Bridging The Gaps In Global AMR Surveillance: A Mini-Review Of Challenges And Innovations

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Abstract:
Antimicrobial resistance (AMR) poses a severe and growing threat to global public health, especially in low- and middle-income countries (LMICs), where inadequate infrastructure, irrational antibiotic use, and weak diagnostic systems persist. This mini-review examines recent developments in AMR surveillance systems and highlights key gaps in Sub-Saharan Africa, South and Southeast Asia, China, and selected high-income nations. Surveillance initiatives like CAPTURA, IEDCR in Bangladesh, CHINET and CARSS in China, and Europe's sexual health clinic networks show both progress and persistent challenges, such as fragmented data collection, insufficient clinical-laboratory integration, and limited financial investment. Despite National Action Plans (NAPs) being formulated, their impact is hindered by poor implementation and capacity gaps. WHO's GLASS program has facilitated standardization but struggles with data from conflict-affected regions. Strengthening digital, harmonized AMR surveillance frameworks and integrating cross-sectoral training and stewardship are necessary. This review underscores the need for sustainable, context-specific approaches to effectively contain AMR.

Keywords: *AMR, Surveillance, LMICs, CAPTURA, GLASS, Stewardship, Health Policy*

I. Introduction

Antimicrobial resistance (AMR) is one of the most pressing public health challenges globally, causing an estimated 1.27 million deaths annually, with LMICs bearing the brunt. Factors such as poor laboratory capacity, unregulated antibiotic use, and inadequate public health policies contribute significantly to the crisis. Surveillance plays a foundational role in addressing AMR; however, it faces multiple barriers, including fragmented data ecosystems and inadequate workforce training. This review aims to explore existing global and regional AMR surveillance programs, identify ongoing challenges, and suggest sustainable solutions.

II. Global AMR Surveillance Initiatives

International efforts have focused on standardizing AMR data collection. The Fleming Fund, funded by the UK government, supports AMR surveillance in Asia and Africa. CAPTURA, launched in 2019, covers over 100 facilities across 12 Asian countries and provides insights into AMR, antimicrobial consumption (AMC), and use (AMU). WHO's GLASS program aggregates global AMR data with emphasis on bloodstream infections and sexually transmitted infections.

Despite these efforts, disparities persist. Bangladesh's IEDCR maintains electronic, case-based AMR data, whereas most CAPTURA sites rely on paper-based systems. This contrast illustrates the need for improved digital infrastructure and consistent practices across facilities.

III. Regional Surveillance Efforts

Sub-Saharan Africa: Hospital-based surveillance in countries like Nigeria and South Africa shows most AMR cases emerge from general medicine departments, making them effective focus points. However, limited diagnostic capacity and poor coordination between medical departments remain significant barriers.(Aruhomukama & Nakabuye, 2023)

South and Southeast Asia: CAPTURA has led regional surveillance efforts. In Bangladesh, the IEDCR's electronic system contrasts with CAPTURA's paper-based data collection, reflecting disparities in infrastructure. Bhutan and Bangladesh have initiated e-learning platforms and local training programs to improve surveillance capabilities.(Holm et al., 2023)

China: China's CHINET and CARSS networks focus on resistance in Gram-negative bacteria. A decline in carbapenem-resistant *Klebsiella pneumoniae* followed stewardship reforms, demonstrating the impact of surveillance-informed policies.(Qin et al., 2024)

Europe (Netherlands): Sexual health clinics identified increasing azithromycin resistance and decreasing cefixime resistance from 2013 to 2019. Behavioral and demographic factors drive these trends, requiring population-targeted interventions.(Visser et al., 2022)

Tanzania and Kuwait: Tanzania employs a One Health approach integrating human and animal AMR data. However, underfunding and the absence of costed NAPs hinder progress. Kuwait has restricted OTC antibiotics and adheres to international guidelines, but lacks local public awareness initiatives.(Neema et al., 2023; Torumkuney et al., 2022)

WHO GLASS Program: GLASS aggregates standardized AMR data globally but faces challenges like underrepresentation of conflict zones and weak infection prevention and control (IPC) systems in LMICs.(Moghnieh et al., 2025)

Bangladesh Case Study: IEDCR collected 16,816 electronic case-based entries, while CAPTURA compiled over a million records manually. CAPTURA sites lacked integration with patient data, highlighting a need for digitization and improved data quality protocols.(Sujan et al., 2023)

WHO-SEAR Perspective: All 11 WHO-SEAR countries have adopted NAPs; however, drug resistance remains high due to limited financial support, regulatory weaknesses, and COVID-19 setbacks.(Bahl et al., 2023)

India-Specific Challenges: India's dense population, high disease burden, and variable healthcare practices exacerbate AMR. Without strong regulation and improved diagnostics, infections could become untreatable. India's success in AMR containment is vital to global public health.(Sharma et al., 2023)

IV.   Challenges In AMR Surveillance

AMR surveillance is hampered by numerous systemic and structural barriers. One significant challenge is the fragmented data infrastructure, with institutions operating on both paper and digital systems, leading to inconsistencies in data collection and reporting. Additionally, there is often weak integration between laboratory results and clinical records, which undermines comprehensive analysis. Many LMICs face a critical shortage of trained personnel capable of managing surveillance data. Moreover, financial and technical constraints obstruct the effective implementation of National Action Plans (NAPs). Compounding these issues are inadequate infection prevention and control (IPC) measures and lax enforcement of antibiotic stewardship protocols.(Meštrović et al., 2023)

V.   Innovations And Solutions

Adopting platforms like WHONET and digital dashboards can streamline AMR reporting. Mobile-based data collection, virtual training modules, and One Health integration can strengthen capacity. Policies should be tailored to local contexts, and antibiotic R&D must be incentivized. Country-specific guidelines should be developed based on surveillance data to promote rational antibiotic usage.

VI.   Summary Table

Region/Country	Initiatives/Projects	Key Findings	Challenges
SSA (Nigeria, SA)	Hospital surveillance	Targeting general medicine is cost-effective	Poor diagnostics; limited collaboration
South/Southeast Asia	CAPTURA	Data from 100+ sites; electronic vs. manual methods	Inconsistent data; poor lab-clinical linkage
Bangladesh	IEDCR, CAPTURA	Digital case-based (IEDCR); paper-based (CAPTURA)	Quality variation; lack of data integration
China	CHINET, CARSS	Resistance patterns tracked; success post-reforms	Policy sustainability challenges
Europe (Netherlands)	Sexual Health Clinics	Changing resistance trends; improved surveillance	Regional variation; extra-genital gaps
Tanzania	One Health	Human-animal sector integration	Funding gaps; no costed plans
Kuwait	Policy & Awareness	Limited OTC antibiotic sales; international alignment	Public awareness lacking
Global (WHO GLASS)	GLASS database	Global resistance data platform	Conflict-zone underrepresentation

Table-01 Summary of Antimicrobial Resistance (AMR) Surveillance Efforts, Key Findings, and Challenges

VII.   Future Perspectives

Investments must prioritize costed NAPs and scalable digital infrastructure. Regional socio-political contexts should be considered for sustainability. Multidisciplinary collaborations across microbiology, public health, and social sciences can address both biological and behavioral dimensions of AMR. Regular antibiotic usage audits will aid targeted policymaking.

VIII.   Conclusion

AMR surveillance has progressed significantly, but disparities in funding, infrastructure, and trained personnel remain. Implementing harmonized, digital, and context-sensitive models supported by strong stewardship and community engagement is essential for containing antimicrobial resistance globally.

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