes provision of continuous virtual and/or hands-on trainings. Onsite support visits and onsite trainings are also conducted for handholding the sites to strengthen bacteriology laboratory capacity by improving the quality of culture and AST practices. In addition, trainings and

workshops on WHONET software to streamline AMR surveillance data flow from network sites are regularly organised.

Kerala becomes first State to release an antibiogram

An antibiogram is the clinical data summarising the profile of various bacterial pathogens and its susceptibility to antibiotics that are meant to treat them

November 15, 2022 06:24 pm | Updated November 17, 2022 03:52 pm IST – Thiruvananthapuram

District Antibiogram of Ernakulam was released in 2023 (first State to do so). Based on district antibiogram, customized antibiotic guidelines for tertiary care, secondary care and primary care hospitals in the district has been released.

Plan is to have district antibiograms for all districts in Kerala within two years.

KARSNET ANTIBIOGRAM 2024

. The network of laboratories over the years has expanded from 21 labs in 9 districts to 59 labs across 14 districts in a phased manner . KARS-NET currently includes 12 government medical college hospitals and 14 government hospitals/laboratories under Directorate of Health Services, 5 semi-autonomous institutions, 20 private medical colleges, and 8 private hospitals/laboratories Priority pathogens under surveillance currently include nine commonly isolated pathogens from identified specimens. The WHONET software is used for the collection and analysis of antimicrobial susceptibility data.

The nine priority pathogens monitored by KARS-NET are:

1. *Staphylococcus aureus*
2. *Enterococcus species*
3. *Klebsiella species*
4. *Escherichia coli*
5. *Acinetobacter species*
6. *Pseudomonas species*
7. *Salmonella enterica* serovar Typhi and Paratyphi
8. *Shigella species*
9. *Vibrio cholerae*

Pathogens and Specimens under surveillance

	Staph. aureus	*Entero coccus spp.*	*Klebsiella spp.*	*E. coli*	*Acineto bacter spp.*	*Pseudo monas spp.*	*Salmonella Typhi/ Paratyphi*	*Shigella spp.*	*Vibrio cholerae*
Blood	✓	✓	✓	✓	✓	✓	✓	X	X
Urine	X	✓	✓	✓	✓	✓	X	X	X
PA	✓	✓	✓	✓	✓	✓	X	X	X
OSBF	✓	✓	✓	✓	✓	✓	X	X	X
Stool	X	X	X	X	X	X	✓	✓	✓

The annual report covers the AMR data from 1 January to 31 December 2024. A total of 47 surveillance laboratories from 13 districts submitted their data during this period. Antimicrobial susceptibility (AST) data of 62,087 priority pathogens, along with the demographic information of the patients from whom these pathogens were isolated, were reported under KARS-Net during 2024. After data deduplication, data from 55,640 unique patient isolates were analysed; 45% (25,176) of reported isolates were from males; 55% (30,441) were from females.

Urine was the most commonly reported specimen 56.3% (31,339), followed by pus aspirate 32.6% (18,113), blood 8.3% (4,603), other sterile body fluids 2.7% (1528) and stool 0.1% (57). The most frequently reported priority pathogen from all specimens was *E. coli* (40.4%), followed by *Klebsiella species* (22.7%), *S. aureus* (12.5%), *Pseudomonas species* (11.4%), *Enterococcus species* (8.3%), *Acinetobacter species* (4.4%), *Salmonella enterica* serotype Typhi and Paratyphi A & B (0.2%), *Shigella species* (0.1%) and *Vibrio cholerae* (0.01%)

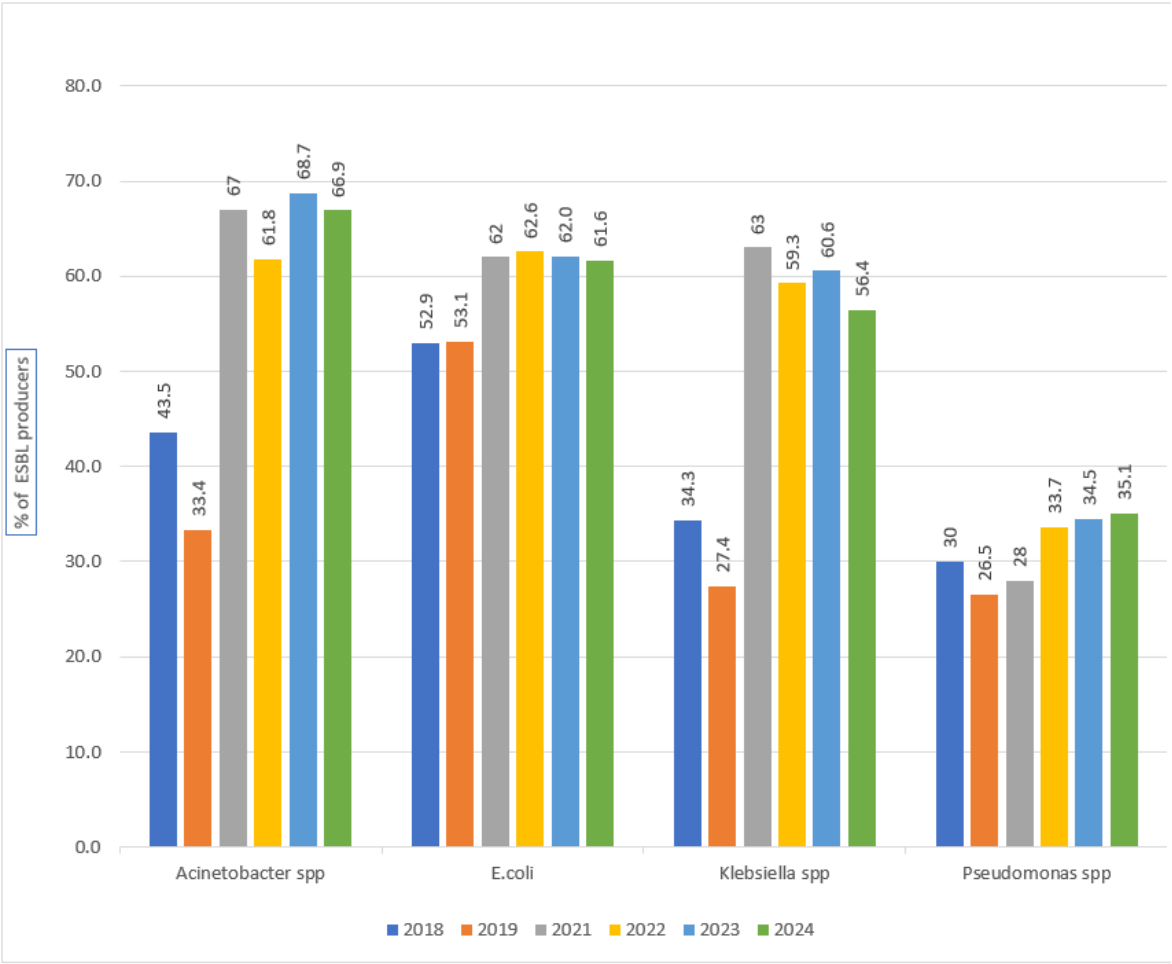
Among the reported *Staphylococcus aureus* isolates from blood, 32% were Methicillin resistant *Staphylococcus aureus* (MRSA). Among the Enterococcus isolates from blood, Vancomycin resistance was 3% and Linezolid resistance was 1%. Extended spectrum beta-lactamase (ESBL) was observed in 71% of *E. coli* and 68% of *Klebsiella spp*. isolated from blood. With respect to carbapenem resistant Enterobacterales (CRE) in blood, 9% resistance was observed in *E. coli* and 43% in *Klebsiella spp*.

Resistance to carbapenem was observed in 47% blood isolates of *Acinetobacter spp*. and 17% of *Pseudomonas spp*. Despite the relatively high resistance levels amongst Gram-negatives isolates in general, the overall resistance to colistin in gram negative isolates was only 0.3%.

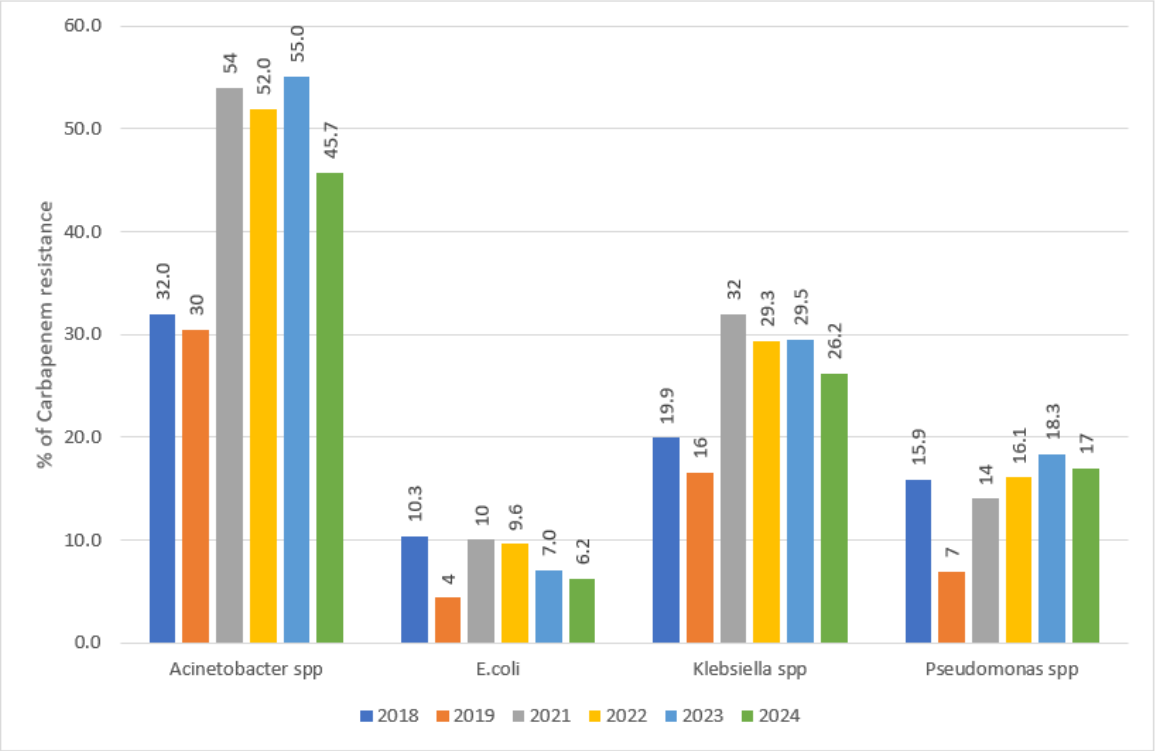
Trends of AMR in Kerala over 6 years

The trends of AMR in Kerala over six years (2018, 2019, 2021, 2022, 2023 and 2024) were analysed from the KARS-NET data. The data for 2020 was not included as most of the centres were unable to test and report AMR due to the COVID pandemic. It was observed that ESBL production as well as carbapenem resistance has generally shown a slight decrease last year . The apparent decrease in MRSA in 2021 may be attributed to the non-uniformity in data from some centres in the initial months of 2021 owing to the subsequent waves of pandemic in the state and majority of centres being COVID care centres. Slight decrease in MRSA rate was observed during 2024, but the VRE rate showed a similar trend compared to previous year report.

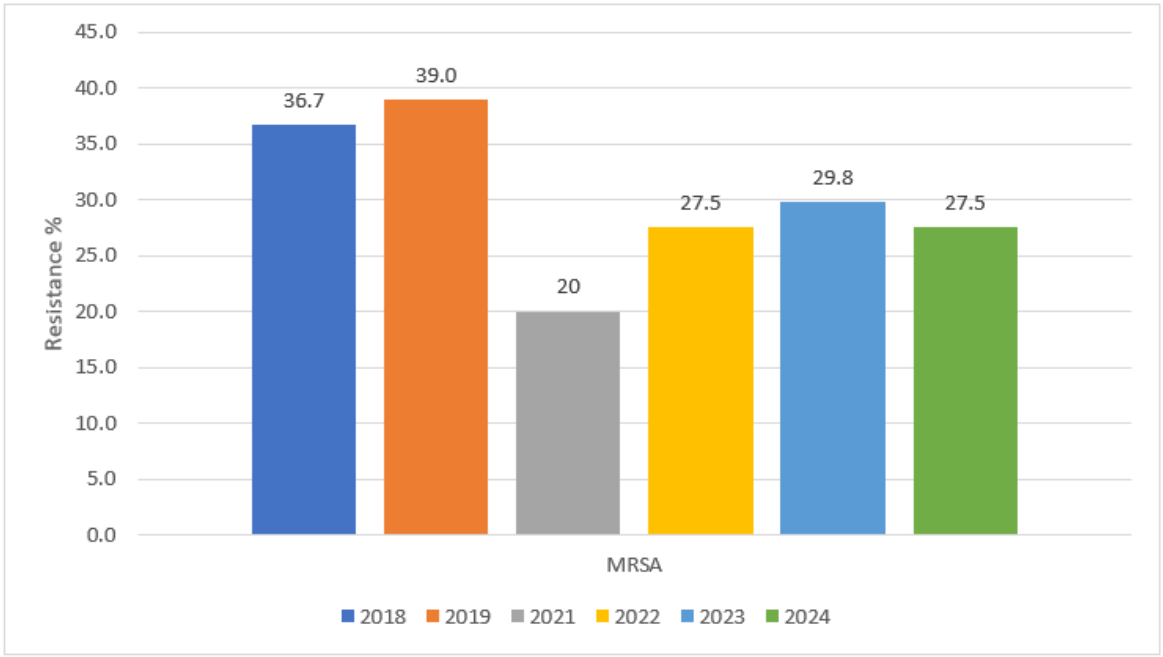
Trends of ESBL-KARS-NET data over 6 years



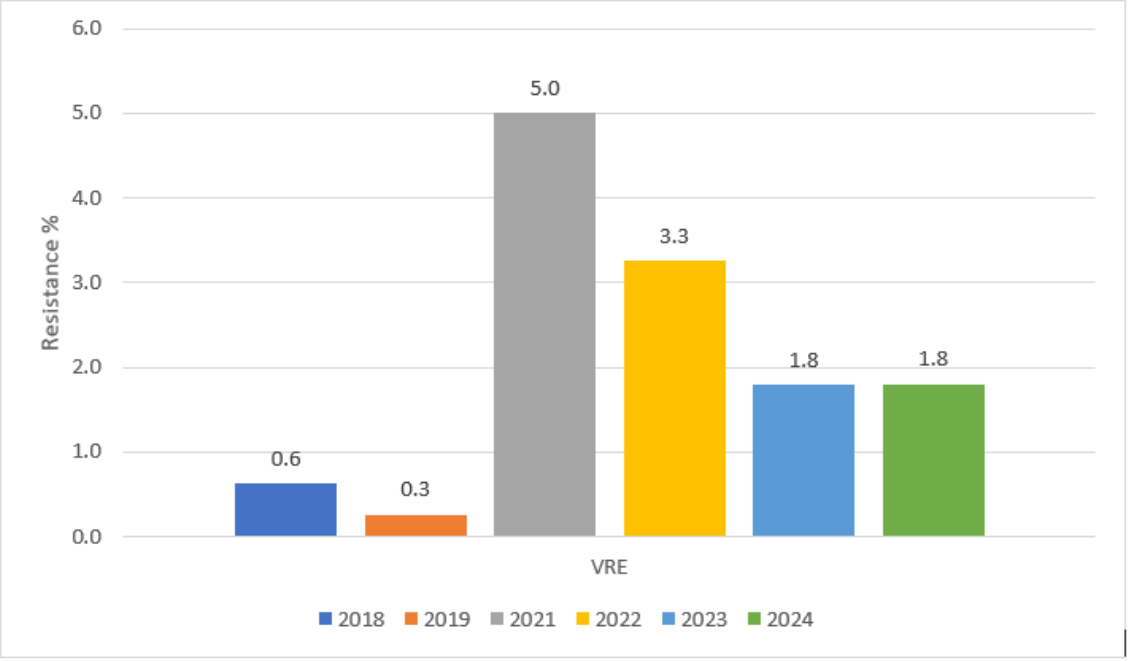
Trends of Carbapenem Resistance-KARS-NET data over 6 years



Trends of MRSA KARS-Net data over 6 years



Trends of VRE-KARS-NET data over 6 years



Strategic priority 3 – Infection Prevention and Control (IPC)

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

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

3.3. Strengthen medical and surgical asepsis

3.4. Strengthen sterilization & disinfection

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

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)

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

3.10. Establish surveillance of common healthcare associated infections

3.11. Monitor the IPC programme

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

3.12. Identify environmental sources of infection

3.13. Improve housekeeping and environment management

3.14. Ensure appropriate bio-medical waste management

3.15. Strengthen facility infrastructure including environment controls and sewage treatment plant

Kerala state consultancy meet on IPC related activities was conducted followed by a two-day training of trainers' workshop on IPC with the aim of optimizing and strengthening IPC related activities. All IPC trainers have been inducted to District AMR committees. Two workshops on IPC for staff Nurses were conducted in 2017 and 2019 by Director of Medical Education, following which Master trainers in IPC were identified .Now all medical colleges have Master trainers in IPC.In 2022 a state consultancy meet for strengthening IPC in Kerala was conducted in Thiruvananthapuram with help of NCDC.A training of trainers workshop on IPC was also conducted through which trainers on IPC were identified from all districts.

Healthcare-associated infections (HAIs) are infections people get while they are receiving health care for another condition. HAIs are a significant cause of illness and death — and they can have serious emotional, financial, and medical consequences. At any given time, about 1 in 31 inpatients have an infection related to hospital care. It has been recognized that HAIs are

an important public health and patient safety issue. Surveillance for HAIs is important to measure their burden, identify high-risk populations and procedures, and guide efforts to reduce HAI incidence. HAI surveillance is a core component of infection prevention and control programs worldwide. Stringent IPC practices must be adopted in hospitals to bring down incidence of HAIs and thereby ensure the safety of patients, bystanders, health care workers and visitors.

Right from the inception of KARSAP, IPC was given key importance. This is because through strengthening of IPC in hospitals, incidence of HAIs can be reduced. When incidence of HAIs come down, the need for broad spectrum antibiotics also come down which will lead to decrease in antimicrobial resistance. So, in a hospital setting the low hanging fruit model to be adopted to bring down the incidence of AMR is to strengthen IPC.

Activities done under KARSAP to strengthen IPC

- All hospitals in the State were directed to form functional Hospital Infection control committees (HICC).
- In 2017 Nurses were handpicked from all Government Medical Colleges through a written examination and were given a seven-day training in IPC at Thiruvananthapuram. These certified nurses in IPC were deployed as link nurses and Infection control nurses in medical colleges.
- All these IPC trained nurses were used to train other healthcare workers in their respective institutions. Due to which all the Medical Colleges have a robust link nurse led IPC programme.
- In 2019, DME organized an advanced IPC training program for all the initially trained nurses and based on the exit exam, 25 of them were certified as master trainers in IPC.
- Small group learning sessions [SGL's] on IPC which is a decentralized learning platform based on "each one – teach one" concept piloted in GMC Thiruvananthapuram has been a huge success. This model has been expanded to other institutions as well.
- IPC forms a major part of quality improvement initiatives in all hospitals. Hospital Quality improvement initiatives [HQII] are a priority of the Government and phase 1 has been successfully implemented in GMC Thiruvananthapuram in 2022.HQII has been extended to other major Government Medical colleges also. Quality improvement circles have been formed as part of this.
- Under KARSAP, Government also has envisaged a 5-year target of getting all the hospitals in the state accredited. As of now, there are 230 Govt Hospitals in the State which has NQAS [National Quality Assurance standards] accreditation.
- The focus on IPC helped the State in tackling COVID 19 also. The success of "Break the chain" campaign and "Back to basics" campaign are testimony of that. Also, Kerala was the first state to make universal mask use mandatory months prior to same recommendation from WHO.
- On November 2022, a State level TOT workshop on IPC was conducted, based on which all districts have IPC trainers now.

- A separate checklist-based colour coded grid has been devised to assess IPC practices in wards and ICUs, this has been piloted in GMC Thiruvananthapuram.
- HAI surveillance is performed in all tertiary care centres.
- IPC program for Kerala State is being finalized.
- As part of district and block AMR committee activities, minutes of HICC meetings in all hospitals are verified.
- As part of monitoring and evaluation framework, world Hand Hygiene day and Global handwashing day are supposed to be observed in all hospitals.
- Percentage of healthcare workers trained in IPC in each hospital is monitored by block AMR committees so as to ensure incremental improvement.
- Performance of Hand hygiene compliance audit in hospitals is being monitored by block AMR committees.
- Components on IPC are also incorporated into Antibiotic smart hospital criteria .

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.

Focus area: Environment

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

3.22. Identify sources of AMR

3.23. Collect baseline data

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

3.27. Develop standard operating procedures (SOP)

3.28. Develop policy on registration and licensing of farms, factories, slaughterhouses, 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, slaughterhouses, 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

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

4.3. Conduct education sessions

4.4. Ensure compulsory attendance at 6-monthly educational sessions

4.5. Conduct public awareness activities targeted at consumers and community, including social media

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

4.9. Monitor the quality of antimicrobials

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

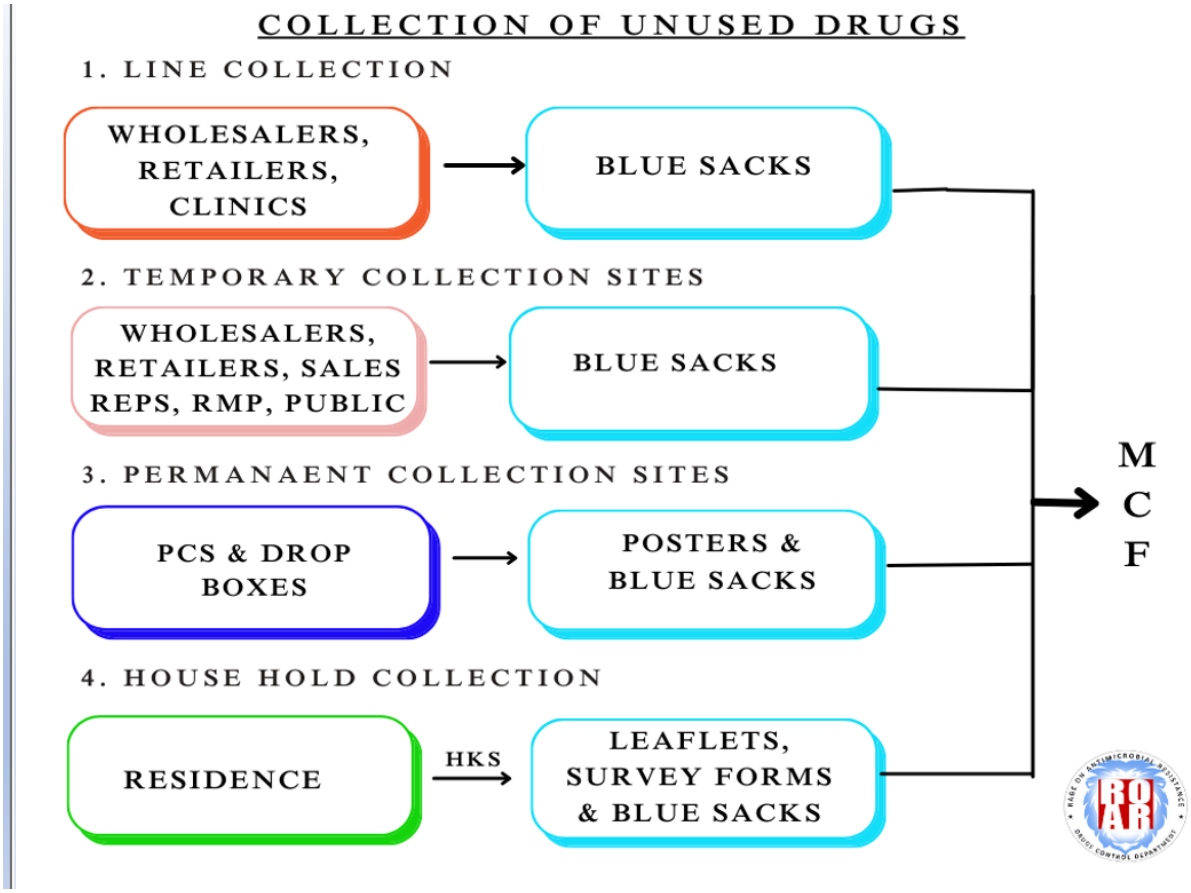
Key achievements of Drug Control Department

2019	Programme for removal of unused drugs (PROUD-1) Pilot @ Trivandrum with AKCDA
2020	PROUD-2 launched @ Trivandrum & Kollam via Clean Kerala Company
2021	IEC targeting retail and wholesale traders conducted by drug inspectors 2023 AMR squad – statewide network – department – hub only
2024	January 1-Operation AMRITH – Punitive action – targeted inspections to monitor antimicrobial misuse.Total ban on OTC sale of antibiotics without prescription in Kerala. Toll free number provided to public to register complaints in case antibiotics are dispensed without prescription from medical shops.

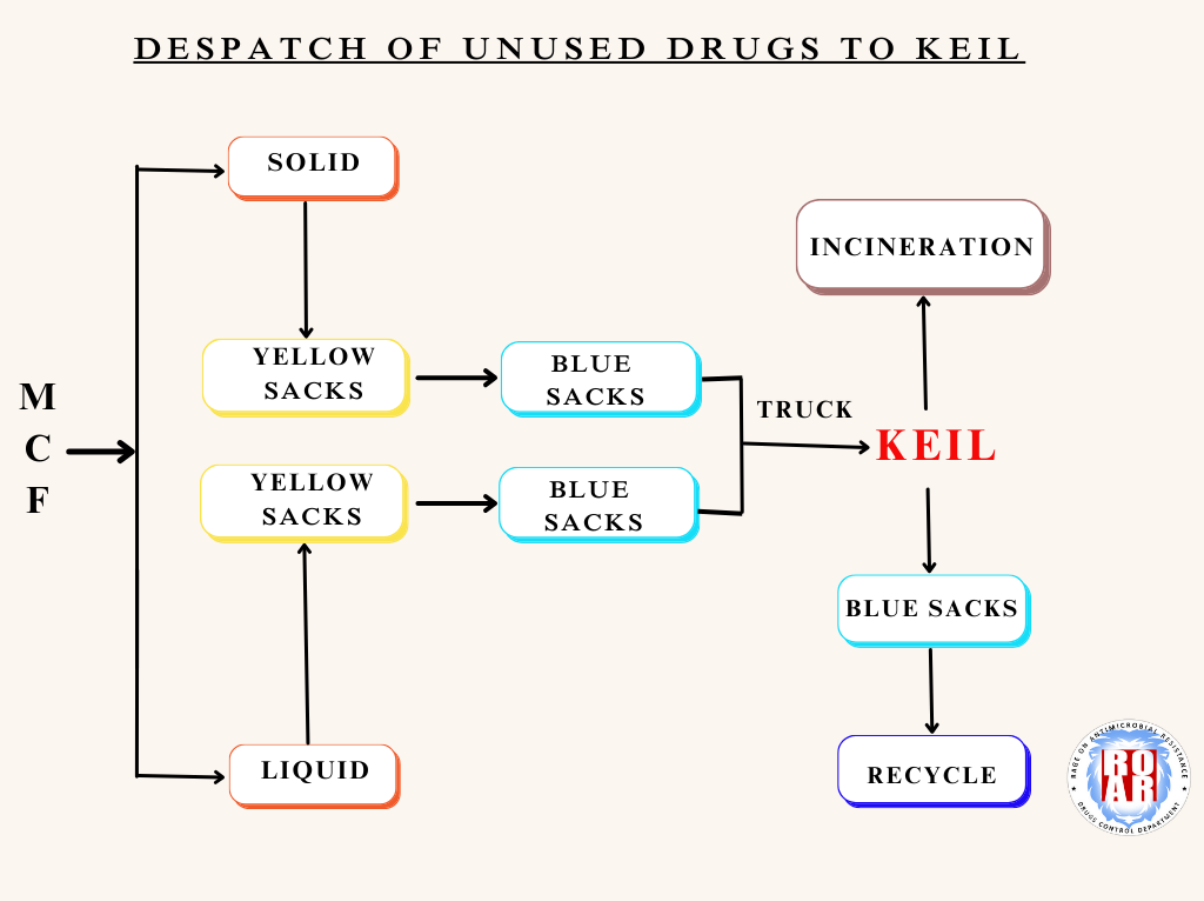
	Media report – INR 1000 crores annual reduction in usage 300 crores annual reduction substantiated by first point survey
2024	• Operation VET-BIOTIC – launched by drugs control department.Under this raids are conducted by enforcement officials of drugs control department across state on pet shops selling veterinary medicines to curb indiscriminate selling of schedule H and H1 category antibiotics to farms and animal feed merchants without following norms. • Launch of "ROAR" – Rage On Antimicrobial Resistance – blue colour envelope & posters with statutory warning – by hon'ble health minister • Operation double check – monitoring quality of antimicrobials • Colour coded inspection reports – AMRITH & NCORD • National recognition for AMR initiatives
Dec.2024	• Launch of student programme on antimicrobial awareness Kerala (SPAARK) – with 'Sokhyam Sada' – inaugurated by hon'ble Health minister • 

ENTE KERALAM EXHIBITION-PHARMACY SENTINEL THEME STALL

2025-Nproud-Kozhikode Corporation March 2025: Ulliyeri panchayat April 2025.




nPROUD
New Program for
Removal of Unused Drugs
ഡ്രഗ്സ് കൺട്രോൾ വകുപ്പ്
കേരള സർക്കാർ
KL 54.D6345



- Household survey on AMR awareness as part of ROAR program was conducted at Kozhikode corporation and Ulliyeri panchayat.As part of this 2 lakh households were covered and 20000 forms were distributed.
-

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 & fosfomycin, etc.; carbapenems and linezolid to be included after 6 months into 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

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

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

4.22. Conduct educational sessions for private practitioners

4.23. Conduct prescription audits in healthcare facilities

Antimicrobial stewardship committees have been set up in all major hospitals.

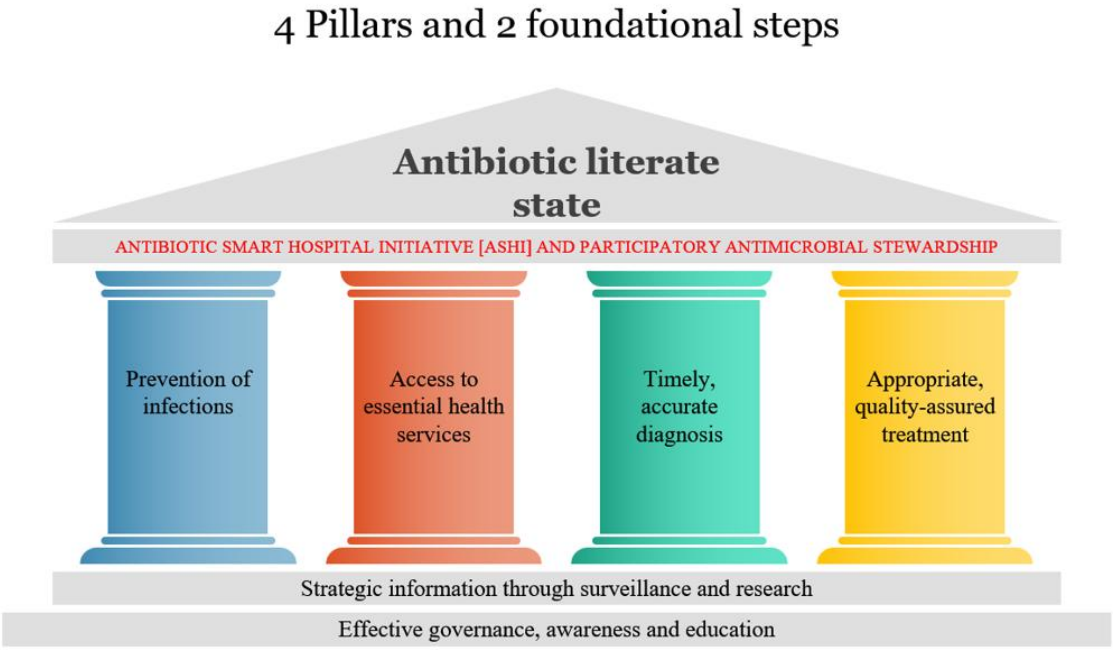
Unique Hub and spoke model for antimicrobial stewardship was initiated for first time in India at GH Ernakulam in 2019.Now the hub and spoke model has been extended to all 14 districts.

Prescription Audit has been made mandatory.

In 2019 a unique initiative PROUD [Programme on removal of unused drugs] was launched for the first time in India jointly by Drugs control department and All Kerala Chemical and druggists [AKCDA] Association for collection and appropriate disposal of medicines wasted from pharmacy and household premises. PROUD was piloted in Thiruvananthapuram. In 2020, PROUD -2 was launched in TVM and Kollam in collaboration with clean Kerala company. PROUD program has been launched in 2025, at Kozhikode which was piloted at Ulliyeri panchayath.

Antibiotic Smart Hospitals: a pragmatic approach to tier based antimicrobial stewardship

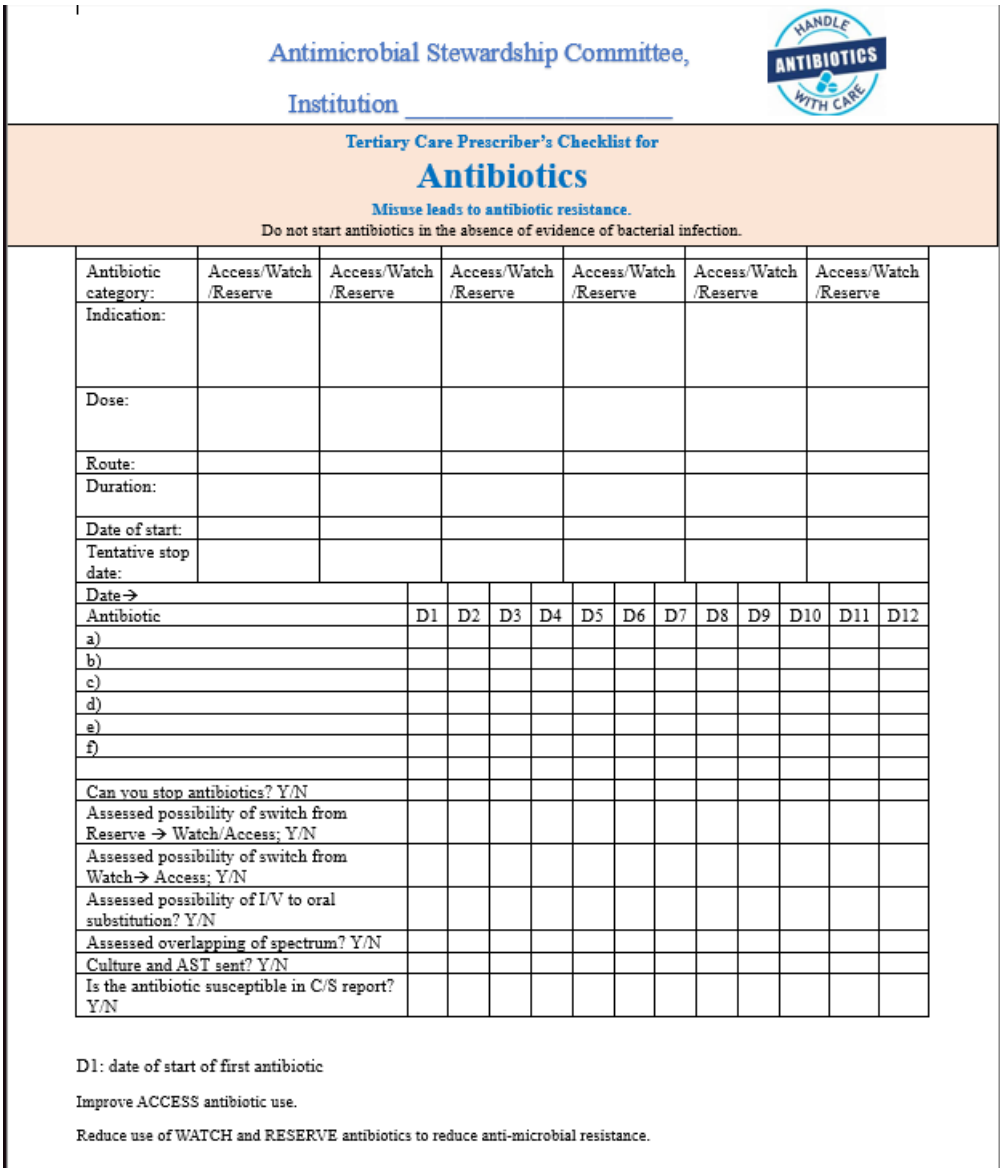
The GoK as part of KARSAP took a significant step in combating AMR by launching the Antibiotic Smart Hospital Initiative (ASHI).Antibiotic smart hospitals (ASH) are healthcare institutions which implements a pragmatic model of antimicrobial and diagnostic stewardship while ensuring compliance with standard IPC practices. These hospitals act as source of continuous IEC activities to healthcare workers and public thereby fostering participatory stewardship. Antibiotic smart primary care institutions act as the fulcrum for community engagement at the grassroot level. Antibiotic smart hospitals are based on four pillars and two foundational steps.



The criteria for becoming ASH are different for primary, secondary and tertiary care institutions based on the patient profile to which they cater and available resources. The following figure highlights the criteria to be satisfied by hospitals in each tier to be declared as antibiotic smart. Primary care hospitals should satisfy 10 criteria and secondary/tertiary care hospitals should satisfy 12 criteria.95% of antibiotics used in outpatient department (OPD) in primary care hospitals should be from Access category, whereas for secondary care it is 90% and tertiary care is 85%.

	PRIMARY CARE LEVEL	SECONDARY CARE LEVEL	TERTIARY CARE LEVEL
Display of Posters on AMR in Malayalam	✓	✓	✓
All healthcare workers and students fully trained in AMR and IPC	✓	✓	✓
Prescription audit quarterly	✓	✓	✓
Antibiotics utilisation metrics calculation quarterly by pharmacy	✓	✓	✓
AWaRe metrics- ACCESS usage in OPD	95%	90%	85%
Functional HICC and AMSP committee	✓	✓	✓
IEC for public fortnighly	✓	✓	✓
Posters on AWaRe classification in prescribing areas	✓	✓	✓
Certified by	NQAS (or within 1 year)	NQAS/KAYAKALP /NABH(or within 2 years)	NQAS/KAYAKALP /NABH(or within 2 years)
Implementation of PROUD programme	✓	✓	✓
Surgical safety checklist in surgical specialities		✓	✓
Prospective audit and feedback for Reserve antibiotics by AMSP team		✓	✓
Low hanging fruit model of AMSP		✓	✓
HAI surveillance		✓	✓
STPs (Sewage Treatment Plants)/ ETP (Effluent Treatment Plant) as per the guidelines from pollution control		✓	✓

ANTIBIOTIC PRESCRIPTION PAGE BASED ON LOW HANGING FRUIT MODEL OF ANTIMICROBIAL STEWARDSHIP



Antimicrobial Stewardship Committee,

Institution _____

HANDLE ANTIBIOTICS WITH CARE

Tertiary Care Prescriber's Checklist for

Antibiotics

Misuse leads to antibiotic resistance.

Do not start antibiotics in the absence of evidence of bacterial infection.

Antibiotic category:	Access/Watch /Reserve	Access/Watch /Reserve	Access/Watch /Reserve	Access/Watch /Reserve	Access/Watch /Reserve	Access/Watch /Reserve
Indication:						
Dose:						
Route:						
Duration:						
Date of start:						
Tentative stop date:						

Date→ Antibiotic	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12
a)												
b)												
c)												
d)												
e)												
f)												
Can you stop antibiotics? Y/N												
Assessed possibility of switch from Reserve → Watch/Access; Y/N												
Assessed possibility of switch from Watch→ Access; Y/N												
Assessed possibility of I/V to oral substitution? Y/N												
Assessed overlapping of spectrum? Y/N												
Culture and AST sent? Y/N												
Is the antibiotic susceptible in C/S report? Y/N												

D1: date of start of first antibiotic

Improve ACCESS antibiotic use.

Reduce use of WATCH and RESERVE antibiotics to reduce anti-microbial resistance.

Through a GO, directions were given to make all primary and secondary care hospitals in the state "Antibiotic smart Hospitals" FHC Kakodi has been declared as the first Antibiotic smart hospital in the State followed by FHC Ozhalapathy in Palakkad. A colour grid has been formulated for all tiers of hospitals to assess where they stand regarding Antibiotic smart status. An emblem/insignia will be given to all antibiotic smart hospitals.

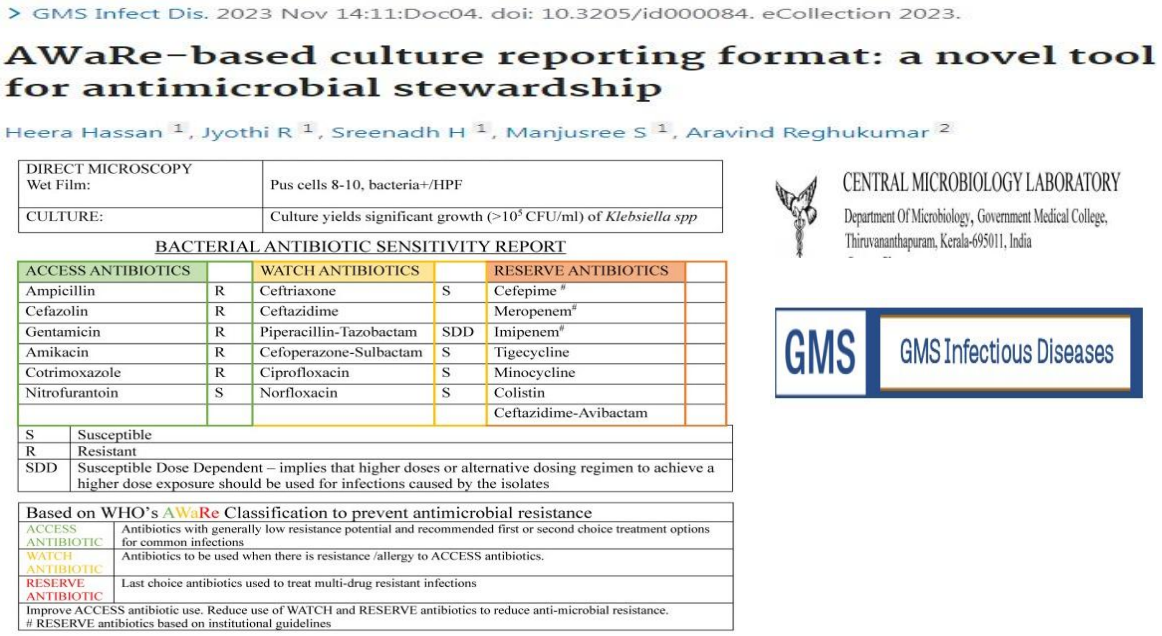
Direction has been given to Drugs controller to cancel the licenses of all pharmacies, who dispense antibiotics without prescription - Operation AMRITH [2024] [Targeted inspections to avoid misuse of antimicrobials]. For this a toll-free number was also provided. Following this as per media news there is 1000 crore decrease in sales of antibiotics in Kerala in 2024. As per first point survey a 20 to 30% decrease in antibiotic sales [Rs 300 crore] has been observed.

An AI based interactive Antibiogram App has been launched with help of K-DISC to help doctors to practice antibiotic stewardship.

A 6-hour module on Antibiotic stewardship has been devised and is freely available in State training site from 2021 onwards.

Prescription audit in the stipulated format has been made mandatory in all hospitals. In all FHC/CHCs > 95% of prescribed antibiotics should be from Access category.

AWaRe based microbiology susceptibility reporting format for the first time in world was devised and published by GMC Thiruvananthapuram.



> GMS Infect Dis. 2023 Nov 14:11:Doc04. doi: 10.3205/id000084. eCollection 2023.

AWaRe–based culture reporting format: a novel tool for antimicrobial stewardship

Heera Hassan [1], Jyothi R [1], Sreenadh H [1], Manjusree S [1], Aravind Reghukumar [2]

DIRECT MICROSCOPY Wet Film:	Pus cells 8-10, bacteria+/HPF
CULTURE:	Culture yields significant growth (>10^5 CFU/ml) of *Klebsiella spp*

BACTERIAL ANTIBIOTIC SENSITIVITY REPORT

ACCESS ANTIBIOTICS		WATCH ANTIBIOTICS		RESERVE ANTIBIOTICS	
Ampicillin	R	Ceftriaxone	S	Cefepime #	
Cefazolin	R	Ceftazidime		Meropenem#	
Gentamicin	R	Piperacillin-Tazobactam	SDD	Imipenem#	
Amikacin	R	Cefoperazone-Sulbactam	S	Tigecycline	
Cotrimoxazole	R	Ciprofloxacin	S	Minocycline	
Nitrofurantoin	S	Norfloxacin	S	Colistin	
				Ceftazidime-Avibactam	

S	Susceptible
R	Resistant
SDD	Susceptible Dose Dependent – implies that higher doses or alternative dosing regimen to achieve a higher dose exposure should be used for infections caused by the isolates

Based on WHO's AWaRe Classification to prevent antimicrobial resistance	
ACCESS ANTIBIOTIC	Antibiotics with generally low resistance potential and recommended first or second choice treatment options for common infections
WATCH ANTIBIOTIC	Antibiotics to be used when there is resistance /allergy to ACCESS antibiotics.
RESERVE ANTIBIOTIC	Last choice antibiotics used to treat multi-drug resistant infections
Improve ACCESS antibiotic use. Reduce use of WATCH and RESERVE antibiotics to reduce anti-microbial resistance. # RESERVE antibiotics based on institutional guidelines	

CENTRAL MICROBIOLOGY LABORATORY
Department Of Microbiology, Government Medical College, Thiruvananthapuram, Kerala-695011, India

GMS Infectious Diseases

State level formulary restriction regarding preferentially supplying antibiotics from Access category [comprising >95% of total drugs made available at primary care level] only to primary care centres will come into force from 2026.

Antibiotic use tracking up to pin code level has been piloted with assistance of world Bank and Pharmarack.

Tier based Antibiotic guidelines will be released in 2025.

Concept note to incorporate AWaRe colour coding matrix into e-health with visual cues to guide prescription- short term goal.

In 2023, Drugs control department constituted AMR squad for inspections.

Operation VET-BIOTIC was launched to address issue of feed supplements containing antibiotics.

Rage on Antimicrobial Resistance campaign (ROAR) was launched by Drugs control department. Directions have been given to ensure that antibiotics are dispensed only in BLUE

COLOUR envelopes and to display posters with statutory warning in all pharmacies.

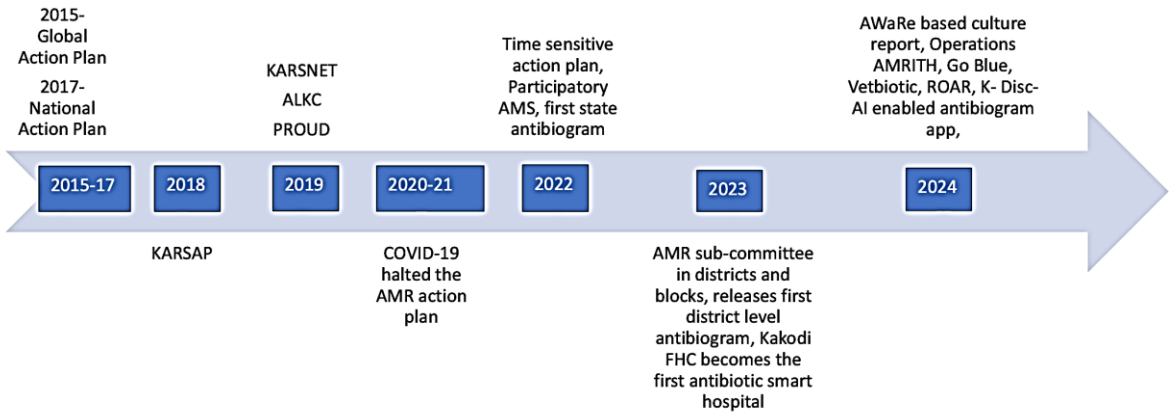
Operation Double Check was launched to monitor quality of antimicrobials.

Colour coded inspection reports - AMRITH and NCORD.

Instructions have been given to ensure that antibiotics are dispensed only in blue covers across the state from all hospitals and pharmacies. Majority of the blue covers have printed IEC messages as well.

In order to strengthen antimicrobial stewardship activities in private sector and dentistry, working committee has been expanded by incorporating representatives from IMA, IAP,API , CIDS and Indian dental association Kerala chapter.

Criteria have been drafted to make Dental Hospitals also antibiotic smart and an accreditation emblem for the same is being planned.



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 and antibiotics for growth promotion in veterinary and aquaculture

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

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

Department of Animal Husbandry actively participate in KARSAP activities. As part of achieving the aim of making the state 100% AMR literate, the department DID a comprehensive literacy campaign throughout the state targeting veterinary professionals and farmers IN 2022. State level master training program was conducted at Thiruvananthapuram to create resource persons for literacy campaign under the leadership of State Institute for Animal Diseases (SIAD), Palode. State level workshop for developing IEC materials was organized at Ernakulam by State Laboratory for Livestock Marine and Agri Products (SLMAP). As part of educating farmers, a poster in local language highlighting good practices for addressing AMR was prepared. Five hundred copies were printed and distributed to different department institutions for exhibiting. District level awareness programs were arranged in all districts by district administrative offices, IMG and Livestock Management Training Centres (LMTC). LMTCs conducted field visits for farmers for educating on best practices, farm biosecurity and other infection prevention control measures.

SIAD, the apex laboratory of the department has done laboratory capacity assessment for AMR surveillance and laboratories were networked for AMR surveillance. One day sensitization training was conducted for all laboratory veterinarians followed by two days wet lab training at SIAD on laboratory techniques for AMR identification for staff of selected laboratories in 2022. Nine laboratories which have infrastructure were selected for the first phase and a multi centric integrated AMR surveillance was initiated with SIAD as nodal centre. Targets were fixed for each laboratory for starting AMR surveillance from January, 2023. The department had conducted a cross sectional questionnaire based survey among practicing veterinarians to assess KAP. Four hundred and twenty one veterinarians participated in the survey.
The first phase of the collaborative research project by SIAD and School of Biosciences, MG University on AMR gene flex between livestock and society, risk assessment and development of management strategies was completed in the year. The research project was funded by department of animal husbandry. Under the project, AMR pattern of important bacterial isolates of public health significance, screening for the presence different antibiotics in feed materials, molecular identification of resistant genes, biofilm production by resistant bacteria, cell toxicity study and analysis of microbiome based on metagenomic practices were conducted. Twenty farms from five districts of south and central Kerala were sampled. 1909 clinical and environmental samples were analysed. 24 feed samples were analysed for antibiotic residues by LC-MS/MS. Tetracycline was the most common adulterant. Residues of antibiotics like Oxytetracycline, Ciprofloxacin, Sulpha and Levofloxacin were also found in the feed. Among the poultry isolates, 45% were resistant to Tetracycline. 16.6% (27/162) of *Staph aureus* were methicillin resistant. 24.1% (7/29) of gram negative bacterial isolates were ESBL positive. Analysis revealed tetA and tetB genes in poultry gut microbiome, mecA gene

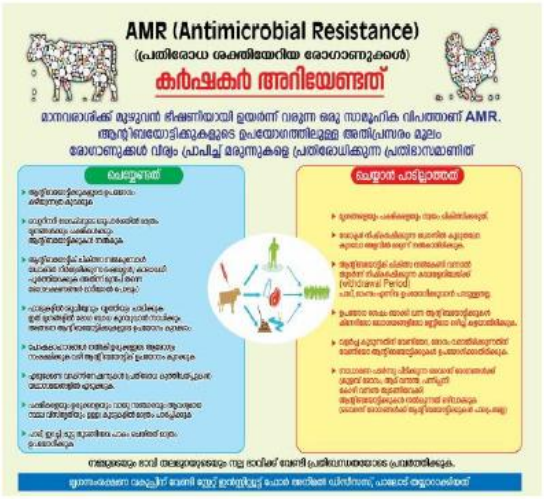
in *Staph aureus and* SHV gene in ESBL positive isolates. Colistin resistant MCR9 and EptB genes were also detected in the study. Fosfomycin resistant genes (FosA6 & FosA2) were detected in a few isolates of *Enterobacter & Klebsiella*. Biofilm production is a major mechanism for AMR development. *Klebsiella pneumoniae* showed biofilm production and *E. coli* showed antibiotic induced biofilm production in the study.

The State Livestock Marine Agri Products (SLMAP), Ernakulam, the animal product testing laboratory of Animal Husbandry department has conducted antibiotic residue analysis in chicken samples, AMR study of bacteria isolated from meat, egg, milk and environmental samples and genomic study of bacteria isolated from animal products & farm environmental samples. 121 farms of 11 districts were sampled for the AMR study. 1196 chicken samples, 622 animal products & environmental samples and 164 bacterial isolates were analyzed as part of the study. 20% chicken samples showed antibiotic residues. The liver showed higher presence than muscles. Tetracycline was the most common antibiotic detected in animal products. A few samples of KEPCO/Kerala chicken analyzed did not show presence of antibiotic residues. 19% of the bacterial isolates showed AMR. Resistance was higher among *Staphylococci* and *Klebsiella*. Resistance was found higher to Ampicillin, Tetracycline and Azithromycin and least to Carbapenem. Genomic analysis revealed tetA, TEM, SHV and CTX genes in *E. coli* & *Klebsiella*, tetA, TEM and SHV genes in *Proteus*, tetA & CTX genes in *Acinetobacter*, tetA and MECA genes in *Staphylococci,* tetA and SHV genes in *Enterobacter* and CTX gene in *Citrobacter*. Two peer reviewed journal publications, six conference presentations and one poster presentation in were achieved with the research findings of SIAD, Palode. Three of these publications received best or second best paper awards.

Department of Animal Husbandry has actively participated in the Kerala Antibiotic Literacy Campaign of Government of Kerala to make the state 100% literate . The department has initiated state-wide programs to create awareness among veterinarians, para-veterinarians, farmers and others engaged/related to animal husbandry activities. As per the order no. AHD/3243/2022-E3 dated 3/7/2022, Director of Animal Husbandry has accorded sanction for a comprehensive literacy campaign plan of the department for the year 2022-23. The campaign plan was prepared by the State Institute for Animal Diseases (SIAD), Palode. Funds are allotted to various divisions viz laboratories, livestock management training centres, district animal husbandry offices, media division for the campaign under Plan head 2403-00-109-96-34 OC (Extension and Training).

AMR Poster for Farmers

SIAD, Palode has prepared a poster on “dos and don’ts” of AMR for practice by farmers. Five hundred copies are printed and distributed throughout the state for exhibiting in AHD institutions where farmers arrive for various services from the department. It is released by the Hon. Minister of Animal Husbandry, Smt. Chinchuranni in presence of Director of Animal Husbandry, Dr. A. Kowsigan IAS on 4th May, 2022. The event kick started AMR literacy campaign of the year.



State Level Workshop for Developing AMR IEC Training Modules

SLMAP (State Livestock Marine and Agri Products), Ernakulam has conducted state level workshop on 13/12/22 for developing IEC materials for AMR education among professionals and farmers. Twenty one veterinarians representing 14 districts participated in the workshop.

STATE LEVEL WORKSHOP FOR DEVELOPING AMR IEC MODULES

Educating farmers

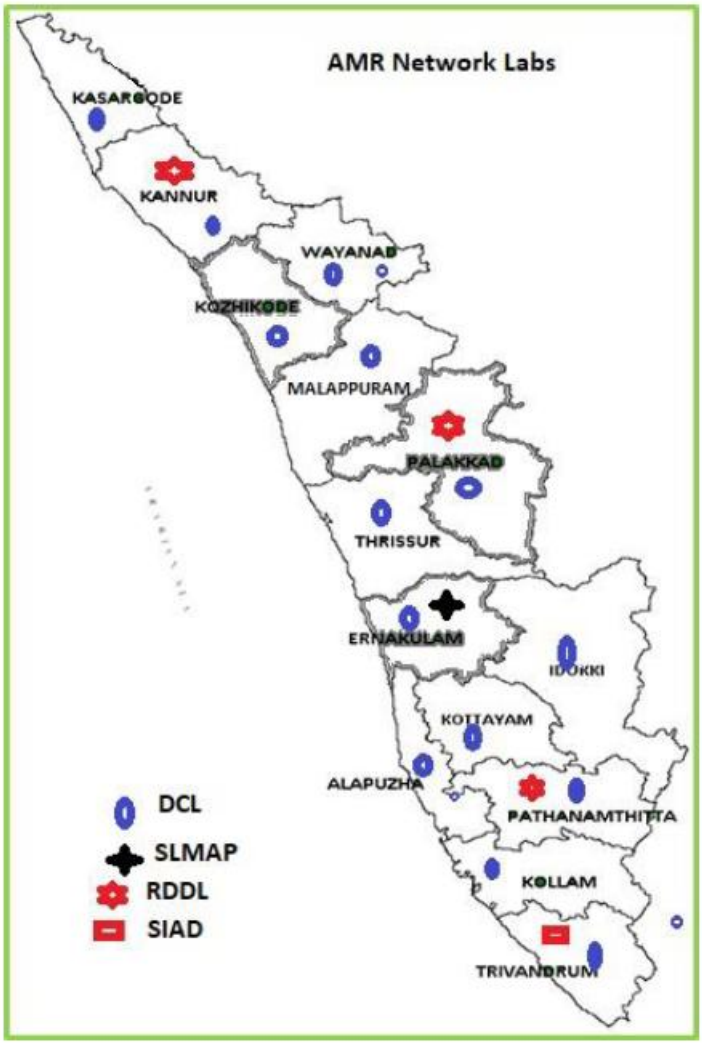
Through various livestock management training centres of the animal husbandry department, awareness classes and farm visits are conducted throughout the state for farmers of livestock and poultry sector as part of educating them on best practices, disease prevention through vaccination

and improving farm biosecurity.

LABORATORIES & SURVEILLANCE

Laboratory Capacity Assessment & Networking

SIAD Palode, being the apex laboratory of the department has taken initiative to assess laboratory capacity of the department for AMR surveillance and residue analysis and to network laboratories for an integrated surveillance. The following laboratories of the animal husbandry department are selected and networked for AMR surveillance. Gap analysis revealed lack of infrastructure & qualified staff in many laboratories. Shortage of manpower & lack of specific funds for AMR activities are the other limiting factors.



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

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

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

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

5.2. Compile list of institutes and relevant investigators

Objective: Define research priorities on AMR in Kerala

5.3. Define research priorities for veterinary aspects

5.4. Define research priorities for human aspects

5.5. Define research priorities for ayurvedic aspects

5.6. Encourage research on cytokine response – resistant/susceptible bacteria

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

5.8. Surveillance study on antimicrobial resistance in the community in Thiruvananthapuram and Kollam districts of Kerala

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

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.

5.11. Organise “Research Day on AMR” in institutions to showcase their research and to establish collaborations

AMR –Research Workshop-Feb 2024

Focus area: Innovations

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

5.12. Herbal drug research and development

5.13. Promote research on biofilm inhibition

5.14. Research on development of probiotics of human origin

Objective: Development of new diagnostics

5.15. Promote research for rapid bacterial diagnostic kits

Objective: Innovations using information technology

5.16. Introduce information technology for tracking and analysing AMR & HAI surveillance trends for real time feedback and action

Intersectoral research in AMR has been given top priority by all universities.

All research on AMR done by various stakeholders have been collated and published.

Current Plans

Strategic Priority 1

- To convert all panchayats/ incorporate AWaRe colour coding matrix into e-health with visual cues to guide prescription- short term goal municipalities/towns to antibiotic literate. For this community volunteers trained as part of One Health will be used to disseminate the customized messages in Malayalam to everyone in the Panchayat/municipalities/townships. The community volunteers will act in co-ordination with FHCs/Block AMR committees – short term goal.
- The community volunteers are being trained to identify AMR hotspots in each panchayat like poultry farms, dairy farms, aquaculture, butcher shops, pharmaceutical industries, hospital effluents etc. All the identified AMR hotspots are being tagged geospatially, and focussed IEC interventions should be delivered – short term goal.

Strategic Priority 2

- Do a Gap analysis to optimize the functioning of Hub and spoke model of AMR

surveillance in all districts – short term goal

- Generation of Spoke Antibiograms [stratified community antibiogram] in all Districts – short term goal .
- Generation of Antibiogram for Animal Husbandry department – short term goal.

Strategic Priority 3

- To start Infection Prevention and control programme in the State – short term goal.
- To initiate HAI surveillance network in all tertiary care centres in the State – short term goal .
- To conduct Gap analysis and facilitate all FHCs to get NQAS – short term goal .

Strategic Priority 4

- To develop a framework for antibiotic use tracking [e.g. Pharmarack] to the pin code level in Kerala – short term goal 2 years.
- To develop a health care tier based antibiotic guidelines – short term goal 1 year.
- To incorporate AWaRe colour coding matrix into e-health with visual cues to guide prescription – short term goal

- Creation of a dashboard for AMR-to display antibiograms, time sensitive target attainment schedule [Gantt chart], antibiotic use metrics etc. – short term goal (1 -2 years).
- Creation of AMR biorepository – 3 years
- Enhancing facility for antibiotic residue monitoring in environmental and food samples – 3 years
- Development of bacteriophage library in collaboration with Institute of Advanced Virology – 3 years

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

6.2. Provide space for private firms in Infection Prevention Programme and AMR surveillance programme

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

Initiatives

Representatives from IMA,CIDS,API and IAP Kerala chapter are part of working committee of KARSAP. Through them all private hospitals are also encouraged to become antibiotic smart.

District AMR committees have representatives from IMA to ensure engagement with private hospitals.

At the block level, LSGI level etc all private hospitals and pharmacies are made part of AMR containment initiatives.

AMR is one of the components of Kerala State One Health Programme along with zoonotic infections through One health collaboration with various programmes is streamlined.

Review of the M&E 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
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* spp., *Pseudomonas aeruginosa*, *Acinetobacter* spp., MRSA and *Enterococcus* spp.

Priority indicators	**Input** (basic resources)	**Process** (activities)	**Outputs** (results at programme level)	**Outcomes** (results at population level)
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

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 AMS	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**

These M&E indicators could be reviewed after each strategic priority.

Major achievements

- First state to develop and implement its SAPCAR.
- Hub and spoke model of AMR surveillance initiated in all 14 districts to ensure that surveillance data from secondary care hospitals is included in KARS-NET.
- First State in India to release its state Antibiogram in 2022.
- First state to develop a district level antibiogram for the district of Ernakulam which was released in 2023.In 2026 District antibiograms of five districts were released.
- PROUD (Program on Removal of Unused and date expired Drugs) in 2019 and Nproud IN 2025.
- District level AMR committees have been constituted in all districts in Kerala, for the first time in the country. Also AMR committees have been constituted in all health blocks.
- AMRITH (AMR Intervention for Total Health) launched by the Kerala Drug Control Department to combat antimicrobial resistance (AMR) by preventing the overuse of antibiotics. It primarily focuses on eliminating the over-the-counter (OTC) sale of antibiotics without a doctor's prescription.
- Antibiotic literate Kerala campaign is the first participatory stewardship program in Global south.
- Antibiotic Smart hospital Initiative [ASHI] promoting AWaRe based antimicrobial use.
- Colour coding of all hospitals and LSGIs in the state based on stipulated criteria to assess antibiotic smart, AMS compliant hospitals and Antibiotic literate panchayath status.
- The first AWaRe based culture and susceptibility reporting format in the world was introduced by GMC Thiruvananthapuram Microbiology department.

Animal Husbandry Department

Department of Animal Husbandry have actively participated in the KARSAP activities of Government of Kerala with the aim of making the state 100% AMR literate in a time bound manner. The department has done a comprehensive literacy campaign throughout the state targeting veterinary professionals and farmers. State level master training program was conducted at Thiruvananthapuram in 2022 to create resource persons for literacy campaign under the leadership of State Institute for Animal Diseases (SIAD), Palode. State level workshop for developing IEC materials was organized at Ernakulam by State Laboratory for Livestock Marine and Agri Products (SLMAP). As part of educating farmers, a poster in local language highlighting good practices for addressing AMR was prepared and distributed to all institutions District level awareness programs have been arranged in all districts by district administrative offices, IMG and Livestock Management Training Centres (LMTC). LMTCs routinely organise field visits for farmers for educating on best practices, farm biosecurity and other infection prevention control measures.

SIAD, the apex laboratory of the department had done laboratory capacity assessment for AMR surveillance and laboratories have been networked for AMR surveillance. Sensitization trainings have been conducted for all laboratory veterinarians followed by two days wet lab training at SIAD on laboratory techniques for AMR identification for staff of selected laboratories. Nine laboratories which have infrastructure were selected for the first phase and a multi centric integrated AMR surveillance was initiated with SIAD as nodal centre. Targets were fixed for each laboratory for starting AMR surveillance from January, 2023.

The department had conducted a cross sectional questionnaire based survey among practicing veterinarians to assess KAP. Four hundred and twenty one veterinarians participated in the survey.

The first phase of the collaborative research project by SIAD and School of Biosciences, MG University on AMR gene flex between livestock and society, risk assessment and development of management strategies was completed in 2022. The research project was funded by department of animal husbandry. Under the project, AMR pattern of important bacterial isolates of public health significance, screening for the presence different antibiotics in feed materials, molecular identification of resistant genes, biofilm

production by resistant bacteria, cell toxicity study and analysis of microbiome based on metagenomic practices were conducted. Twenty farms from five districts of south and central Kerala were sampled. 1909 clinical and environmental samples were analysed. 24 feed samples were analysed for antibiotic residues by LC-MS/MS. Tetracycline was the most common adulterant. Residues of antibiotics like Oxytetracycline, Ciprofloxacin, Sulpha and Levofloxacin were also found in the feed. Among the poultry isolates, 45% were resistant to Tetracycline. 16.6% (27/162) of *Staph aureus* were methicillin resistant. 24.1% (7/29) of gram negative bacterial isolates were ESBL positive. Analysis revealed tetA and tetB genes in poultry gut microbiome, mecA gene in *Staph aureus and* SHV gene in ESBL positive isolates. Colistin resistant MCR9 and EptB genes were also detected in the study. Fosfomycin resistant genes (FosA6 & FosA2) were detected in a few isolates of *Enterobacter & Kebsiella*. Biofilm production is a major mechanism for AMR development. *Klebsiella pneumoniae* showed biofilm production and *E. coli* showed antibiotic induced biofilm production in the study.

The State Livestock Marine Agri Products (SLMAP), Ernakulam, the animal product testing laboratory of Animal Husbandry department has conducted antibiotic residue analysis in chicken samples, AMR study of bacteria isolated from meat, egg, milk and environmental samples and genomic study of bacteria isolated from animal products & farm environmental samples. 121 farms of 11 districts were sampled for the AMR study. 1196 chicken samples, 622 animal products & environmental samples and 164 bacterial isolates were analyzed as part of the study. 20% chicken samples showed antibiotic residues. The liver showed higher presence than muscles. Tetracycline was the most common antibiotic detected in animal products. A few samples of KEPCO/Kerala chicken analyzed did not show presence of antibiotic residues. 19% of the bacterial isolates showed AMR. Resistance was higher among *Staphylococci* and *Klebsiella*. Resistance was found higher to Ampicillin, Tetracycline and Azithromycin and least to Carbapenem. Genomic analysis revealed tetA, TEM, SHV and CTX genes in *E. coli* & *Klebsiella*, tetA, TEM and SHV genes in *Proteus*, tetA & CTX genes in *Acinetobacter*, tetA and MECA genes in *Staphylococci,* tetA and SHV genes in *Enterobacter* and CTX gene in *Citrobacter*.

Two peer reviewed journal publications, six conference presentations and one poster presentation in were achieved with the research findings of SIAD, Palode. Three of these publications received best or second best paper awards.

KARSAP: STRATEGIC PRIORITIES & FOCUS AREAS

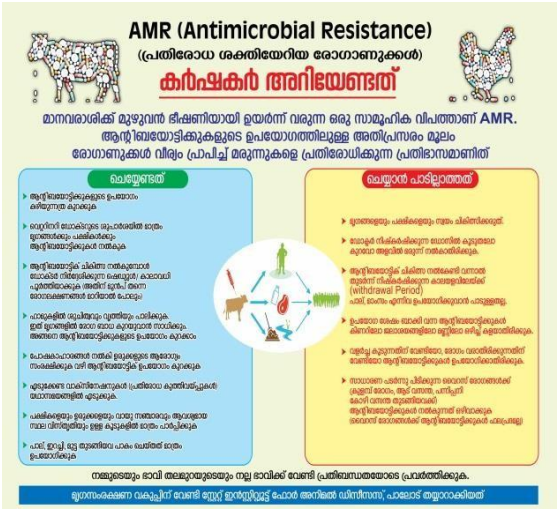
1. KERALA ANTIBIOTIC LITERACY CAMPAIGN

Department of Animal Husbandry has actively participated in the Kerala Antibiotic Literacy Campaign of Government of Kerala to make the state 100% literate . The department has initiated state-wide programs to create awareness among veterinarians, para- veterinarians, farmers and others engaged/related to animal husbandry activities. As per the order no. AHD/3243/2022-E3 dated 3/7/2022, Director of Animal Husbandry has accorded sanction for a comprehensive literacy campaign plan of the department for the year 2022-23. The campaign plan was prepared by the State Institute for Animal Diseases (SIAD), Palode. Funds were allotted to various divisions viz laboratories, livestock management training centres, district animal husbandry offices, media division for the campaign under Plan head 2403-00-109-96-34 OC (Extension and Training).

In 2025,IEC materials in malayalam and English were printed, sessions on AMR were conducted on All India Radio, Njattuvela through FIB also in Krishidarshan program on Doordarshan. As part of capacity reinforcement ,35 Veterinarians underwent training on “Improving Animal Health Practices of Veterinarians and Livestock Farmers to Contain Antimicrobial Resistance and Promote One Health” conducted by COHEART, KVASU. Training program for farmers , livestock Inspectors through LMTC, Veterinarians working in Dispensaries, Hospitals, and for Laboratory Veterinarians, AHD were organized.

1.1 AMR Poster for Farmers

SIAD, Palode has prepared a poster on “dos and don’ts” of AMR for practice by farmers, which have been printed and distributed throughout the state for exhibiting in AHD institutions where farmers arrive for various services from the department. It was released by the Hon. Minister of Animal Husbandry, Smt. Chinchuranni in presence of Director o Animal Husbandry, Dr. A. Kowsigan IAS on 4th May, 2022. The event kick started AMR literacy campaign of the year.



1.1 State Level Master Training Program on AMR

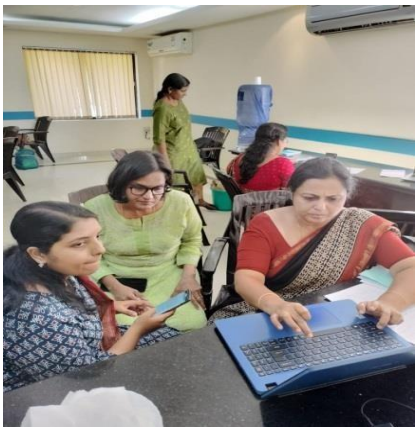
SIAD Palode arranged a TOT program on 29th to 31st August, 2022 at Thiruvananthapuram to create resource persons for leading the campaign in the various parts of the state. Fifty veterinarians representing 14 districts participated in the program. Subject experts from health, veterinary & regulatory sector handled different aspects of AMR.

STATE LEVEL MASTER TRAINING PROGRAM ON AM

1.2 State Level Workshop for Developing AMR IEC Training Modules

SLMAP (State Livestock Marine and Agri Products), Ernakulam has conducted state level workshop on 13/12/22 for developing IEC materials for AMR education among professionals and farmers. Twenty one veterinarians representing 14 districts participated in the workshop.

STATE LEVEL WORKSHOP FOR DEVELOPING AMR IEC MODULES



1.3 District Level Training Programs

Using the resource persons generated through state level TOT program & other subject experts, district authorities arranged awareness programs for professionals and farmers.

Topic	Beneficiates	Date of Training	Organizer/District
One Health Approach to AMR	Veterinarians	16/8/22	IMG, Kochi
One Health Approach to AMR	Veterinarians	26/8/22	IMG, Trivandrum
AMR awareness	Veterinarians	5/9/22	KVASU

AMR awareness	Livestock Inspectors	24/01/22	LMTC, Aluva
AMR awareness	Livestock Inspectors	11/11/22	Trissur
AMR awareness	Veterinarians	03/11/22	Palakkad
AMR awareness	Veterinarians	11/11/22	Ernakulam
AMR awareness	Livestock Inspectors	14/11/22	Ernakulam
AMR awareness	Farmers	15/11/22	Ernakulam
AMR awareness	Veterinarians	8/11/22	Wayanad
AMR awareness	Livestock Inspectors	14/11/22	Wayanad
AMR awareness	Veterinarians	10/11/22	Kozhikode
AMR awareness	Veterinarians	8/11/22	Pathanamthitta
Of campus training on AMR	Veterinarians	16/12/22	Pathanamthitta
Of campus training on AMR	Livestock Inspectors	11/11/22	Pathanamthitta
AMR Awareness	Livestock Inspectors	14/11/22	Pathanamthitta
AMR Awareness	Farmers	23/11/22	Pathanamthitta
Of campus training on AMR	Farmers	23/11/22	Pathanamthitta
Animal welfare and One Health	Farmers	19/10/22	Thiruvananthapuram


SHOT ON REDMI Y3
AI DUAL CAMERA

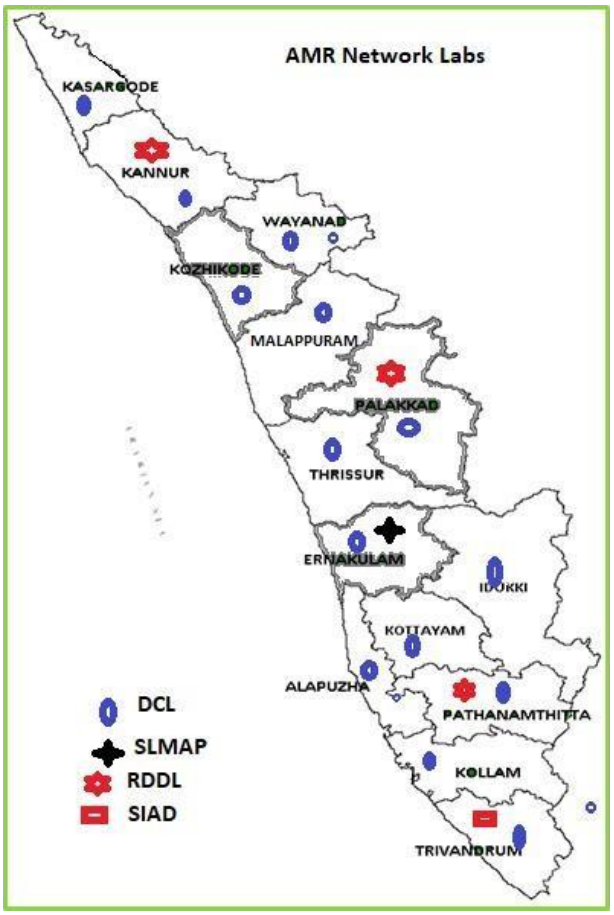
1.4 Educating farmers

Through various livestock management training centres of the animal husbandry department, awareness classes and farm visits are conducted throughout the state for farmers of livestock and poultry sector as part of educating them on best practices, disease prevention through vaccination and improving farm biosecurity.

2. LABORATORIES & SURVEILLANCE

2.1 Laboratory Capacity Assessment & Networking

SIAD Palode, being the apex laboratory of the department has taken initiative to assess laboratory capacity of the department for AMR surveillance and residue analysis and to network laboratories for an integrated surveillance. The following laboratories of the animal husbandry department have been selected and networked for AMR surveillance. Gap analysis revealed lack of infrastructure & qualified staff in many laboratories. Shortage of manpower & lack of specific funds for AMR activities were identified as the other limiting factors.



2.2 Sensitization Training for Laboratory Veterinarians

SIAD, Palode has organized sensitization training on AMR surveillance for veterinarians of the AHD network laboratories on 4/5/22 at Mattupetty.

2.3 Level II Training on Laboratory Techniques on AMR surveillance

Wet lab training on laboratory techniques for identification of AMR has been organized at SIAD on 30th & 31st August, 2022 for officers of laboratories selected for the first phase of integrated surveillance. Laboratory veterinary officers of the following laboratories participated in the training.

- SIAD, Palode
- RDDL, Thiruvalla
- RDDL, Palakkad
- RDDL, Kannur
- SLMAP, Ernakulam
- District Clinical Laboratories: Thiruvananthapuram, Kollam, Trissur, Palakkad, Kasargode

The following formed the technical program:

Integrated AMR Laboratory Surveillance Plan	Dr. Prathiush P.R Veterinary Surgeon, SIAD
Laboratory techniques for identification of AMR with special reference to priority pathogens.	Dr. Previn Punnoose, Assistant Director, Regional Disease Diagnostic Laboratory, Thiruvalla.
Wet lab practical session on isolation & identification of bacteria and performing AST.	Dr. Previn Punnose, Assistant Director, Regional Disease Diagnostic Laboratory, Thiruvalla. Dr. S. Aparna Veterinary Surgeon, SIAD

WHONET – Software installation, data entry and analysis.	Dr. Prathiush P R, Veterinary Surgeon, SIAD
Application of genome sequencing and metagenomics for surveillance of pathogens and AMR	Sreejith S, PhD Scholar Biosciences Department, Mahathma Gandhi University
Wet lab practical session on isolation & identification of bacteria and performing AST	Dr. Previn Punnoose, Assistant Director, Regional Disease Diagnostic Laboratory, Thiruvalla. Dr. S. Aparna Veterinary Surgeon, SIAD

2.4 Multi Centric Integrated AMR Surveillance

With nodal centre as SIAD Palode, multi-centric integrated AMR surveillance has been initiated with the networking the above listed laboratories. An integrated surveillance plan is prepared and targets were fixed for each lab. Surveillance and data pooling will be initiated from January, 2023.

2.5 Survey among Practicing Veterinarians on Antibiotic Prescription Pattern

A cross sectional questionnaire based survey was conducted among practicing veterinarians of Animal Husbandry Department to assess the AMR awareness and practices. 421 veterinarians responded in the survey. Quack practice and self -medication by farmers accounted for almost 75% emergence of AMR in veterinary sector. More than 95% of veterinarians participated in the survey never prescribed colistin, a listed life-saving antibiotic for human use. Fluroquinolones are the most prescribed antibiotics for livestock and poultry followed by Cephalosporins and Tetracycline. Cephalosporins are the most prescribed for pet animals. 100% of veterinarians participated in the survey are aware of AMR issue. Increasing farmer awareness, improving hygiene and adopting better management practices are suggested as measures to reduce the pace of development of AMR.

RESEARCH, PROJECT STUDIES & COLLABORATIONS

2.5.1 SIAD Palode- MG University Collaborative Research Project on AMR

Title: Studies on AMR gene flux between livestock and society, risk assessment and development of management strategies

Period: 3 year (commenced in 2019 & completed in 2022)

Aim of the study: Screening of evolution and route of AMR gene transfer among farm animals to humans

Objectives:

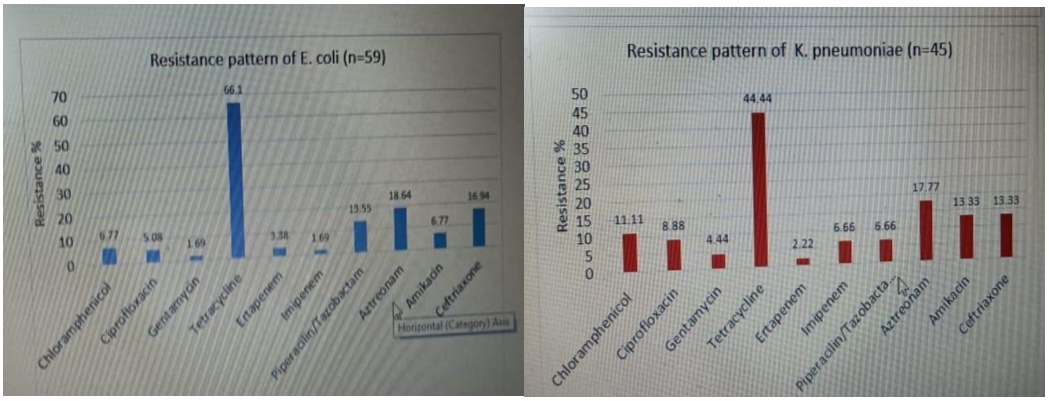
- AMR pattern of important bacterial isolates of public health significance
- Screening for the presence different antibiotics in feed materials
- Analyzing microbiome based on metagenomic practices

Methodology & Findings:

2.5.2 AMR Pattern of Bacterial isolates

A total of 1600 samples including milk, dung, conjunctival, nasal, buccal and skin swabs of livestock and poultry were collected from 15 government and commercial farms of Thiruvananthapuram, Kollam, Kottayam, Ernakulam & Trissur districts. 148 necropsy samples & 161 environmental samples were also collected as part of the project. Bacterial

isolation, identification & antibiotic sensitivity were done following CLSI guidelines. Antibiotic resistance pattern was analysed. 16.6 % (27/162) of *Staphylococcus aureus* isolates were MRSA. Of 29 gram negative (E.coli & K. pneumonae) isolates obtained from the study, 7 isolates (24.1%) were phenotypically classified as ESBL positive. The pattern of resistance among bacteria is found in the following order: Tetracycline>Aztreonam>Piperacilin tazobactam>Cefriazone. Tetracycline resistance can lead to doxycycline resistance which is a proven hypothesis and this can critically affect the infection control systems.



3.1.2. Analysis of Feed for Presence of Antibiotics:

Feed samples were collected from 20 broiler farms of central & south Kerala and tested for antibiotic presence using LC-MS/MS analysis. 15 feed samples out of 24 tested showed presence of one or more antibiotics. Various antibiotics (tetracycline, oxytetracycline, ciprofloxacin, sulphadiazine, trimethoprim, levofloxacin) have been detected and tetracycline class has been identified as the most common antibiotic used in feed concentrate. The average tetracycline content in the feed is found as 48.44ppb.

3.1.3 Molecular Identification of Resistance Genes:

Tetracycline resistance was found rampant in the current study and on an average 45 percentage of poultry isolates were found tetracycline resistant. Metaplasmid was isolated from 29 poultry faecal samples and 8 were TET A and 9 were TET B positive. Of the 27 MRSA, 3 isolates (11%) were MEC A positive. Of the 7 ESBL positive isolates of the study, 1 was found positive for SHV gene. As the leading mechanism for tetracycline resistance is efflux pump mediated, the study selected *tet*A and *tet*B genes. The phylogentic analysis of *tet*A gene sequence has revealed the evolutionary changes in the gene sequences in the maximum likely-hood phylogeny, 14 *tet*A genes from the 17 formed a distinct phylogenetic clade from the reference sequence. Tetracycline resistance mutations have also been reported to confer resistance or reduce the susceptibility to tigecycline which is classified under glycylcyclines family. Hence, development of antibiotic resistance in livestock may also cause cross drug resistance, which might be critical in medical practices.

3.1.4. Biofilm Production by Multi drug resistant bacteria

Biofilm is a critical factor contributing to the antimicrobial resistance in any microbial niche. The thick outer slime layer of the biofilm will prevent the antibiotics from entering the bacteria. Here the biofilm production of two multi-drug resistant bacteria isolated in the study was analyzed on Congo Red Agar medium (CRA). The *Klebsiella pneumoniae* showed production of biofilm. The *E. coli* which didn't form any biofilm in CRA plate was found to form biofilm on supplementation of antibiotics. This may be due to the induction of biofilim production in the presence of certain antibiotic which have to be further investigated. The quantitative analysis showed biofilm production of *Klebsiella* sp. is enhanced by 5 different antibiotics. In this tetracycline showed the highest activity in biofilm enhancement compared to other antibiotics. The selected *E. coli* isolate was generally a non- biofilm producer, however it showed enhanced biofilm production with tetracycline, ceftazidime and amoxicillin/clavulanate antibiotics. Antibiotic induced biofilm formation has previously been reported in bacterial pathogens such as *E. coli*, *Klebsiella pneumonia* and pseudomonas which is due to gene regulations. Here, the biofilm formation in chicken gut microflora may be enhanced due to antibiotic containing feed intake. This may strengthen the establishment of resistant microflora and environmental dissemination.

Whole Genome & Metagenome Sequencing

The whole genome sequencing (WGS) and antibiotic resistance analysis of the selected poultry associated multi drug isolates showed presence of resistance genes in both the *Enterobacter hormaec*hei and *Klebsiella pneumonia*. These heavy accumulation of resistance genes are alaming and demands extensive investigation. Whole genome sequencing was done for 7 MDR and XDR isolates. The genomes possess strong efflux systems which reduce the concentration of antibiotics in the bacterial cell and can lead to resistance to wide range of antibiotics including colistin. MCR-9 and eptB genes which encode colistin resistance and FosA6 & FosA2 which encode fosfomycin resistance have been detected in Enterobacter & Klebsiella. eptB encoding colistin resistance was described for first time in India. The WGS also showed the presence of bacteriophages in the genome of *Klebsiella pneumoniae* and *Enterobacter hormaechei* which might be involved in the antimicrobial resistance evolution.

2.6 SLMAP (State Livestock Marine Agri Products), Ernakulam

Being the food testing laboratory of Animal Husbandry Department, SLMAP has been actively participating in the AMR activities of the department since the launch of KARSAP in 2018.

3 Antibiotic Residue Monitoring

Antibiotic residue monitoring in animal products like chicken meat and liver collected from various farms is being done from 2017-18. One hundred and twenty one farms of various districts (Thiruvananthapuram, Kollam, Pathanamthitta, Ernakulam, Malapuram, Kozhikode, Palakkad, Wayanad, Trissur, Kannur and Kasargode) are sampled and samples have been screened for Tetracycline, Enrofloxacin and Sulphonamide. Summary of the work is as follows:

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- **Antibiotic Residue Analysis in Chicken meat & liver**

Year	Number of Farms screened	Districts	Samples (Chicken meat & liver)	Number of samples positive (Percentage)
2017-18	27	Ernakulam Malappuram Kozhikode	53	6 (11.3)
2018-19	12	Thiruvananthapuram Kollam	19	4 (21.1)
2019-20	KEPCO chicken		7	0 (0)
2020-21		Thiruvananthapuram Pathanamthitta Ernakulam Malappuram Palakkad Wayanad	72	1 (1.3)
2021-22	34	Thiruvananthapuram Kottayam Ernakulam	55	8 (14.5)
2022-23	48	Thiruvananthapuram Ernakulam Trissur Palakkad Wayanad Kannur Kasargode	63	36 (57.1)
	121		269	55 (20.4)

- Antibiotics detected: Sulpha, Tetracycline, Enrofloxacin
- Tetracycline was the most common antibiotic
- Presence of antibiotic was higher in liver than in meat (muscle)

- Antibiotic residues detected in more than 55% of chicken liver and 12% of chicken meat
- Kerala chicken & KEPCO were found free of antibiotic residues

3.2.2 Identification and Antibiotic Resistance Study of Bacteria isolated from Broiler meat

Samples tested: 40 **Bacteria identified: 45** **Antibiotics tested: 11**

Bacterial groups identified (9): *Staphylococcus sp, Klebsiella sp, Acinetobacter sp, Pseudomonas sp, Enterobacter sp, Enterococci, E.coli, Citrobacter sp and Bacillus cereus*

Antibiotic tested for resistance	**Number of bacterial isolates tested**	**Number of isolates showing resistance**	**% Resistance**	**Resistance Pattern**
Ampicillin	44	13	27.7	E.coli (6) Klebsiella (3) Proteus (3) Staphylococci (1)
Azithromycin	45	21	37.7	Proteus (8) Staph (6) Klebsiella (3) Enterococcus (2) Micrococcus (2) E. coli (1)
Cefotaxime	43	2	2.3	Staph (1) Acinetobacter (1)
Chloramphenicol	45	8	15.5	Proteus (5) Staph (2) Klebsiella (1)
Cefoxitin	44	4	9.1	Enterococcus (2) Staph (1) Klebsiella (1)

Cefpodoxime	44	18	27.2	E.coli (7) Staph (4) Proteus (4) Klebsiella (1) Enterococcus (1) Acinetobacter (1)
Tetracycline	45	27	57.7	E.coli (12) Staph (5) Proteus (5) Klebsiella (2) Acinetobacter (1) Enterococcus (1) Macrococcus (1)
Oxacillin	17	4	23.5	Staph (2) Enterococcus (2)
Gentamicin	44	2	2.2	Staph (1) Enterococcus (1)
Imipenem	39	0	-	-
Amoxy-clav	45	0	-	-

3.2.3 Identification and Antibiotic Resistance Study of Bacteria isolated from Eggs

Samples tested: 532 **Bacteria identified: 54** **Antibiotics tested: 10**

Bacterial groups identified (11): *Staphylococcus sp, Klebsiella sp, Acinobacter sp, Pseudomonas sp, Enterobacter sp, Enterococci, E.coli, Citrobacter sp, Bacillus cereus, E.fergusoni, Stutzerimonas sp.*

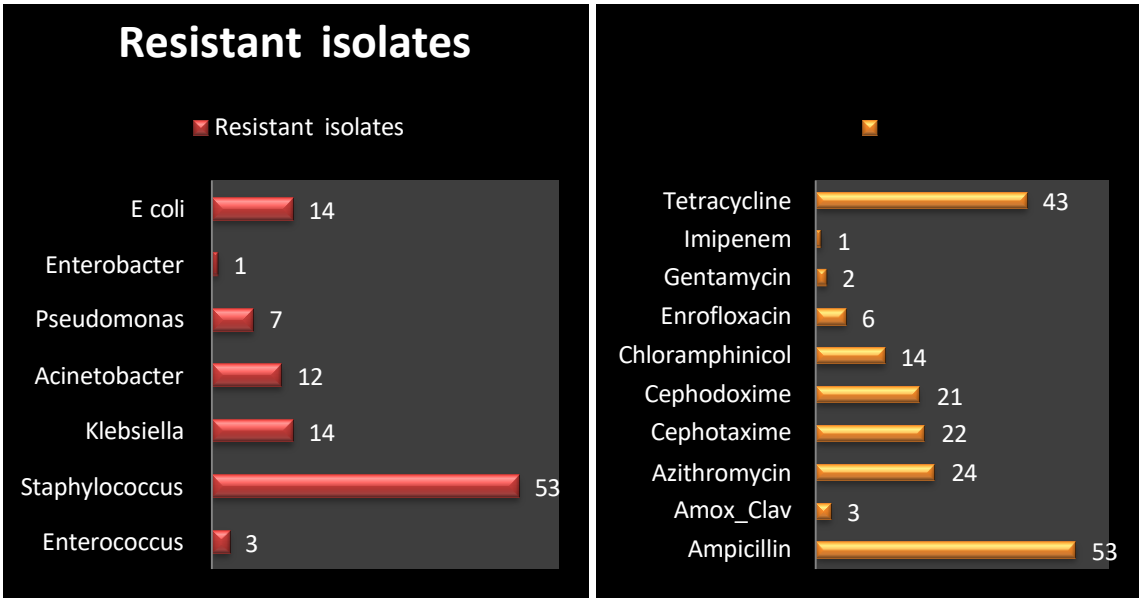
Antibiotic tested for resistance	**Number of bacterial isolates tested**	**Number of isolates showing resistance**	**% Resistance**	**Resistance Pattern**
Ampicillin	53	9	16.9	Klebsiella(3) E.coli (3)

				Enterococcus (1) Pseudomonas (1) Enterobacter (1)
Amox-Clav	37	1	2.7	Klebsiella(1)
Azithromycin	25	2	8	E.coli (1) Pseudomonas (1)
Cefotaxim	59	3	5	E.coli (1) Klebsiella (1) Acinetobacter (1)
Cefotaxim-Clavulinic acid	29	2	6.8	Klebsiella (1) Enterococcus(1)
Cefpodoxime	26	3	11.5	E.coli (1) Klebsiella (1) Pseudomonas (1)
Tetracycline	24	4	16.6	E.coli (2) Klebsiella (1) Enterobacter(1)
Enrofloxacin	15	1	6.6	Klebsiella (1)
Chloramphenicol	33	3	9.0	Pseudomonas (2) Acinetobacter(1)
Imipenem	44	0	-	-

Key findings:

- More than 55% of chicken liver and 12% of chicken meat tested showed antibiotic residues
- Tetracycline residues was the most common among the tested antibiotics.
- Antibiotic residues were not detected in KEPCO & Kerala chicken samples
- 19% of bacterial isolates from animal products or farm environmental samples showed antibiotic resistance
- Resistance was found among all members of ESKAPE pathogens
- Higher resistance was found among *Staphylococci* followed by *Klebsiella sp* and *E.coli*
- Among the 10 major antibiotics tested, maximum resistance was found to Ampicillin, followed by Tetracycline and Azithromycin and least to Carbapenem. Among 113

bacterial isolates tested, only one (0.1%) showed resistance to Imipenem (carbapenem).



3.2.4 Genomic study of Bacteria isolated from meat, eggs, milk and environmental samples

Search for the presence of a few proven AMR resistance genes in the bacterial isolates of the study revealed presence these genes in bacteria present in animal products and environment.

Resistance genes identified

Bacteria tested	TET A gene	TEM Gene	SHV Gene	MEC A gene	CTX gene
E.coli	11	9	4	-	4
Proteus	3	3	1	-	
Klebsiella	1	2	4	-	2
Acinetobacter	1	-	-	-	1
Staphylococci	1	-	-	18	-
Enterobacter	1	-	1	-	-
Citrobacter	-	-	-	-	1

OPERATIONAL GUIDELINES FIVE YEAR TARGETS

I Awareness & Understanding

Actions	Responsibility	Y 1	Y 2	Y 3	Y 4	Y 5
Master Training Program (to create resource person)	SIAD	✓	✓			
District level training of Vets, Para vets, Private vets, Farm officers	DAHO	✓	✓	✓	✓	✓
Farmer targeted trainings (Dairy & Poultry)	LMTC	✓	✓	✓	✓	✓
Developing IEC materials	LMTC	✓	✓			
Including curriculum : Para vets, Interns…		✓				
Through Media division, Dooradarshan, Radio talks	LMTC	✓	✓	✓	✓	✓

II

Knowledge & Evidence

Laboratories & Surveillance

Actions	Responsibility	Y 1	Y 2	Y 3	Y 4	Y 5
Identification of labs & Networking, Develop plan..	SIAD	✓	✓			
Strengthening labs to detect AMR	DAH	✓	✓	✓		
Training for lab based AMR surveillance	SIAD, RDDLs, SLMAP	✓	✓	✓		
Isolation & AMR pattern (diagnostic samples)	Labs	✓	✓	✓	✓	✓
Screening clinically healthy animals	Labs		✓	✓	✓	✓
Environmental sampling : farms	Labs		✓	✓	✓	✓
Developing infrastructure for residue analysis	DAH		✓	✓		
Residue analysis (animal products, environment)	SLMAP			✓	✓	✓

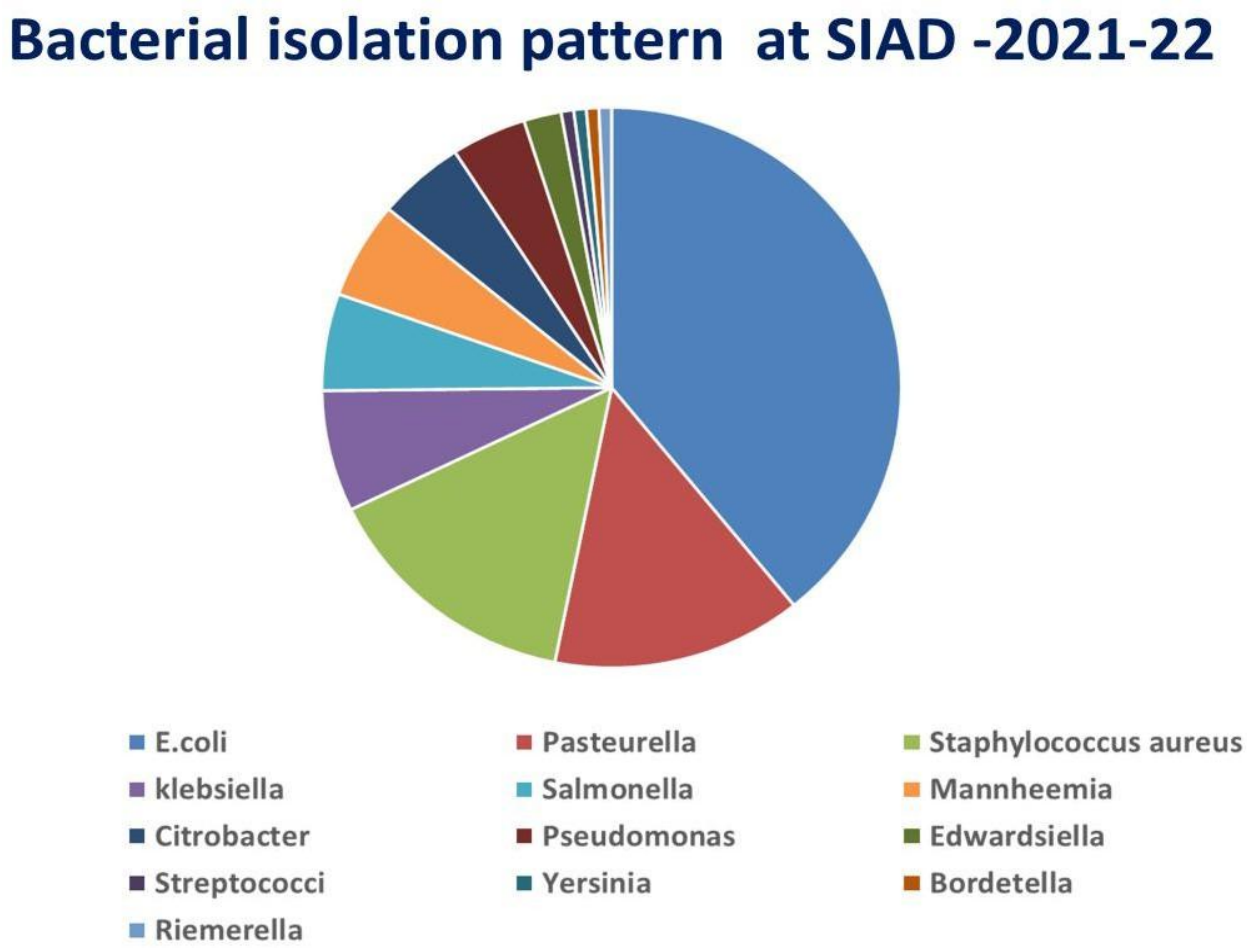
II

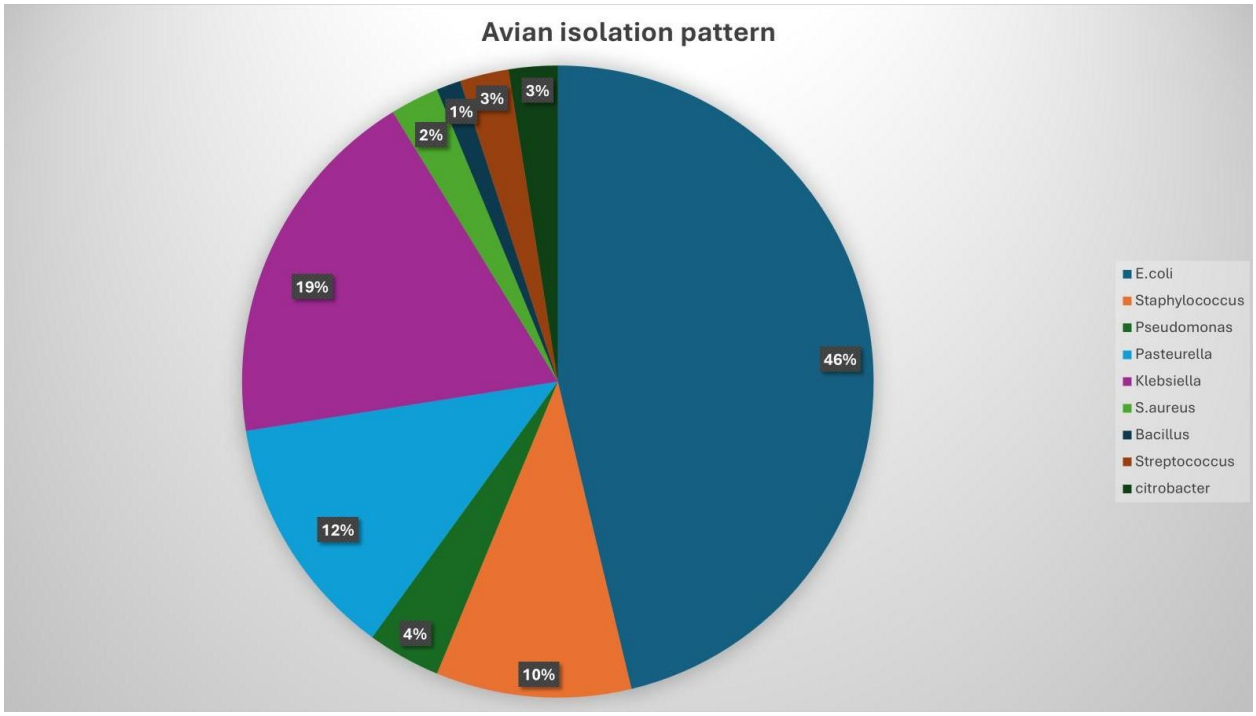
Knowledge & Evidence

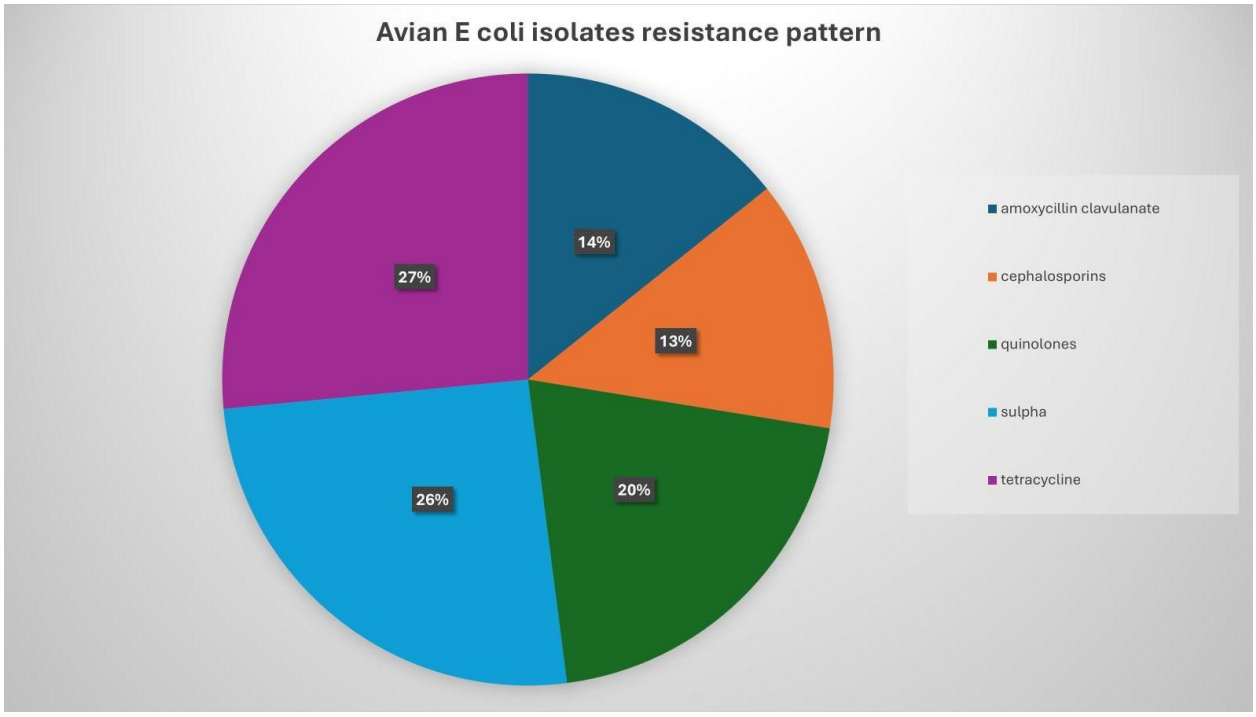
Laboratories & Surveillance

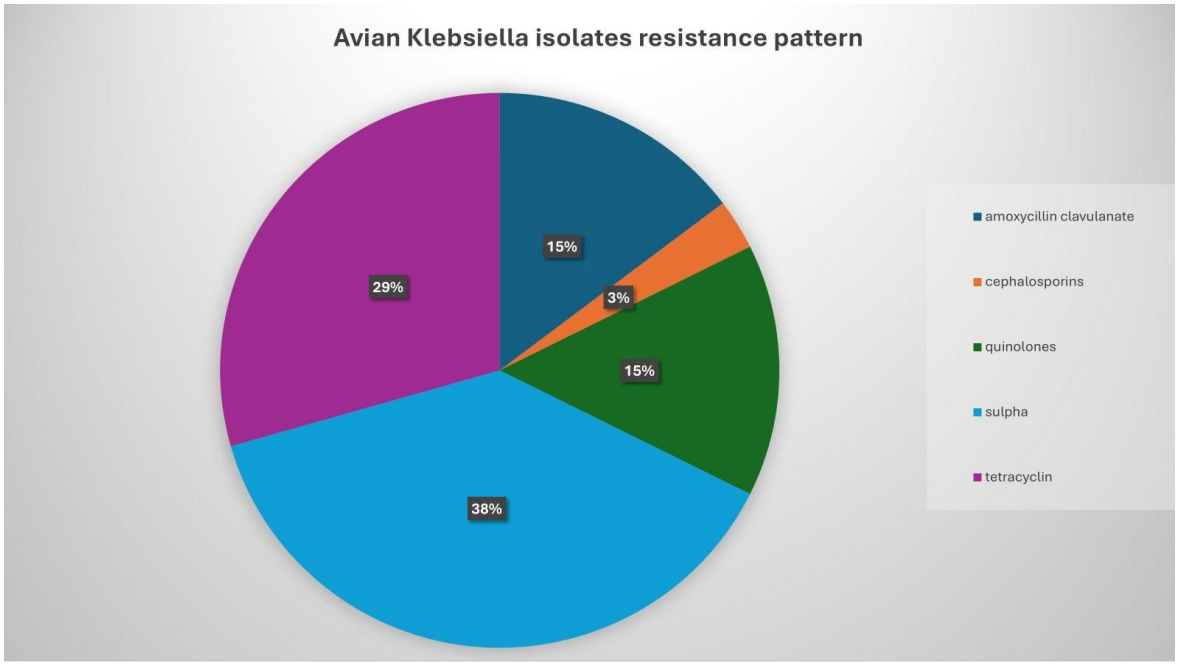
Actions	Responsibility	Y1	Y2	Y3	Y4	Y5
Hospital survey on AMC & AMU	CVO	✓	✓	✓	✓	
Study on KAP (Questionnaire based survey) : Vets, farms	SIAD, LMTC	✓			✓	
Data analysis					✓	
Developing Departmental Policy					✓	✓

- Laboratory Capacity Assessment & Networking: has been done between SIAD, RDDLs & District Labs
- Multicentric AMR surveillance involving 9 laboratories of different regions was initiated in 2022.
- 4 RDDLs and 5 District Laboratories have been selected based on laboratory infrastructure.
- AST Data from 488 clinical samples have been entered in WHONET




Avian isolation pattern
46%
10%
4%
12%
19%
2%
1%
3%
3%
E.coli
Staphylococcus
Pseudomonas
Pasteurella
Klebsiella
S.aureus
Bacillus
Streptococcus
citrobacter


Avian E coli isolates resistance pattern
14%
13%
20%
26%
27%
amoxycillin clavulanate
cephalosporins
quinolones
sulpha
tetracycline



State Institute for Animal Diseases [SIAD]

- State referral Laboratory
- Located at Thiruvananathapuram
- SIAD is part of Indian Network for Transboundary and Emerging and Zoonotic diseases (INTEZ) (FAO)- One of the 18 labs in India.
- 3- year Collaborative research with MG University. Funded by AHD completed and project report submitted this year.
- New facility for Antibiotic Residue Analysis with LC – MS/MS and GC- MS/MS under Kerala Chicken Project.
- Research findings published in forums & journals including peer reviewed ones.
- 2nd phase of the project is in pipeline as a collaborative work with a human component also .

Avian Disease Diagnostic Laboratory (ADDL)

Only lab in Kerala with biorepository of more than 300 bacterial isolates.

- Biochemical typing & antibiogram completed on these isolates
- Pilot study on AMR genes undertaken

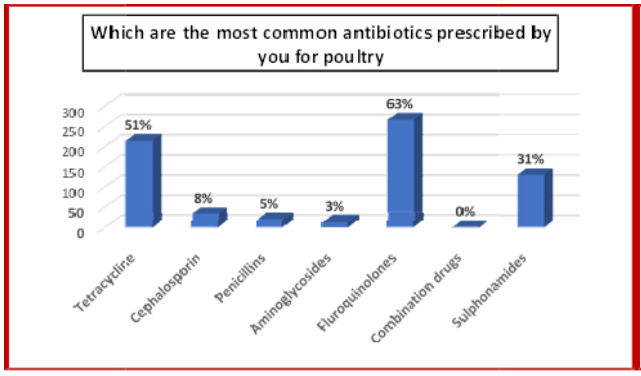
State Laboratory for Livestock Marine &Agri Products (SLMAP), Kochi

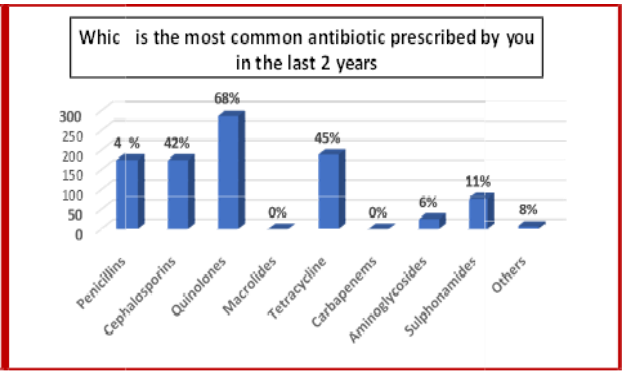
- Lab for food testing under AHD
- Chemistry, Microbiology & Molecular Biology Divisions
- Lab notified by FSSAI\
- Guided by QCI and ILAC
- Lot of work done on monitoring Antibiotic residue in Chicken

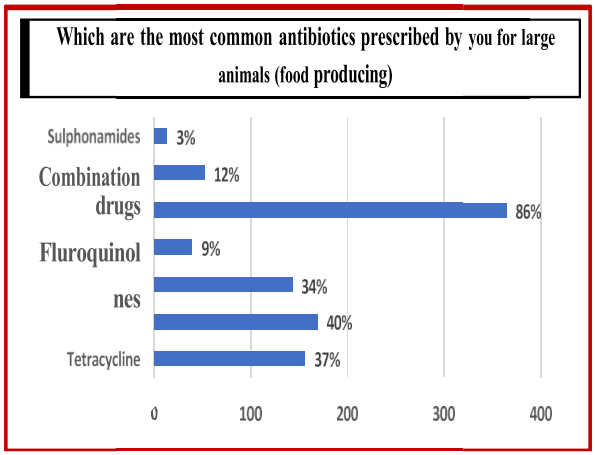
food testing certification by APEDA

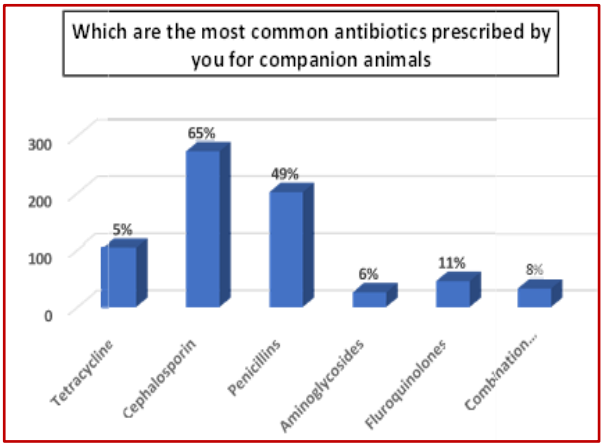
KUDUMBASHREE ®
KERALA CHICKEN
THE ORIGINAL KERALITE

CROSS SECTIONAL SURVEY ON ANTIBIOTIC PRESCRIPTION PATTERN AMONG VETERINARIANS









3.Infection Prevention and Control

Actions	Responsibility	Time line
SOP for IPC in hospitals (Development & Implementation)	Selected clinical experts' team CVOs	2-3 years
Enumeration & mapping of farms	DAHOs & IT wing	1 year
SOP for farm biosecurity (Development & Implementation)	Selected experts' team Farm Officer	3-4 years
Vaccination calendar for farms	Farm Officers	1-3 years
Safe disposal of antibiotics in hospitals, farms..(PROUD like..)	Res. Institute Head	4-5 years
BMW management in institutions : IMAGE	Res. Institute Head	2 years

IV Optimize Use of Antibiotics

Actions	Responsibility	Y 1	Y 2	Y 3	Y 4	Y 5
Constitution of district level audit team	DAHO	✓				
Auditing of antibiotic usage in clinical institutions (10% of clinical institutes /district/year)	CVO	✓	✓	✓	✓	✓
Developing institutional antibiotic policy (MSH/DVCs)	Institute head	✓	✓			
Promoting alternatives		✓	✓	✓	✓	✓
Regulations						✓
Departmental antibiotic policy						✓

V Research & Innovations

Actions	Responsibility	Y 1	Y 2	Y 3	Y 4	Y 5
Prioritize AMR research in AHD R & D	DAH	✓				
Identify potential research institutions	DAH	✓	✓			
Identify research priorities	SIAD	✓	✓			
Organize "Research Day" to showcase findings/publish	SIAD		✓			✓
Publications	Participating institutions		✓	✓	✓	✓
Innovations : Tools to mitigate AMR					✓	✓

Research & Collaboration

- Research on AMR is identified as a priority area in R&D head of AHD.
- 3- year Collaborative research with MG University and SIAD, Palode has completed which was funded by AHD.
- Findings of research projects are being published in forums & journals including peer reviewed ones.
- 2nd phase of the project is looking for funds in which human component is also included.
- ADDL, Thiruvalla & SLMAP, Ernakulam are also conducting many AMR related studies and projects.

INDICATORS TO BE CAPTURED TO KARSAP DASHBOARD FROM ANIMAL HUSBANDARY

Serial no	Indicators	timeline
1.	Repository of IEC materials	1 month
2	Mapping of AMR surveillance labs-	1 month
3	Antibiogram of Klebsiella and Ecoli	1 month
4	Mapping of farms	3 months
5	Antibiotic residue monitoring data	6 months
6	Antibiotic smart hospitals	1 year
7	Farms with AMU systems	6 months
8	Drug bug combinations for priority pathogens	6 months
9	Antibiogram for ESKAPE Pathogens	1 year
10	Antibiogram for poultry	1 year

FISHERIES AND AQUACULTURE

REPORT ON ANTIMICROBIAL RESISTANCE SURVEILLANCE IN AQUATIC PATHOGENS (2022–2025)

. Following a transition in funding models, KUFOS shifted from broad environmental screening to a **Targeted Clinical Surveillance Model**. By utilizing data from the National Surveillance Programme for Aquatic Animal Diseases (NSPAAD) and high-level postgraduate research, The data provide evidence of escalating **Multidrug Resistance (MDR)** in Kerala's ornamental and food-fish sectors.

1. Antibiogram Analysis of *Aeromonas* spp. from cultured food fish

A comprehensive study was conducted on 50 *Aeromonas* spp. isolates from fish to evaluate their resistance profiles against 24 antibiotics. The results indicate a critical level of Multidrug Resistance (MDR), particularly against common first-line treatments like penicillins and quinolones. This poses a significant threat to both aquaculture productivity and public health through the food chain.

Key Findings

High-Resistance Categories

- Penicillins (β-lactams): Widespread resistance was observed for Ampicillin (86%) and Amoxicillin (84%). This is likely due to the intrinsic production of β-lactamases by *Aeromonas*.
- Quinolones & Fluoroquinolones: A concerning 86% resistance to Levofloxacin and 74% to Nalidixic acid was recorded. Specific isolates (e.g., ARL-17, ARL-46) showed resistance to all tested agents in this class (Ciprofloxacin, Levofloxacin, and Ofloxacin).
- Other Critical Agents**:** High resistance rates were also noted for Imipenem (82%), Oxytetracycline (68%), and Erythromycin (52%).

Species-Specific Observations

- ***A. veronii biovar sobria:*** Demonstrated the broadest resistance profiles, with isolate **ARL-46** resistant to 23 of the 24 antibiotics tested.
- ***A. hydrophila:*** Isolate **ARL-23** showed complete resistance to all seven tested cephalosporins.
- ***A. caviae:*** Notably more susceptible than other species, showing only intermediate resistance to Aztreonam.

Multiple Antibiotic Resistance (MAR) Index

The MAR index was used to assess the environmental antimicrobial pressure.

- **Risk Threshold:** 88% of isolates (44/50) had a **MAR index > 0.2**, indicating they originate from environments with high-risk, intensive antimicrobial use.
- **Range:** Values ranged from **0.166 to 0.958**.

- **Environment Status:** Only 12% (6 isolates) originated from low-risk or minimally contaminated environments.

Implications for Fisheries & Public Health

- **Economic Impact:** The prevalence of MDR *Aeromonas* (especially *A. salmonicida*) threatens fish health, leading to potential outbreaks of Motile Aeromonas Septicemia (MAS) that are difficult to treat.
- **Zoonotic Risk:** Resistance to Imipenem and Fluoroquinolones drugs are critical for human medicine which highlights the risk of resistant gene transfer from the aquatic environment to humans.

2. Antibiogram Analysis of *Vibrio* species from Shrimp Aquaculture ponds

A total of 51 *Vibrio* isolates (including *V. alginolyticus*, *V. parahaemolyticus*, and *V. harveyi*) were analyzed against 12 antibiotics from seven distinct classes. The study reveals significant resistance to Quinolones (80.4%) and Macrolides, while Tetracyclines remain the most effective therapeutic class. Over 72% of isolates originate from high-risk contamination sources.

Antibiogram Analysis (Sensitivity & Resistance)

The following table summarizes the susceptibility of the 51 isolates based on CLSI (2018) guidelines:

SL No.	Class	Antibiotic	% Sensitive	% Intermediate	% Resistant
1	Quinolones	Nalidixic acid	19.6	-	80.4
2	Tetracyclines	Chlortetracycline	76.5	15.7	7.8
3		Oxytetracycline	56.8	11.8	31.4
4		Tetracycline	47.1	13.7	39.2
5	Nitrofuran	Nitrofurantoin	50.9	29.4	19.6
6	β-lactams	Ampicillin	21.5	31.4	47.1
7		Meropenem	37.3	21.5	41.2
8		Imipenem	47.1	17.6	35.3
9		Cefotetan	39.2	25.5	35.3
10	Aminoglycosides	Amikacin	39.2	17.7	43.1
11	Fluoroquinolones	Enrofloxacin	21.6	35.3	43.1
12	Macrolide	Erythromycin	5.9	50.9	43.2

Species-Specific Observations

- **Most Resistant Strain:** VH-06 (*V. harveyi*) exhibited resistance to 9 out of the 12 antibiotics tested.
- **Most Susceptible Strain:** VA-08 (*V. alginolyticus*) showed resistance only to Nalidixic acid.
- ***V. alginolyticus:*** VA-05 showed complete resistance to the beta-lactam class (Cefotetan, Imipenem, Meropenem, and Ampicillin).

- ***V. parahaemolyticus:*** Displayed high variability, with a significant portion of isolates (VP-09, 10, 11, 12, 17, 18) being resistant to Enrofloxacin**.**

Multiple Antibiotic Resistance (MAR) Index

The MAR Index was calculated to assess the level of antimicrobial pressure in the aquatic environment.

- Environmental Status: 72.55% (37 isolates) had a MAR Index > 0.2, signalling they originated from environments with frequent and intensive antimicrobial use.
- Range of Values: MAR index values ranged from 0.08 to 0.75.
- High-Risk Predominance: The highest MAR index (0.75) was recorded for *V. harveyi* (VH-06), indicating extensive multidrug resistance.
- Low-Risk Sources: Only 14 isolates (27.45%) were classified as coming from least-contaminated sources (MAR <_ 0.2).

3. Antibiogram Analysis oof *P. damselae* subsp. *damselae* (PDD)

A study of 10 *P. damselae* subsp. *damselae* (PDD) isolates was conducted against 15 antibiotics across seven classes. The results show a total failure of the penicillin class and emerging resistance in cephalosporins and carbapenems. The findings highlight significant environmental risk, with a majority of isolates originating from high-risk contamination sources.

Key Findings: Antibiotic Resistance Profiles

- **Penicillins:** 100% of isolates (all 10) were resistant to Ampicillin and Amoxicillin. This indicates either intrinsic resistance or widespread acquired β-lactamase activity.
- **Aminoglycosides (Gentamicin):** Largely ineffective, with the majority of isolates showing complete resistance.

Variable & Emerging Resistance

- **Cephalosporins:** Showed high heterogeneity. Cefotaxime was the most effective (70% sensitive), whereas Ceftazidime and Cefepime showed only 50% and 40% sensitivity, respectively.
- **Carbapenems:** A concerning "Intermediate" trend was observed. 50% of isolates showed intermediate susceptibility to Imipenem, and 50% to Meropenem. This suggests these "last-resort" drugs are losing their potency.
- **Fluoroquinolones:** Currently the most viable class, with Levofloxacin (60% sensitive) showing the best performance.

Multiple Antibiotic Resistance (MAR) Index Analysis

The MAR Index serves as a critical indicator of the antimicrobial pressure in the environment from which these isolates were collected.

- **Risk Origin:** Most isolates recorded a MAR Index > 0.2, indicating they likely originated from high-risk sources with intensive antimicrobial use (e.g., medical runoff or unregulated aquaculture sites).
- **Most Resistant Isolate:** PDD-09 was identified as the most dangerous strain, exhibiting resistance to 7 different antibiotics tested.

- **Environmental Pressure:** The high percentage of "Intermediate" results across carbapenems and tetracyclines suggests an environment where bacteria are under constant sub-lethal exposure to antibiotics.

4. AMR Profile of Co-infecting Pathogens in Nile Tilapia (Kerala)

This section details the antimicrobial susceptibility of *Lactococcus garvieae* (Gram-positive) and *Aeromonas hydrophila* (Gram-negative) isolated from a disease outbreak in cultured Nile Tilapia (*Oreochromis niloticus*).

***Lactococcus garvieae* Resistance Profile**

The *L. garvieae* strain demonstrated a significant multi-drug resistance (MDR) phenotype, showing resistance to 7 out of the 13 antibiotics tested (54% resistance rate).

- **Key Resistance:** High resistance was noted against Ciprofloxacin, a fluoroquinolone often used in both veterinary and human medicine.
- **Implications:** The broad resistance profile of this Gram-positive pathogen complicates treatment, especially in co-infection scenarios where typical "broad-spectrum" choices may fail.

***Aeromonas hydrophila* Resistance Profile**

The *A. hydrophila* strain exhibited specific resistance to several traditionally used antibiotics:

- **Key Resistance:** Resistance was confirmed for Streptomycin (Aminoglycoside) and Erythromycin (Macrolide).
- **Significance:** Resistance to Erythromycin is particularly notable as it is frequently used to treat Gram-positive infections; its failure against this Gram-negative isolate further limits therapeutic windows.

Comparative Summary

- **Selective Pressure:** The presence of MDR in both pathogens isolated from the same diseased host suggests significant antimicrobial selective pressure within the freshwater pond environment in Alappuzha.
- **Virulence Correlation:** The study confirmed the presence of **adhesin and hemolysin genes** in *L. garvieae* and the **aerolysin gene** in *A. hydrophila*, indicating that these resistant strains are also highly

5. AMR in *Streptococcus agalactiae* from farmed Tilapia

Streptococcus agalactiae is a highly invasive pathogen causing devastating economic losses in Kerala's tilapia industry. This study identifies a critical shift toward Multidrug Resistance (MDR), with isolates showing resistance to seven structurally distinct antibiotic classes. The high Multiple Antibiotic Resistance (MAR) index (0.6) suggests that conventional antimicrobial therapies are becoming obsolete, necessitating the urgent adoption of alternative biocontrol strategies such as phage therapy.

Antibiogram Analysis

The isolates were evaluated against a broad spectrum of antibiotics. The susceptibility profiles revealed widespread resistance, particularly among the most commonly used drugs in the sector.

Antibiotic Class	Key Antibiotics Tested	Resistance Status
β-lactams	Ampicillin, Amoxicillin, Oxacillin, Methicillin	High Resistance
Macrolides	Erythromycin	High Resistance
Tetracyclines	Tetracycline	Significant Resistance
Glycopeptides	Vancomycin	Resistant
Aminoglycosides	Kanamycin, Streptomycin, Amikacin	Resistant
Lincosamides	Clindamycin	Resistant

Key Findings:

- **MDR Profile:** The isolates exhibited resistance to seven different classes, including early-generation and advanced antimicrobials.

Multiple Antibiotic Resistance (MAR) Index

The MAR index was used to calculate the environmental pressure and origin risk of the pathogen.

- **Calculated Value:** The study recorded **a MAR Index of 0.60.**
- **Interpretation:** This value is significantly higher than the high-risk threshold of **0.2**, indicating that the bacteria originated from an environment where antibiotics are intensively and frequently applied.
- **Environmental Impact:** This reflects a high selective pressure in Kerala's freshwater aquaculture systems, potentially due to unregulated antibiotic use or contaminated water sources.

Phenotypic and Genotypic MDR in *S. agalactiae* indigenous Green Chromide (*Etroplus suratensis*) and Tilapia.

- **Primary Pathogen:** *Streptococcus agalactiae* (Group B Streptococcus) isolated from farmed Nile Tilapia and indigenous Green Chromide (*Etroplus suratensis*).
- **Confirmed Resistance Profile:** High-level resistance across multiple classes, including:
    - **Glycopeptides:** Vancomycin
    - **β-lactams:** Ampicillin, Oxacillin, and Methicillin (MRSA-like phenotype)
    - **Tetracyclines:** Tetracycline
    - **Aminoglycosides:** Amikacin, Kanamycin, and Streptomycin.
- **Significance:** The study highlights a dangerous trend of resistance to human "last-resort" antibiotics like **Vancomycin**, suggesting a significant overlap between aquatic environments and clinical resistance reservoirs

6. AMR in Ornamental Fish (Central Kerala)

An analysis of 48 isolates from ornamental fish revealed high levels of Multidrug Resistance (MDR), particularly in *Aeromonas* species and *Staphylococcus aureus*. Alarmingly, nearly 90% of these isolates originated from high-risk environments, highlighting the ornamental fish industry as a significant reservoir for resistant pathogens in Kerala.

Antibiogram Analysis by Species

High-Risk Pathogens

- ***Aeromonas veronii* (biovar sobria & veronii):** β-lactams**:** Extremely high resistance to Amoxicillin and Ampicillin (up to 80%).
    - **Carbapenems:** A critical finding of 70–90% resistance to Imipenem and Meropenem. Since these are "last-resort" drugs, this suggests extreme selective pressure.
- ***Staphylococcus aureus*:** Demonstrated a highly resistant phenotype with **>75% resistance** across β-lactams, macrolides, and quinolones.
- ***Aeromonas hydrophila*:** Resistance exceeded 60% for both β-lactams and macrolides.

Moderate to High Susceptibility

- ***Aeromonas caviae*:** Significantly more sensitive than other *Aeromonas*, with 70–85% susceptibility to cephalosporins.
- ***Vibrio mimicus*, *S. putrefaciens*, and *C. violaceum*:** These species remained largely sensitive (>65–80%) to most tested drug classes.

Species	Primary Resistance Class	Resistance Rate	Recommended Action
A. veronii	Carbapenems (Imipenem)	70–90%	High Concern (Human crossover)
A. hydrophila	Macrolides/β-lactams	>60%	Restricted use of Erythromycin
Vibrio cholerae	Quinolones/Macrolides	35–45%	Monitor for food-safety risk
S. aureus	Multidrug (MDR)	>75%	Biosecurity threat

Publications

1. Reshma R. Nair**, M. P. Safeena**, Anu Ruby Benny, Praveen Rai and Devika Pillai, 2023. Incidence, virulence potential and antibiotic susceptibility of *Vibrio parahaemolyticus* associated with traditional shrimp culture systems of Ernakulam, Kerala J. Mar. Biol. Ass. India, 65 (1) 58-68. (NAAS Score: 5.40)
2. **Maniyappan, K. K.**, Krishnan, R., Girijan, S. K., & Pillai, D. (2023). *Streptococcus agalactiae infection in cage-cultured green chromide Etroplus suratensis in Kerala, India*. Diseases of Aquatic Organisms, 155, 11-21. https://doi.org/10.3354/dao03734
3. Nair, R. R., John, K. R., Preenanka, R., Krishnan, R., & **Safeena, M. P.** (2024). Co-infection of Lactococcus garvieae and Aeromonas hydrophila in cultured Nile Tilapia in Kerala, India. Brazilian Journal of Microbiology, 55(3), 2071–2083. https://doi.org/10.1007/s42770-024-01415-w
4. Preenanka, R., and **Safeena, M.P**. (2024). In vitro lytic potential of Streptococcus bacteriophage against multidrug resistant Streptococcus agalactiae. Biologia, 79, 2581. https://doi.org/10.1007/s11756-024-01730-5

5. Nair, R. R., John, K. R., Preenanka, R., Krishnan, R., & **Safeena, M. P.** (2024). Co-infection of Lactococcus garvieae and Aeromonas hydrophila in cultured Nile Tilapia in Kerala, India. Brazilian Journal of Microbiology, 55(3), 2071–2083. https://doi.org/10.1007/s42770-024-01415-w
6. **Maniyappan, K. K.**, Girijan, S. K., Krishnan, R., & Pillai, D. (2025). *Assessing Multi-Drug Resistance in Streptococcus agalactiae infecting farmed Nile Tilapia: Findings from Kerala, India*. **Microbial Pathogenesis**, 205. [https://doi.org/10.1016/j.micpath.2025.xxxx]

List of the published abstracts

- Shelina Shaji, Saranya P and Jameema Jamal K.I, **Muhammed P Safeena***, 2024. "Isolation, Identification and Antibiogram Analysis of *Edwardsiella piscicida* from *Clarius batrachus* of Kerala". International Fisheries Congress, 2024.
- Reshma R Nair, **Muhammed P Safeena**, Anu Ruby Benny, Praveen Rai and Devika Pillai. 2022. Incidence, virulence potential and antibiotic susceptibility pattern of Vibrio parahaemolyticus associated with traditional shrimp culture systems of Ernakulam, Kerala" In the National Seminar on Reorienting the Strategies Towards Sustainable Aquaculture and Fisheries, Organized by Faculty of Fisheries (KUFOS) During 6th and 7th January 2022. (EHFA01)
- Preenanka, R. and **Safeena, M.P.**, 2022. Protective efficiency of bacteriophage cocktail against multidrug resistant Streptococcus agalactiae in farmed tilapia" In 3rd International Conference on Bacteriophage Research & Antimicrobial Resistance. Jointly organized by SBRT and Karnatak University during 26-27th November 2022.
- Aiswarya K P, Safeena M P and Preenanka R., 2022. Occurrence of disinfectant-resistant bacteria in a fish processing plant In International Seminar on Interventions for control of AMR: Harnessing one health knowledge, a parallel event of GAF8, organized by Central Institute of Fisheries Technology (ICAR-CIFT) during 21-23rd November, 2022.PE-152

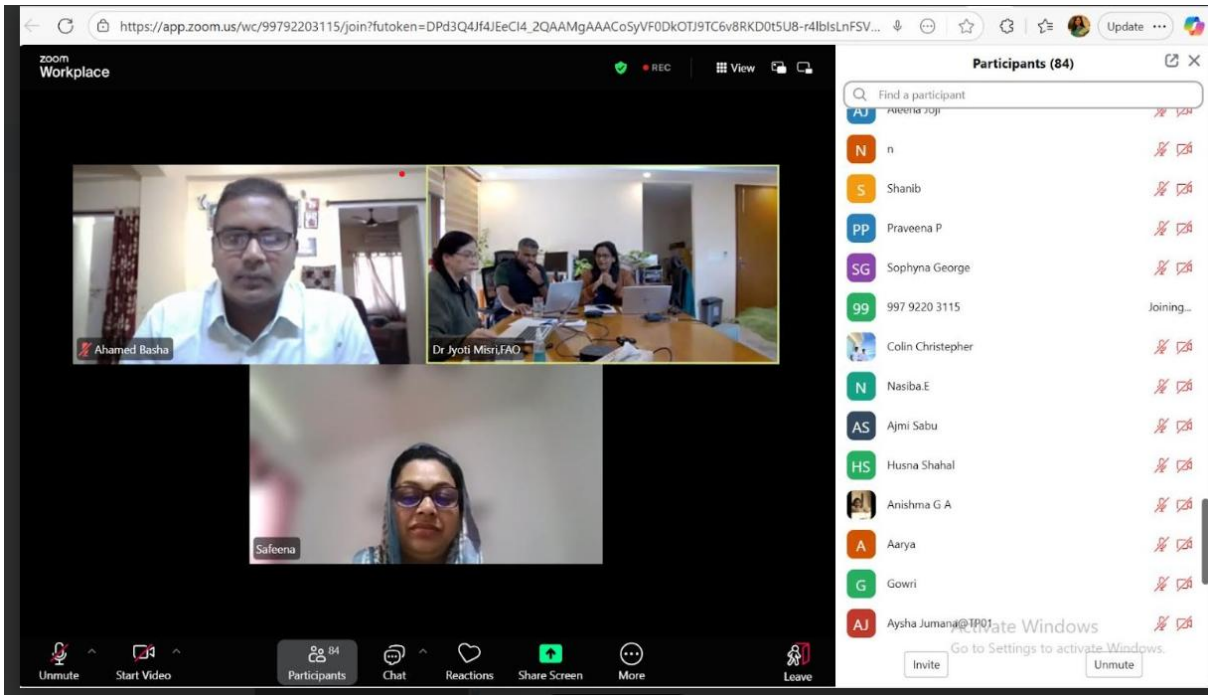
Master's Thesis Produced (MFSc)

1. Incidence, virulence gene screening and antibiotic resistance profiling of major vibrio species from shrimp farms of Kerala 2024. Athira U. MFSc. student of Dept. of Aquatic Animal Health Management.
2. Isolation, Molecular characterization, virulence gene profiling, and Antimicrobial susceptibility of *Photobacterium damselae* subsp. *damselae* from aquaculture systems in Kerala 2025 submitted by Fiza S (AAH-2023-22-03) MFSc. student of Dept. of Aquatic Animal Health Management, Kerala University of Fisheries and Ocean Studies (KUFOS)
3. Phenotypic, Genotypic and Pathological insights into Vibrio vulnificus Isolated from *Etroplus suratensis* submitted by Sneha K S (AAH-2023-22-12) MFSc. student of Dept. of Aquatic Animal Health Management, Kerala University of Fisheries and Ocean Studies (KUFOS)

Extension & Awareness Initiatives

- **World AMR Awareness Week (WAAW) Observance:** Conducted a high-impact sensitization program on **21/11/2024** in collaboration with **ICAR-CIFT**, aligning with the global theme *"Educate. Advocate. Act now."* Facilitated a specialized training session for **127 participants**, including students, researchers, and stakeholders, focusing on antimicrobial stewardship in the fisheries sector. Organized a **Technical Poster Competition** for Master's students to encourage research-based Communication on the "Silent Pandemic" of AMR in aquatic systems.
- **FAO-KUFOS Joint Initiative** : On **November 21, 2024**, the Department of Aquatic Animal Health Management (AAHM), KUFOS, organized a high-level national webinar titled **"Understanding AMR Perspectives in Fisheries and Aquaculture."** The program featured strategic leadership from **Dr. Devika Pillai**, Assistant Director General (Fisheries), ICAR, and technical experts from **FAO India**, including Dr. Robin Paul and Dr. Jyoti Misri. Key sessions addressed global health priorities, regulatory policies, and practical mitigation strategies within the aquaculture sector, specifically highlighting the unique AMR challenges faced by export-oriented fisheries. This event successfully reinforced the institutional synergy between **KUFOS, ICAR, and FAO**, promoting a unified "One Health" approach to combat antimicrobial resistance in Kerala's aquatic ecosystems
- **World AMR Awareness Week (WAAW) 2025: FAO-KUFOS Joint Initiative:** In observance of World AMR Awareness Week 2025, the Department of Aquatic Animal Health Management (AAHM), KUFOS, in collaboration with FAO India, organized a high-level webinar titled "One Health Approach for AMR Mitigation" on November 22, 2025. Supervised by Dr. Safeena M.P. Associate Professor and Head, Dept of AAHM, the event successfully engaged 137 participants, emphasizing the "Act Now" theme and the recent launch of India's National Action Plan (NAP-AMR 2.0). The session highlighted KUFOS's pivotal role as the nodal center for aquaculture AMR surveillance in Kerala and showcased innovative mitigation strategies, including phage therapy and the use of antibiotic potentiators. The program underscored the transition of the INFAAR network toward genomic surveillance and called for a coordinated "One Health" effort to secure food safety and public health against the global threat of multidrug-resistant pathogens.

World AMR Awareness Week (WAAW) 2024: ICAR-CIFT-KUFOS Joint Initiative Kerala University of Fisheries and Oceans Studies, Panangad, Kerala



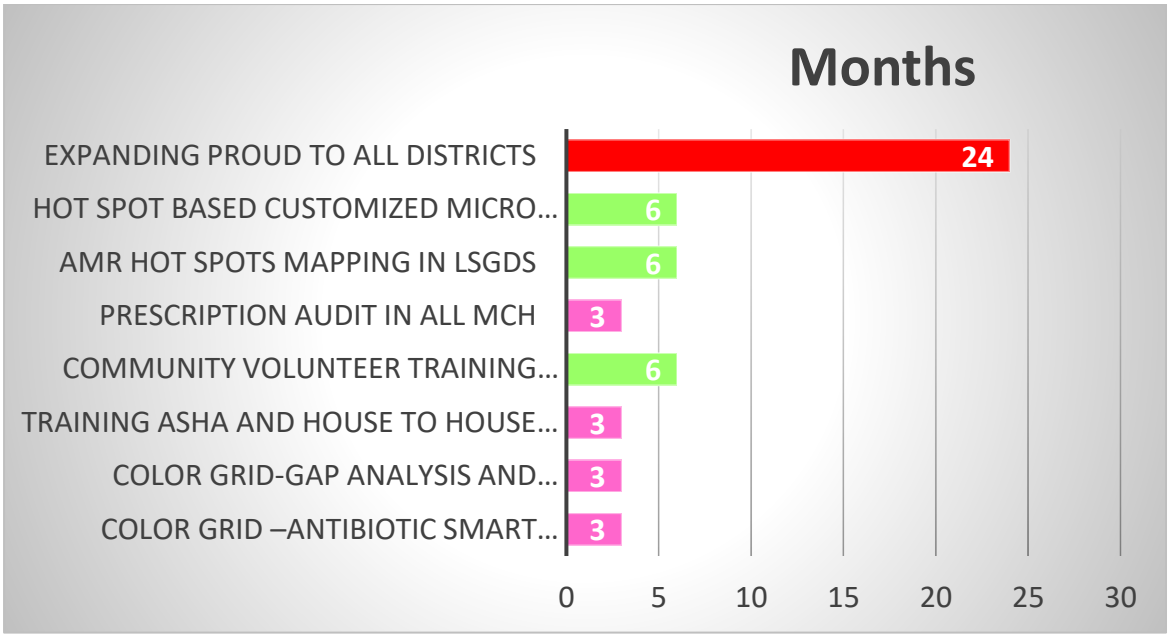
World AMR Awareness Week (WAAW) 2025: FAO-KUFOS Joint Initiative Kerala University of Fisheries and Oceans Studies, Panangad, Kerala

Annexures

TIMELINES-GANTT CHART

	TARGET	TIME FRAME
1.	COLOR GRID –Antibiotic smart Hospitals	3 months.
2.	COLOR GRID-Gap analysis and customized micro action plans for each hospital.	3 months.
3	Training ASHA and house to house campaign with customized IEC	3 months
4	Community volunteer training to identify AMR hot spots	6 months
5	Prescription audit in all MCH	3 months
6.	AMR hot spots mapping in LSGDs	6 months.
7.	Hot spot based customized micro action plan in all LSGDs to become antibiotic smart	6 months
8	Expanding PROUD to all districts	2 years

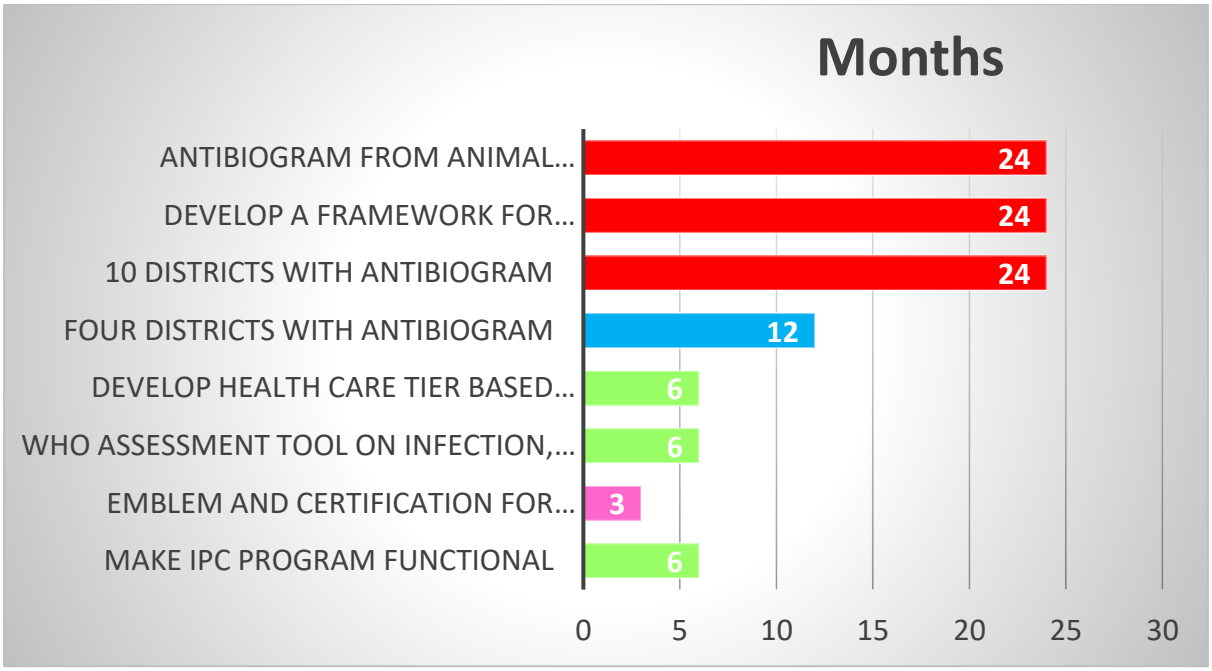
GANTT CHART



TIMELINES-GANTT CHART

	TARGET	TIMELINE
9	Make IPC program Functional	6 months
10	Emblem and certification for Antibiotic Smart Hospitals	3 months
11	WHO Assessment tool on infection, prevention and control minimum requirements for tertiary health care facilities	6 months
12	Develop health care tier based antibiotic guidelines	6 months
13	Four districts with Antibiogram	12 months
14	10 districts with Antibiogram	24 months
15	Develop a framework for Antibiotic use tracking at pincode level	24 months
16	Antibiogram from Animal Husbandary	24 months

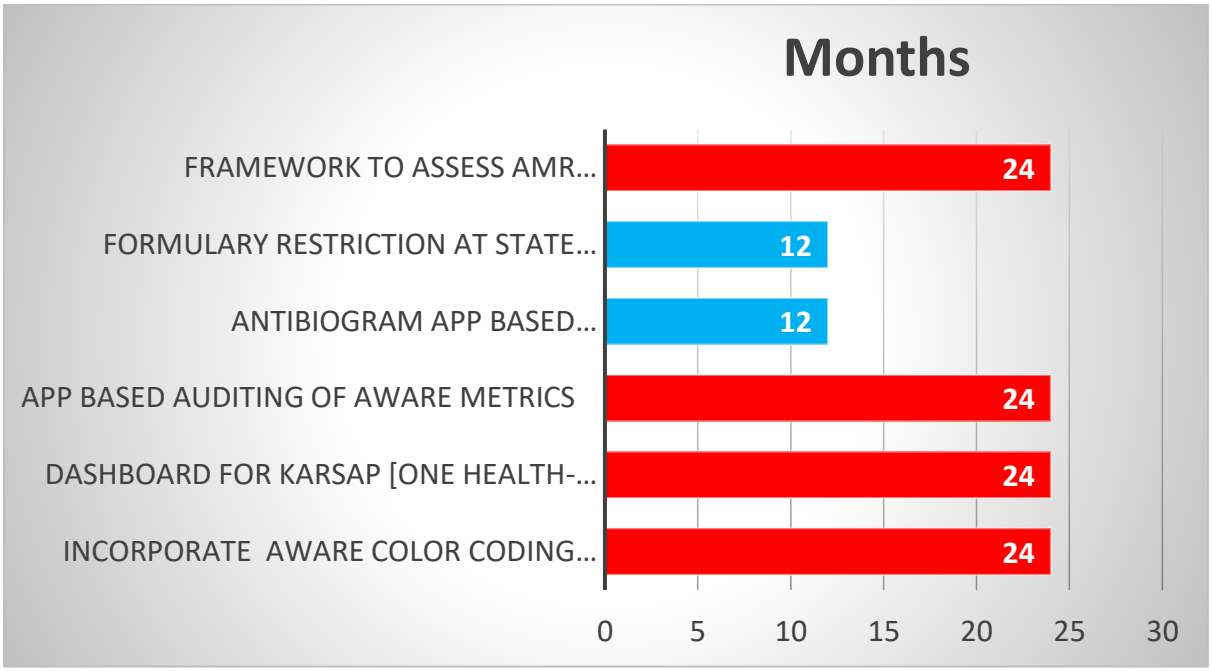
GANTT CHART



TIMELINES-GANTT CHART

	TARGET	TIME FRAME
17	Incorporate AWaRe color coding matrix into e-health	24 months
18	Dashboard for KARSAP [One Health-priority pathogens]	24 months
19	App based auditing of AWaRe metrics	24 months
20	Antibiogram App based Antimicrobial stewardship certification for Interns and doctors	12 months
21	Formulary restriction at state level to ensure that 95%antibiotics supplied to PHCs are from Access category	12 months
22	Framework to assess AMR associated and related deaths in Kerala	24 months

GANTT CHART


Months
FRAMEWORK TO ASSESS AMR...
FORMULARY RESTRICTION AT STATE...
ANTIBIOGRAM APP BASED...
APP BASED AUDITING OF AWARE METRICS
DASHBOARD FOR KARSAP [ONE HEALTH-...
INCORPORATE AWARE COLOR CODING...
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KARSNET TEAM

	Centers	**HOD/District Nodal Officer**	**Focal Point / Microbiologist**
1	GMC Kozhikode	Dr. Anitha P M	Dr. Vishnu
2	GMC Thrissur	Dr. Pushpa K	Dr Anitha
3	GMC Kottayam	Dr. Sreekumary PK	Dr. Vipin Sam Alexander
4	GMC Alappuzha	Dr. Shanimole P E	Dr Arun Sachu
5	GMC Manjeri	Dr. Raji	Dr. Lijitha
6	GMC Ernakulam	Dr. Ardra	Dr. Sushitha
7	GMC Kollam	Dr. M C Sathya Bhama	Dr. Sidharth
8	GH Ernakulam		Dr. Arya R V
9	State Public Health Laboratory, TVM	Dr. Sunija	Dr. Lekshmi
10	Believer's Church Medical College, Thiruvalla	Dr. Renu Mathew	Dr. Reena Anie
11	Aswini Diagnostics, Kozhikode	Dr. Amritha S Kurup	Mr. Gangesh
12	Dane diagnostics, Palakkad	Dr. Ramya T G	Mr. Ajith kumar
13	Karuna Medical College , Palakkad	Dr. Sabitha Baby	
14	Pushpagiri Medical College Hospital, Thiruvalla	Dr. Mercy John Idikula	Dr. Aneeta
15	Regional Cancer Center, Thiruvananthapuram	Dr. Swapna R Nath	Dr. Sagila RG
16	Sree Chitra Tirunal Institute for Medical Sciences & technology,	Dr. Kavitha Raj C	Dr. Dinoop
17	MVR Cancer Center , Kozhikode	Dr. Nagma Rafi	Dr. AyshaMunna
18	Thangam hospital, of PMRC Palakkad	Dr. Najma Asim	Smt. Malavika
19	Rajiv Gandhi Center for Biotechnology, TVM		
20	GH Thiruvananthapuram	Dr. Athira Mohan	Dr. Renuka M
21	GH Kottayam	Dr Vinod P	Dr. Anupama
22	GMC Kannur	Dr. Kalpana George	Dr. Ajitha Anandh
23	Jubilee Mission Medical College and Research Institute, Thrissur	Dr. Chithra Valson	Dr. Rosmi
24	Amala Institute of Medical Sciences,Thrissur (AIMS)	Dr Reena John	Dr. Aiswarya
25	MES Medical college and Paramedical Science, Perinthalmanna	Dr. Syed Mustaq	Dr. Jumail
26	Malabar Cancer Center, Thalassery	Dr. R Parthiban	Dr. Saravanan
27	SreeUthradamTirunal Institute of Medical Sciences (SUT)	Dr. Sarada Devi K L	Dr. Bewin Oral
28	Regional Public Health Laboratory, Kannur		Dr. Vijina
29	Regional Public Health Laboratory, Pathanamthitta	Dr. Nishana	Dr. Lakshmi Balaraman
30	District Public Health Laboratory, Malappuram	Dr. Shibu K	Dr. Deepthi P N
31	GMC Konni	Dr. Manju Sree S	Dr. Anit Antony

32	Dr Sommerviel Memorial CSI Medical College,Karakonam	Dr. Shoba Kurian	Mr. Jobin
33	Mount Zion Medical College, Adoor	Dr. Harshan	Dr. Jerin
34	KMCT Medical college Kozhikkode	Dr. Beena Philomina	Dr. Aparna
35	MOSC Kolencherry	Dr. Chithra Jayaprakash	Dr. Sharon J
36	SreeGokulam Medical College, TVM	Dr. Resmi Rajan	Dr. Sony S
37	PRS Hospital , TVM	Dr. Archana Sasimohan	Smt. Anjali
38	KIMS , TVM	Dr. Ashalaltha Nair	
39	GMC Wayanad	Dr. Jyothi R	Dr. Fairooz
40	Azeezia Kollam	Dr. Prasobh	Dr Deepthi Dilip
41	DH Kollam	Dr. Divya	Smt. Nisha
42	TH Punalur	Dr. Divya	Smt. Neethu
43	PHL Alappuzha	Dr. Anupama	Dr. Suman susan
44	GH Thrissur	Dr. Rajesh	Dr. soumya
45	GH Kozhikode	Dr. Smitha Rahman	Dr Jahana
46	Travancore Medical College Kollam	Dr Anna Cherian	
47	Kannur MCH Ancharakandy	Dr. Muhammed Hisham	Dr Neethu Pavithran
48	Dr. Moopan's MCH[WIMS]	Dr. Suresh Chander	Dr. Ashitha
49	P K DIMS,	Dr.L Ravichandan	Dr.Sneha
50	SNIMS, Ernakulam	Dr. Regha I R	Dr. Suman Joshy
51	Al Azhar, Thodupuzha	Dr. Shareen George	Dr. Ami Patel
52	Regional Public Health Lab Kozhikode	Dr. Smitha Rahman	Dr. Jahana
53	GM C Idukki	Dr. Beena V G	Dr. Aju krishna
54	IPHL Kasaragod	Dr. Anusree	Dr.Linny Mithun
55	MMCH (Malabar Medical College Hospital,Modakkallur,Ulliyeri,Calicut)	Dr Shailaja	
56	Moulana Hospital,Perintalmanna		
57	G G Hospital, TVM	Dr. Bhargavi L	Dr. Gayathri
58	Baby Memorial Hospital,Kozhikode		Dr. Poornima M V
59	GMC Thiruvananthapuram	Dr. Saritha N	Dr . Neethu Kishore

AMR TEAM

1. Dr. Rajan Khobragade, Additional Chief Secretary (Health)
2. Dr Vinay Goyal SMD NHM
3. Mr Rahul Sharma SMD NHM
4. Dr Vishwanathan KV, DME
5. Dr Reena KJ, DHS
6. Dr Saritha N, Prof and HOD Microbiology GMC Thiruvananthapuram, Nodal Officer KARSAP
7. Dr. Aravind R, HOD Infectious Diseases, GMC Thiruvananthapuram, Convenor,KARSAP Working Committee.
8. Dr Anuja Jt Director DME
9. Dr Reetha K, ADHS Public Health
10. Dr Sandeep , ADHS Medical
11. Dr Sunija S, Director, State Public Health Lab
12. Dr KS Preeya, Director, ISM
13. Dr Sabu Thomas, Director, Centre of Excellence for Microbiome, Govt of Kerala
14. Food & Safety Department , Office of the Commissioner

15. Dr. Jyothi. R, Nodal officer AMR Surveillance, Associate Professor, Dept of Microbiology, GMC Idukki.
16. Dr. Sivaprasad PS, Nodal officer for co-ordinating activities under DHS.
17. Dr. Jithesh, Executive Director, SHRC, Nodal officer for engaging civil societies and LSGDs
18. Dr Ajan, Assistant Diector DHS
19. Dr Nikhilesh Menon, Nodal Officer for Strengthening Lab Systems for AMR Surveillance
20. Dr Rajalakshmi Arjun, ID Consultant, KIMS Health, Thiruvananthapuram
21. Dr. Juby John, Professor ID from GMC Kottayam.
22. Dr Netto George, Asst Professor ID GMC Kottayam
23. Dr Dileep Kumar, DMO office Alappuzha
24. Dr Deebu Mathew , IDA representative
25. Representative, State Pollution Control Board
26. Dr Shyam S, Professor & HOD , Department of Pharmacology, GMCT,
27. Dr Aparna, Nodal Officer Animal Husbandry, SIAD Palode
28. Dr Lekshmi GG, State Quality assurance officer, NHM, Kerala
29. Dr Sujith Kumar, State Drugs Controller
30. Sri Sasi PK, Asst Drugs Controller
31. Dr Dileep Deputy DMO Alappuzha
32. Dr Smitha DNO Kozhikode
33. Dr Suman Susan Prakash, AMR District Nodal Officer Alappuzha
34. Dr Sreenadh H, AMR District Nodal Officer Wayanad
35. AMR District Nodal Officers