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**Community Based Surveillance for
AMR Monitoring:
Significance, Requirements and Feasibility
in LMICS**

Afreenish Amir



**SOUTH
CENTRE**

RESEARCH PAPER

223

COMMUNITY BASED SURVEILLANCE FOR AMR MONITORING: SIGNIFICANCE, REQUIREMENTS AND FEASIBILITY IN LMICs

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ABSTRACT

Community based surveillance, in addition to clinical antimicrobial resistance (AMR) surveillance, plays an essential role in AMR and antimicrobial use trend monitoring. Various community-based AMR surveillance studies to monitor trends in AMR and use of antimicrobials have been conducted and shown its potential to facilitate evidence-based interventions and policy making for control of AMR. Many low and middle income countries (LMICs) lack the necessary systems and resources to establish effective surveillance systems. Specifically, the surveillance capacity at hospitals and other health facilities is limited, and the overall human resource capacity for community-level data collection, analysis, and multi-sectoral coordination is severely constrained. Prior to planning for community based AMR surveillance, a country should have established mechanisms to run the system efficiently, including strong governance and regulations, surveillance infrastructure, laboratory capacities, skilled human resources, data collection and management, funding and sustainability.

The World Health Organization and quadripartite partners have recommended advancing community based AMR surveillance in LMICs, and integrated AMR surveillance combining information from humans, animals and ecosystems, which seems a challenge in the current situation. Considering the significant gaps in systems, resources, and capacities, it is important to prioritize strengthening the country's core capacities and addressing the underlying gaps in healthcare systems. Efforts should focus on enhancing the country's core capacities, systems, and technical requirements while exploring the potential of advancing selective community based AMR surveillance interventions and systems in the future.

La vigilancia comunitaria, además de la vigilancia clínica de la resistencia a los antimicrobianos (RAM), desempeña un papel esencial en el seguimiento de las tendencias de la RAM y el uso de antimicrobianos. Se han realizado diversos estudios de vigilancia comunitaria de la RAM para seguir las tendencias de la RAM y el uso de antimicrobianos, que han demostrado su potencial para facilitar intervenciones basadas en datos empíricos y la elaboración de políticas para el control de la RAM. Muchos países de ingresos bajos y medios (PIBM) carecen de los sistemas y recursos necesarios para establecer sistemas de vigilancia eficaces. En concreto, la capacidad de vigilancia de los hospitales y otros centros de salud es limitada, y la capacidad general de recursos humanos para la recopilación de datos a nivel comunitario, el análisis y la coordinación multisectorial es muy limitada. Antes de planificar la vigilancia de la RAM basada en la comunidad, los países deben haber establecido mecanismos para gestionar el sistema de manera eficiente, incluyendo una gobernanza y una normativa sólidas, infraestructura de vigilancia, capacidad de los laboratorios, recursos humanos cualificados, recopilación y gestión de datos, financiación y sostenibilidad.

La Organización Mundial de la Salud y los socios cuatripartitos han recomendado avanzar en la vigilancia de la RAM basada en la comunidad en los países de ingresos bajos y medios, así como en la vigilancia integrada de la RAM que combine información de seres humanos, animales y ecosistemas, lo que parece un reto en la situación actual. Teniendo en cuenta las importantes deficiencias en los sistemas, los recursos y las capacidades, es importante dar prioridad al fortalecimiento de las capacidades básicas del país y a la subsanación de las deficiencias subyacentes en los sistemas de salud. Los esfuerzos deben centrarse en mejorar las capacidades básicas, los sistemas y los requisitos técnicos del país, al tiempo que se explora el potencial de avanzar en el futuro hacia intervenciones y sistemas selectivos de vigilancia de la RAM basados en la comunidad.

La surveillance communautaire, en complément de la surveillance clinique de la résistance aux antimicrobiens (RAM), joue un rôle essentiel dans le suivi des tendances en matière de RAM et d'utilisation des antimicrobiens. Diverses études de surveillance communautaire de la RAM ont été menées afin de suivre les tendances en matière de RAM et d'utilisation des antimicrobiens. Elles ont démontré leur potentiel pour faciliter la mise en place d'interventions fondées sur des données probantes et l'élaboration de politiques visant à contrôler la RAM. De nombreux pays à revenu faible ou intermédiaire (PRFI) ne disposent pas des systèmes et des ressources nécessaires pour mettre en place des systèmes de surveillance efficaces. Plus précisément, les capacités de surveillance des hôpitaux et autres établissements de santé sont limitées, et les ressources humaines globales pour la collecte de données au niveau communautaire, l'analyse et la coordination multisectorielle sont très restreintes. Avant de planifier une surveillance communautaire de la RAM, un pays doit avoir mis en place des mécanismes permettant de faire fonctionner efficacement le système, notamment une gouvernance et une réglementation solides, une infrastructure de surveillance, des capacités de laboratoire, des ressources humaines qualifiées, des systèmes de collecte et de gestion des données, un financement et une viabilité.

L'Organisation mondiale de la santé et ses partenaires quadripartites ont recommandé de faire progresser la surveillance communautaire de la RAM dans les pays à revenu faible et intermédiaire, ainsi que la surveillance intégrée de la RAM combinant des informations provenant des humains, des animaux et des écosystèmes, ce qui semble difficile dans la situation actuelle. Compte tenu des lacunes importantes en matière de systèmes, de ressources et de capacités, il est important de donner la priorité au renforcement des capacités de base du pays et de combler les lacunes sous-jacentes des systèmes de santé. Les efforts devraient se concentrer sur le renforcement des capacités de base, des systèmes et des exigences techniques du pays, tout en explorant le potentiel de mise en place, à l'avenir, d'interventions et de systèmes sélectifs de surveillance communautaire de la RAM.

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1. SIGNIFICANCE OF COMMUNITY BASED SURVEILLANCE FOR AMR

Community based surveillance (CBS), in addition to clinical AMR surveillance, plays an essential role in AMR and antimicrobial use trend monitoring. Clinical AMR surveillance primarily focuses on AMR in patients, potentially overlooking environmental and community based AMR reservoirs. By integrating the community based AMR surveillance data in existing clinical AMR surveillance, researchers and policymakers can triangulate the findings from the different datasets. They can understand the complex dynamics of AMR, identify AMR hotspots and reservoirs, track the spread of AMR genes and resistant bacteria, develop targeted interventions and strategies and hence monitor the effectiveness of AMR control measures.

CBS is one of the tested strategies to guide control of antimicrobial overuse or misuse. The natural environment is an important reservoir of AMR. There is discharge of antimicrobials and their metabolites into the environment from a wide range of sectors, including waste, wastewater, sewage, pharmaceutical manufacturing, agriculture and aquatic environment. This makes CBS a vital approach to understand the AMR dynamics.

Community Based AMR Surveillance involves assessment of:
✓ Risks of transmission of resistant pathogens to humans through environmental routes. ✓ The risk of emerging infections with high antibiotic resistance potential. ✓ Geographical and temporal antibiotic resistance trends in human and animal populations at local, regional and global scales. ✓ The effect of antibiotics on various ecosystems including water and soil ✓ Exploring the AMR trends in human population by examining the wastewater or sewage environmental samples. ✓ Studying the antibiotic use in human populations by determining antibiotic concentrations in environmental samples

2. IMPACT OF COMMUNITY BASED AMR SURVEILLANCE APPROACHES

Various community-based AMR surveillance studies to monitor trends in AMR and the use of antimicrobials have been conducted and shown its potential to facilitate evidence-based interventions and policy making for control of AMR (Table 1).

The Swedish Strategic Program for the Rational Use of Antimicrobial Agents and Surveillance of Resistance (STRAMA), coordinated by a national steering committee, is targeting surveillance and tracking AMR trends over time, and also aims to reduce antimicrobial use in community by interventions including clinical guidelines, training of prescribers, and consumer education.² The European Surveillance of Antimicrobial Consumption (ESAC) project tracked antibiotic consumption, and developed quality tools to promote rational use of antimicrobials.³ The European Antimicrobial Resistance Surveillance System (EARSS), another system for monitoring AMR trends in community. The SENTRY Antimicrobial Surveillance Program working in 22 countries, is tracking resistance patterns, using a network of sentinel laboratories.⁴ Countries such as Denmark and Spain have databases containing information on antimicrobials prescribed for all patients in the country. Prescription information for various populations and between different provinces of the country are analyzed to determine trends in antimicrobial use at the population level. Majority of environmental surveillance initiatives are from highly income developed countries e.g., JPIAMR,⁵ the Tricycle project,⁶ NARMS (Surface Water AMR Monitoring SWAM),⁷ EARS-net, EARS-vet. There are many challenges to implement such studies in resource constrained settings.

Community based AMR surveillance studies have been targeting human sewage as a source for monitoring AMR and suggest it as an affordable surveillance option in resource-poor settings for AMR surveillance.⁸ The ongoing surveillance for polio eradication program is also following the sewage systems. Various CBS studies from USA, China and Brazil targeted water sources. A pilot study was conducted across six wastewater treatment plants in urban, rural, and remote communities in Canada. Results revealed that urban sites exhibited higher AMR levels and gene diversity compared to remote sites, highlighting the influence of population density on AMR dissemination.

² Mölsted S, Erntell M, Hanberger H, et al. "Sustained reduction of antibiotic use and low bacterial resistance: 10-year follow-up of the Swedish Strama programme". 2008;8(2):125-132.

³ Vander Stichele R H, Elseviers M M, Ferech M, Blot S, Goossens H, "European surveillance of antimicrobial consumption (ESAC): data collection performance and methodological approach". 2004;58(4):419-428.

⁴ De Kraker M, Jarlier V, Monen J, et al. "The changing epidemiology of bacteraemias in Europe: trends from the European Antimicrobial Resistance Surveillance System". 2013;19(9):860-868.

⁵ Do NT, Vu HT, Nguyen CT, et al. "Community-based antibiotic access and use in six low-income and middle-income countries: a mixed-method approach". 2021;9(5):e610-e619.

⁶ Anjum MF, Schmitt H, Börjesson S, et al. "The potential of using *E. coli* as an indicator for the surveillance of antimicrobial resistance (AMR) in the environment". 2021;64:152-158.

⁷ Hashim R, Husin SA, Ahmad N, et al. "Tricycle Project—One Health approach: Whole genome sequencing (WGS) of Extended-spectrum beta-lactamase (ESBL) producing *Escherichia (E.) coli* derived from human, food chain and environment". 2022;116:S105-S106.

⁸ Fresno M, Pavez L, Poblete Y, Cortez A, Del Pozo TJFiM. "Unveiling antimicrobial resistance in Chilean fertilized soils: a One Health perspective on environmental AMR surveillance". 2023;14:1239761.

Table 1

Community based AMR surveillance studies to monitor trends in AMR and use of antimicrobials

Study reference	Study location	Study period	Study objective	Outcome
Javvadi, Y., & Mohan, S. V. Understanding the distribution of antibiotic resistance genes in an urban community using wastewater-based epidemiological approach. <i>Science of the Total Environment</i> , 868, 161419.	India	2023	Monitored the domestic wastewater samples in urban settings	Community's sewage showed positive detection of targeted antibiotic resistance genes, notably aph, aadA1, and strB being particularly abundant. Resistance to aminoglycoside and trimethoprim classes was prevalent, followed by chloramphenicol, sulfonamide, and β -lactams.
Rodriguez-Mozaz S, Vaz-Moreira I, Della Giustina SV, et al. Antibiotic residues in final effluents of European wastewater treatment plants and their impact on the aquatic environment. 2020;140:105733.	Portugal, Spain, Ireland, Cyprus, Germany Finland, and Norway	2020	To monitor the antibiotics in effluent of waste water treatment plants from seven European countries	Within the 53 antibiotics monitored 17 were detected in the final effluent of the WWTPs. The countries exhibiting the highest effluent average concentrations of antibiotics were Ireland, Portugal and Spain, whereas the Norway, Finland, Germany and Cyprus exhibited lower total concentration.
Rahman Z, Liu W, Stapleton L, Kenters N, Dewi DA, Gudes O, Ziochos H, Khan SJ, Power K, McLaws ML, Thomas T. Wastewater-based monitoring reveals geospatial-temporal trends for antibiotic-resistant pathogens in a large urban community. <i>Environmental Pollution</i> . 2023 May 15;325:121403.	Australia	2022	Monitored 25 wastewater treatment plants for the presence of four clinically significant pathogens	ESBL producing <i>Enterobacteriaceae</i> were consistently detected, Isolates for carbapenem-resistant <i>Enterobacteriaceae</i> , vancomycin-resistant enterococci, and methicillin-resistant <i>Staphylococcus aureus</i> were only occasionally detected.

Charles FR, Lim JX, Chen H, Goh SG, He Y, Gin KY-HJSoTTE. Prevalence and characterization of antibiotic resistant bacteria in raw community sewage from diverse urban communities. 2022;825:153926.	Singapore	2022	Compared to the antibiotic resistance profiles of <i>Escherichia coli</i> , <i>Klebsiella pneumoniae</i> , <i>Pseudomonas aeruginosa</i> and <i>Enterococcus</i> spp. from 3 sewage sources: raw community sewage from 2 housing estates, a foreign workers dormitory and a pet center	Multidrug resistant <i>P. aeruginosa</i> and <i>Enterococcus</i> spp. showed the highest prevalence with percentages above 96%. MDR <i>E. coli</i> and MDR <i>K. pneumoniae</i> was lower, ranging between 9% to 54% and 8% to 23% respectively. Highest prevalence of MDR <i>E. coli</i> and <i>K. pneumoniae</i> were detected in the pet center, with a percentage of 54% and 23% respectively.
Asaduzzaman M, Rousham E, Unicomb L, et al. Spatiotemporal distribution of antimicrobial resistant organisms in different water environments in urban and rural settings of Bangladesh. 2022;831:154890	Bangladesh	2022	Integrated survey of AMR was conducted in drinking water, wastewater and surface water (rivers and ponds) in three settings: rural households, rural poultry farms, and urban food markets.	Wastewater had the highest concentrations of ESBL- <i>E. coli</i> , CR- <i>E. coli</i> , <i>bla</i> _{CTXM-1} and <i>bla</i> _{NDM-1} and these were significantly higher in urban compared to rural samples. ESBL- <i>E. coli</i> is ubiquitous in drinking water, wastewater and surface water bodies in both rural and urban areas of Bangladesh. CR- <i>E. coli</i> found at a high prevalence in wastewater discharged from urban food markets and in rural river samples.
Fresno M, Pavez L, Poblete Y, Cortez A, Del Pozo TJFiM. Unveiling antimicrobial resistance in Chilean fertilized soils: a One Health perspective on environmental AMR surveillance. 2023;14:1239761.	Chile	2023	Identified the AMR genes in fertilized soil and manure	Tetracycline and sulfonamide resistance genes had high prevalence in unamended soil, which highlights the potential risk of persistence of resistance genes in soil microbiome and likelihood of spread of AMR over time.
Abejew AA, Wubetu GY, Fenta TGJPo. A six years	Africa (Mozambique, Ghana,	2024	Community based antibiotic access and use	Vietnam and Bangladesh had the largest proportions of

trend analysis of systemic antibiotic consumption in Northwest Ethiopia. 2024;19(1):e0290391.	and South Africa) and Asia (Bangladesh, Vietnam, and Thailand)		practices across communities were assessed in six LMICs	non-licensed antibiotic dispensing points. Self-medication with antibiotics was found to be widespread in Vietnam (55.2% of antibiotics dispensed without prescription, Bangladesh (45.7%), and Ghana (36.1%), but less so in Mozambique (8.0%), South Africa (1.2%), and Thailand (3.9%)
Gutema G, Ali S, Suleman SJPO. Trends of community based systemic antibiotic consumption: Comparative analyses of data from Ethiopia and Norway calls for public health policy actions. 2021;16(5):e0251400	Ethiopia	2020	Community based consumption of systemic antibiotics for Ethiopia has been studied	Community based consumption of systemic antibiotics increased from 11.02 DID in 2016 to 12.83 DID in 2020 in Ethiopia, an increase by 16.4%

The studies on surveillance interventions have proposed various methods for AMR surveillance, including quantitative polymerase chain reaction, next-generation sequencing, liquid chromatography-tandem mass spectrometry, and shotgun metagenomics. While these techniques provide valuable findings, they require specialized equipment and expertise, making them costly and potentially unsuitable for LMICs. However, these methodologies can be adapted to accommodate limited resources by simplifying sampling strategies, utilizing alternative laboratory methods, and leveraging existing healthcare infrastructure. This makes them a feasible, cost-effective and adaptable approach for understanding antibiotic resistance gene distribution in communities. Collaboration with local institutions, consideration of local contexts, and capacity-building programs can also ensure the sustainability and success of such studies.

3. REQUIREMENTS TO ESTABLISH EFFECTIVE COMMUNITY BASED AMR SURVEILLANCE PROGRAM

3.1 Systems Requirement

When planning for community based AMR surveillance, a country should have already established the necessary mechanisms to run the systems efficiently,^{9,10} (Figure 1). There should be an effective **governance mechanism** at the national level that describes the community based AMR surveillance need and its execution. The policies and action plan should be well defined. The coordination mechanism between health authorities, pharmacies, laboratories, and community healthcare providers should be developed. The ethical and regulatory approvals and community engagement strategies should be defined. **Funding mechanisms** should be established for long-term sustainability. If required, partnerships with local organizations, universities, and global health organizations should be enhanced. The **surveillance infrastructure** is required.

For data collection, a network of community health centers, clinics, and pharmacies is needed. A designated sentinel surveillance sites network would be helpful for systematic sample collection. The country should have reference and sentinel **laboratory network** for pathogen identification and antimicrobial susceptibility testing. The laboratories should be following standardized AMR testing protocols (e.g., CLSI, EUCAST guidelines), and should be enrolled in external quality assurance programs. **Data collection, management and analysis** capacities should be established. Ideally, there should be availability of antimicrobial sales or prescriptions records, standardized data collection tools and electronic AMR surveillance databases for real-time data entry and analysis. It should be integrated with health information systems.

Trained healthcare workers, including nurses, pharmacists, and community health workers are required. Laboratory staff should be skilled in microbial culture, Antibiotic Susceptibility Testing (AST), and molecular diagnostics. There should be data analysts and epidemiologists for trend analysis and reporting. Regular data sharing and CBS AMR surveillance reports should be shared with policymakers and healthcare providers. The trend monitoring can help to identify emerging cases and outbreaks.

⁹ McGowan CR, Takahashi E, Romig L, Bertram K, Kadir A, Cummings R, Cardinal LJ. "Community-based surveillance of infectious diseases: a systematic review of drivers of success". *BMJ Global Health*. 2022 Aug 1;7(8):e009934.

¹⁰ Holloway K, Mathai E, Gray A, "Surveillance of community antimicrobial use in resource-constrained settings. Experience from five pilot projects". Community-Based Surveillance of Antimicrobial Use and Resistance in Resource-Constrained Settings Project Group. *Tropical Medicine & International Health*. 2011 Mar;16(3):368-74.

Figure 1

System requirements to establish community based amr surveillance program in LMICs**3.2 Technical Requirements**

Compared to clinical based surveillance which relies on the large hospitals and laboratories, and common pathogen of concern and specimen type, community based AMR surveillance has different implementation requirements. A comprehensive approach to the community surveillance of AMR uses and combines culture techniques, metagenomics, antimicrobial residues and physicochemical samples.¹¹ There is need for development of a standard protocol for sequencing for resistant bacteria from the environment and correct interpretation of the generated data. The correlation of sewage metagenomics data with clinical surveillance can be challenges as the former provides resistome information covering the whole community. However, molecular methods are continuously advancing over time, and it can be possible in the future.

To implement AMR environmental surveillance, *E. coli* could be used as an indicator complementing surveillance in humans and livestock.¹⁰ Using *E. coli* as an indicator for AMR in the environment has some key advantages including comparisons to data from human and animal sectors are possible, analysis are relatively cost-effective, easy to implement, protocols are available. *E. coli* is implemented in a multitude of national surveillance programs with several programs producing integrated national reports with human clinical data, livestock carriage and occurrence on meat-products, with some reports also including and clinical veterinary data. Examples of integrated European national reports are RESAPATH,¹² NethMap¹³ and DANMAP,¹⁴ NARMS,¹⁵ Canada (CIPARS).¹⁶ Currently, there are no standard methods of surveillance of antimicrobial resistance genes or antibiotics in aquatic and

¹¹ <https://iris.who.int/bitstream/handle/10665/375008/9789240074668-eng.pdf>

¹² Daigle J. "Addressing gaps in community-level antimicrobial resistance monitoring through wastewater surveillance". 2024.

¹³ Jouy E, Chauvin C, Chazel M, Roux AI, Madec J, Kempf I. "Evolution of antimicrobial resistance for *E. coli* isolated from diseased poultry", (Résepath). 2011.

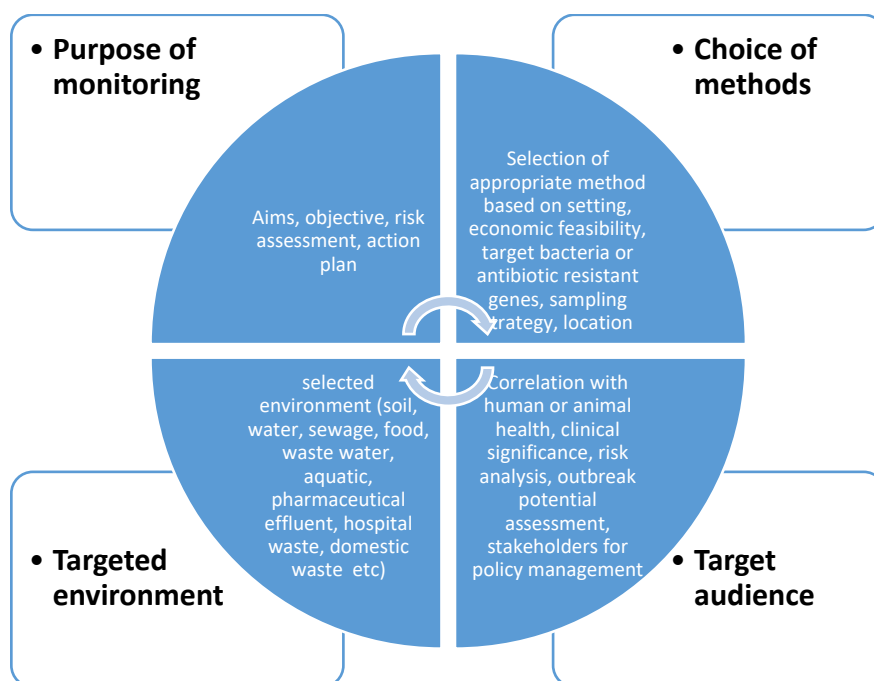
¹⁴ De Greeff S, Schoffelen A, Verduin C. "NethMap 2020: Consumption of antimicrobial agents and antimicrobial resistance among medically important bacteria in the Netherlands in 2019/MARAN 2020: Monitoring of Antimicrobial Resistance and Antibiotic Usage in Animals in the Netherlands in 2019". 2020.

¹⁵ Bager F. "DANMAP: monitoring antimicrobial resistance in Denmark". 2000;14(4):271-274.

¹⁶ White D, Fedorka-Cray P, Chiller C. "The national antimicrobial resistance monitoring system (NARMS)". Paper presented at: NMC-Annual Meeting Proceedings 2006.

terrestrial and sources. Moreover, there are no implemented standards for the removal of antibiotics and antimicrobial resistance genes from these environmental sources.¹⁷ Following can be key considerations for implementing a program for AMR surveillance (Figure 2).

Figure 2
Technical Requirements to Establish Community Based AMR Surveillance in LMICs



¹⁷ Gow S. "Antimicrobial resistance, prudent use, and the Canadian integrated program for antimicrobial resistance surveillance", (CIPARS). 2005.

4. ASSESSING THE READINESS OF LMICs FOR COMMUNITY BASED AMR SURVEILLANCE ESTABLISHMENT

LMICs face a high burden of resistant infections, and there is continuous threat of emerging infections due to various factors that create an enabling environment. Besides clinical AMR surveillance, community AMR surveillance is crucial and needs comprehensive mechanisms (Figure 1). The review of LMICs capacities reveals a dire situation. LMICs lack the necessary systems and resources to establish effective surveillance systems. Specifically, surveillance capacity in hospitals and other health facilities is limited, and the overall human resource capacity for community-level data collection, analysis, and multi-sectoral coordination is severely constrained.

In this context, the recommendation by WHO and quadripartite partners to establish community based AMR surveillance in LMICs appears to be a highly ambitious, if not impractical goal.^{18,19,20} Given the existing gaps in systems, resources, and capacities, it is essential to prioritize enhancing the country's capacities under the required systems and technical requirements, rather than rushing to establish community based AMR surveillance. This strengthening is crucial to ensure that any future efforts to establish community based AMR surveillance are built on a solid foundation, rather than setting up a system that may be collapse due to underlying weaknesses.

Many LMICs continue to face significant challenges in establishing comprehensive AMR surveillance mechanisms. The governance structure for community based AMR surveillance is particularly complex, requiring the coordination of policies, action plans, regulations, and stakeholders, including health authorities, pharmacies, laboratories, and community healthcare providers. A major obstacle is the lack of sustainable funding, as many LMICs have limited health budgets and rely heavily on donor support. Furthermore, the surveillance infrastructure in these countries is often inadequate, with shortages of trained personnel, quality diagnostics, and effective data management systems. The situation is exacerbated by weak and fragmented healthcare systems, the overuse and misuse of antibiotics, and inadequate regulations governing pharmacy practices, ultimately hindering efforts to combat AMR in LMICs.

¹⁸ World Health Organization. "WHO global strategy for containment of antimicrobial resistance". (2001).

¹⁹ Holloway K, Mathai E, Gray A, "Surveillance of community antimicrobial use in resource-constrained settings. Experience from five pilot projects". Community-Based Surveillance of Antimicrobial Use and Resistance in Resource-Constrained Settings Project Group. *Tropical Medicine & International Health*. 2011 Mar;16(3):368-74.

²⁰ World Health Organization. *WHO Outlines 40 Research Priorities on Antimicrobial Resistance*. 2023.

5. CHALLENGES FOR THE IMPLEMENTATION OF COMMUNITY BASED AMR SURVEILLANCE IN LMICS

The healthcare systems in LMICs are struggling to reach standard levels in various areas including strong governance and regulations, surveillance infrastructure, laboratory capacities, skilled human resources, data collection and management, funding and sustainability. The feasibility of community based AMR surveillance implementation is impacted due to these crucial challenges in LMICs. Though community based AMR surveillance being a non-invasive approach seems a rational solution to monitor community-level AMR and use of antimicrobials in LMICs, its implementation needs a comprehensive analysis of the current situation and capacities. Good governance and financial and human resources in LMICs are required. Key challenges in community-based AMR surveillance include establishing adequate sample sizes, maintaining standardized diagnostic protocols, and processing large-scale metagenomic data. AMR analysis from the environmental sources requires specialized techniques and equipment, such as metagenomics and microbiome analysis, which can be resource intensive. The findings generated can be difficult to interpret due to the complex interactions between environmental factors, microorganisms, and AMR genes. Many studies have been conducted and yielded useful findings, yet environmental AMR analysis lacks standardized protocols and quality control measures, which can lead to inconsistencies in data collection and analysis.

The importance of community based AMR surveillance in control of AMR has been recognized and emphasized by various bodies^{21[06]}²² including the United Nations General Assembly 2024[06]. The WHO Global Action Plan (2015) on AMR highlighted the need for surveillance of the AMR genes and use of antibiotics, as it is crucial to addressing the global crisis of infections from antibiotic resistant bacteria. The global database for tracking AMR country self-assessment survey showed development towards the community based environmental AMR surveillance initiatives (²³, 2023)[06]. The survey shows that 29 member countries have a system for regular monitoring (passive surveillance) of antimicrobial compounds and their metabolites (or residues) and resistant bacteria or antimicrobial resistance genes in water, while 139 countries lack such a system. There is a significant disparity in the implementation of regular monitoring systems across different country income groups. Among the 26 low income countries (LICs), only 5 have established regular monitoring systems. In the 44 LMICs, merely 5 have such systems in place.

In the 46 Upper-Middle-Income Countries, 7 countries having regular monitoring systems. Among the 54 High income countries, only 12 have implemented regular monitoring systems, highlighting substantial room for improvement even among developed countries. This shows that awareness needs to be created along with enabling systems to support the surveillance of antimicrobial resistance genes in water systems. 27 out of 171 countries have conducted a national assessment of risks for residues of antimicrobial compounds and antimicrobial resistant pathogens in the environment. 72 out of 166 countries have legislation and/or regulations to prevent contamination of the environment with antimicrobial compounds and their metabolites discharged to the environment. There are 62 out of 70 countries that have legislation and/or regulation and policies to mitigate risks related to disposal of medicines, antimicrobial agents (unused, left-over products and also product containers) for human use.

²¹ <https://www.amrleaders.org/resources/antimicrobial-resistance-and-the-climate-crisis>.

²² <https://www.un.org/pga/wp-content/uploads/sites/108/2024/09/FINAL-Text-AMR-to-PGA.pdf>.

²³ <https://amrcountryprogress.org/#/visualization-view>.

These statistics highlight the urgent need for LICs and LMICs to adopt an active and financially viable strategy for developing CBS AMR systems. These countries need to consider the capacities of their healthcare infrastructure, governance, and human resources to develop community based AMR surveillance. Further qualitative approaches and research are required to develop cost-effective and feasible solutions for community based AMR surveillance in LMICs. International collaborations and knowledge sharing from already established systems can help bridge the gap in implementing CBS AMR surveillance systems in low-income countries.

6. CONCLUSION

The question of how to develop effective strategies for planning and implementing community based AMR surveillance in LMICs considering their complex systems requires greater attention. These should be context-specific solutions, which require consideration of how to ensure their long-term sustainability.

In LMICs, where multiple challenges and a high burden of AMR exist, community based AMR surveillance can help identify areas with high AMR burdens, identify temporal associations between antibiotic use and resistance in different areas, and inform targeted interventions such as antimicrobial stewardship programs and infection control measures. Moreover, promoting community based AMR surveillance can generate community engagement and a sense of responsibility, facilitating behavioral change interventions. By providing valuable data to inform evidence-based policy making, it can guide national and local strategies to combat AMR, contributing to improved health outcomes in LMICs.

Policy makers at national and global level should also recognize that there are significant challenges in establishing clinical AMR surveillance systems in LMICs, let alone advancing to more sophisticated ones like community based AMR surveillance system. The key concerns include limited resources, such as insufficient funding, inadequate infrastructure, and scarcity of skilled personnel, which challenge the development of AMR surveillance systems. Additionally, weak healthcare systems in LMICs, which are often fragmented and under-resourced, struggle to support AMR surveillance efforts. The lack of standardization in data collection, reporting, and analysis methods delays the comparability and reliability of AMR surveillance data. Generating funds for advanced community based AMR surveillance is also a significant challenge. LMICs often face competing demands for limited resources, making it challenging to allocate funds for advanced AMR surveillance systems. The long-term sustainability is also uncertain, as funding may be unpredictable through local health budgets or reliant on external donors. Technology and infrastructure gaps, such as the lack of electronic laboratory information systems, also hinder the development of advanced AMR surveillance systems.

To address these challenges, policy makers must prioritize funding and other resource allocation for defining context-specific priority AMR interventions, including building capacity on AMR surveillance. International collaboration should be promoted to support technical assistance, capacity building, and funding support. Collaboration among governments and local stakeholders is also vital, facilitating the sharing of data, best practices, identifying appropriate legislation, and regulations.

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