



Strengthening AMR surveillance systems using a One Health approach in Ghana

Formative Evidence Brief for Policy from the RADAAR (IVI)–EVIPNet (WHO) Initiative



Formative Evidence Brief for Policy

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ABBREVIATIONS AND ACRONYMS

AMR: antimicrobial resistance

AMS: antimicrobial stewardship meetings

AMU: Antimicrobial Use

ASP: Antimicrobial Stewardship Programme

EBP: evidence brief for policy

EPA: Environmental Protection Agency

ESBL: extended spectrum beta-lactamase

FAO: Food and Agricultural Organization

GHS: Ghana Health Service

GLASS: Global Antimicrobial Resistance and Use Surveillance System

HIV/AIDS: human immunodeficiency virus/acquired immune deficiency syndrome

IDSR: Integrated Disease Surveillance and Response

IPC: infection prevention and control

MEST: Ministry of Environment, Science, Technology

MoFA: Ministry of Food and Agriculture

MoH: Ministry of Health

MRSA: methicillin resistant *Staphylococcus aureus*

NISS: National Integrated Surveillance System

OAHN: Ontario Animal Health Network

OTC: over the counter

RADAAR: Regional AMR Data Analysis for Advocacy Response and Policy

SMART: Study for Monitoring AMR Trends

UNEP: United Nations Environment Programme

VSD: Veterinary Services Directorate

WHO: World Health Organization

WOAH: World Organization for Animal Health

KEY MESSAGES

- AMR poses a greater combined mortality burden in Ghana than malaria and HIV/AIDS.
- Strengthened surveillance across human, animal, and environmental sectors is critical to detect, prevent, and control resistance.
- Implementation of integrated surveillance and feedback systems will enhance data quality, guide treatment policies, and align Ghana with global standards (GLASS/WOAH).
- Sustained domestic financing and governance coordination are vital for long-term success.

EXECUTIVE SUMMARY

In 2019 alone, antimicrobial resistance (AMR) caused an estimated 5,900 deaths directly and 25,300 deaths indirectly in Ghana. The burden of AMR and related mortality in Ghana surpasses those from malaria, HIV/AIDS and other major infectious diseases combined.

Ghana's AMR problem is compounded by limited laboratory capacity, poor data management, inadequate health-care infrastructure and fragmented governance. Without urgent action, AMR will continue to drive increased treatment failures, health-care costs, food insecurity and greater mortality.

This Evidence Brief for Policy (EBP) aims to inform Ghanaian policymakers, technical partners, and stakeholders about feasible and cost-effective policy options to strengthen AMR surveillance under the One Health approach. It synthesizes global and national research evidence to support evidence-informed decision-making and prioritization within Ghana's AMR National Action Plan.

This EBP outlines four priority interventions to strengthen Ghana's AMR surveillance using a One Health approach. These are as follows.

- The development of a robust national integrated AMR surveillance system, including genomic surveillance
- The establishment of a national AMR laboratory network
- The implementation of harmonized and standardized surveillance protocols
- The creation of structured feedback forums to translate surveillance data into treatment guidelines, antimicrobial use (AMU) policies and public education campaigns

The benefits, risks, costs and feasibility of each policy options were analysed, indicating that integrated surveillance can improve early detection, prompt clinical decision-making, and support policy alignment with international standards.

1. EBP DEVELOPMENT APPROACH AND METHODOLOGY

This EBP entailed the use of global and local research evidence about the problem. It offers options for addressing the problem and outlines key implementation considerations. Evidence was retrieved from systematic/literature reviews and primary research studies.

The preparation of the EBP entailed following key steps.

1	Convening a core technical working group team that was responsible for writing the EBP, comprising representatives from the Ministry of Health (MoH), Veterinary Services Directorate (VSD), Fisheries commission, Environmental Protection Agency (EPA), Plant Protection and Regulatory Services, Fleming Fund Fellowship and the Aurum Institute.
2	Convening a steering committee with representatives from the MoH, World Health Organization (WHO), Ghana Health Services (GHS), University of Health and Allied Sciences, EPA, University of Ghana, and the Fisheries Commission.
3	Developing and refining the options for addressing the problem.
4	Identifying, selecting and synthesizing relevant research evidence about the problem, synthesizing options for solutions and counterstrategies to implementation barriers.
5	Developing and finalizing the EBP based on the input of the steering committee and reviewers.

These steps entailed several in-person and virtual meetings of selected core and steering committee members of the Technical Working Group (TWG).

2. DESCRIPTION OF THE PROBLEM

Ghana faces a mounting threat from AMR, which undermines progress toward Universal Health Coverage and national health security. The emergence and spread of resistant infections now threaten to reverse gains in infectious-disease control and food safety.

Microorganisms have become increasingly resistant to drugs (antimicrobials) designed to kill or inhibit their growth, threatening the effective prevention and treatment of the myriad infections and diseases they cause (1,2).

AMR is a growing global public health threat, with sub-Saharan African countries, including Ghana, bearing the highest burden (3,4). Ghana recorded 5,900 attributable deaths and 25,300 associated deaths from AMR in 2019 (5) and is ranked as the 36th highest age-standardized mortality rate per 100,000 population associated with AMR across 204 countries. Additionally, the number of AMR-related deaths in Ghana is reportedly higher than deaths from neglected tropical diseases, malaria, HIV/AIDS, sexually transmitted diseases and other infectious conditions combined (5).

AMR can be transmitted from animals and the environment to humans (6,7), which adds another layer of threat to an already existing serious challenge. Livestock traded within the sub-Saharan African region, including Ghana, have been shown to be contaminated with microbes with significant levels of resistance to common antibiotics (3,8,9), while antibiotic residues have been found in the environment such as dumpsites, hospital effluents and municipal water works, posing significant risk to both the aquatic and terrestrial ecosystem, including life and plants (10,11).

For sustainable impact and long-term success, the fight against AMR must be tackled from a One Health perspective, ensuring that surveillance is done with data from humans, animals, food sources and the environment (12). Although Ghana has made efforts in the implementation of AMR surveillance through initiatives, including the Integrated Disease Surveillance and Response (IDSR) strategy, development of an AMR National Action Plan, and an Integrated AMR surveillance framework, there are still some challenges. Ghana participates in the WHO Global Antimicrobial Resistance and Use Surveillance System (GLASS) and has developed a national AMR Surveillance Framework in 2024. However, data reporting remains limited to a few sentinel laboratories, and integration with animal and environmental surveillance is still nascent. Strengthening coordination between existing frameworks and GLASS reporting is therefore essential for global comparability and sustainability. Surveillance systems in the human health, animal health and environment

sectors are mainly siloed, impacting a coordinated response and effective policy development. Limited laboratory capacity, inadequate infrastructure, including laboratory equipment, and poor data management, among others, are some of the challenges that have hindered the establishment of a robust integrated AMR surveillance system, impeding the country's ability to comprehensively monitor and respond to AMR threats across sectors (13). If these are not sufficiently addressed, AMR-related deaths in Ghana are likely to continue to escalate with increased morbidity, longer hospital stays and higher health-care costs (14).

Consequences of inaction

Without coordinated multisectoral action, Ghana faces escalating health, economic, and agricultural losses due to AMR. The consequences can be grouped under human health, economic, food security, and innovation domains.

- 1. Increased treatment failure:** with doctors prescribing ineffective antibiotics due to a lack of necessary information on local resistance, leading to unnecessary deaths and prolonged illnesses. The mortality rates attributable to AMR in western sub-Saharan Africa are estimated to be between 20.9 to 35.3 per 100,000 population (4, 15).
- 2. Rising health-care costs:** necessitating patients' longer hospital stays and more expensive second- or third-line antibiotics when first-line treatments fail. The annual additional cost of AMR in teaching hospitals in Ghana is approximately US\$ 650,000 per hospital (16), while the annual patient cost due to AMR is up to an estimated US\$ 1 million and US\$ 1.4 million more when compared with susceptible and uninfected patients, respectively (17).
- 3. Increased emergence and spread of new resistance patterns:** potentially leading to large-scale outbreaks before they can be detected and contained (18).
- 4. Barriers to innovation:** the development of new antibiotics and treatment strategies will be hampered by insufficient data on existing resistance patterns and their evolution. Without data, it is difficult to anticipate the evolution of resistance, making it challenging to develop strategies to prevent the emergence of new resistant strains (19).
- 5. Threats to food security:** medication failure in poultry and livestock production will lead to disease outbreak and high mortality, and reduced productivity, ultimately threatening food security by decreasing the availability of animal-source foods (20).

6. **Higher cost of animal production:** due to increase in cost of treatments, cost of veterinary services and more days for animals staying on the farm for a withdrawal period before sales or slaughter (18).
7. **Compromised food safety and cross-sectoral risk:** zoonotic AMR pathogens from improperly monitored animal products, especially at slaughterhouse and retail levels, pose a direct threat to human health and food safety (21).
8. **Escalation of high-risk resistance patterns:** such as extended-spectrum beta-lactamase (ESBL) producers and methicillin-resistant *Staphylococcus aureus* (MRSA), contribute to high rates of surgical site infections and mortality, especially in neonates and immunocompromised individuals (22).

In summary, continued inaction will increase mortality and treatment failure, raise health-care costs, and weaken food security. The cumulative effects will erode public trust in the health system and jeopardize Ghana’s ability to achieve SDG 3 on good health and well-being.

Table 1. Underlying causes of the problem

System arrangements	Governance arrangement
	<ol style="list-style-type: none"> 1. Limited laboratory infrastructure and equipment for testing and analysis. Many health and veterinary facilities lack advanced diagnostic tools, including antimicrobial susceptibility testing systems (23,24). 2. Inadequate number of trained microbiologists and laboratory technicians. Capacity-building programmes are insufficient, and public sector laboratories face high staff turnover without replacement (23,24). 3. Absence of standardized testing methods across facilities and regions. Laboratories use diverse protocols, leading to inconsistent results, making data aggregation unreliable (23,24). 4. Limited coordination between human health, animal health, and environmental sectors. Ministries and agencies often work in silos. The Ontario Animal Health Network (OAHN) provides a

replicable model, highlighting how shared governance and joint data reviews can improve response (23,25).

5. Low prioritization of AMR surveillance in the national health agenda. Competing priorities dominate the policy and funding space. AMR surveillance lacks sustained advocacy and political buy-in (26).
6. Regulatory gaps in enforcing surveillance requirements. There are no legal mandates for private laboratories or veterinary facilities to report resistance data (21).
7. Limited use of standardized software (e.g. WHONET), causing gaps in data capture and analysis (27,28).
8. Limited research and national-level surveillance data. Existing studies are very few and of poor quality. There is also no system of quality assurance in laboratories, which affects the reliability of the data that exists (22,24).

Financial arrangement

1. Insufficient funding for ongoing surveillance programmes. Efforts rely heavily on short-term donor funding. There is no dedicated budget line for AMR surveillance in most Ministry plans (29).
2. High costs of maintaining quality control systems. Routine internal and external quality assessments are either absent or irregular in laboratories (30).

Delivery arrangement

1. Poor laboratory quality management systems. Weak sample tracking, delayed reporting, and lack of proficiency testing compromise data validity (27).
2. Difficulties in collecting and transporting samples, especially in remote areas. Inadequate transport systems and power outages disrupt specimen cold chains (31).
3. Capacity gaps in the use of behaviour change models like COM-B and audit-feedback mechanisms (31), inconsistent antibiotic sensitivity testing (AST) practices and low-quality control (27).
4. Weak digitization. Many sites rely on handwritten registers and data are deleted every 6 months (28).

5. Inadequate training and behaviour change interventions for veterinary professionals and farmers (32).
6. Easy access to veterinary medications by farmers without prescription, which makes farmers resort to self-medication instead of seeking veterinary advice (32).

Degree of implementation of an agreed-upon course of action

- The existing AMR National Action Plan prioritizes surveillance: however, surveillance activities have not been fully implemented (33).
- Lack of a harmonized AMR surveillance system and insufficient information technology (IT) infrastructure impede the integration of AMR data across institutions (15,25).

The underlying causes summarized above underscore the need for a whole-of-government and a people-centred approach to integrating governance reforms, financing mechanisms, laboratory capacity-building, and behavioral change interventions.

3. POLICY OPTIONS TO ADDRESS THE PROBLEM

The four policy options presented below are complementary and jointly contribute toward the establishment of a National Integrated Surveillance System (NISS) for in Ghana (Table 2). Their coordinated implementation would ensure cross-sectoral data flow and evidence-based decision-making in line with WHO and One Health guidance.

Table 2. Four policy options/elements to address the problem

Option 1	Develop a robust national integrated AMR surveillance system, including genomic surveillance
Option 2	Establish an AMR laboratory network (sentinel sites and reference laboratories) to enhance surveillance from the environment, human health and animal health sectors
Option 3	Establish harmonized/standardized surveillance protocols
Option 4	Develop feedback forums where surveillance data influence public health decisions and outcomes

Policy option 1

Develop a robust national integrated AMR surveillance system, including genomic surveillance

Overview and context

Ghana's fragmented AMR surveillance system makes it impossible to clarify the connections between environmental, animal and human AMR (3). Additionally, logbooks and Excel templates are frequently used for data entry, which makes data analysis laborious and time-consuming and increases the likelihood of human error and underreporting.

A robust NISS will ensure real-time detection of AMR and help in early intervention and policy decision-making (34-36).

The proposed NISS will build upon Ghana’s existing AMR Surveillance Framework and GLASS participation, using interoperable data platforms to connect human, animal, and environmental laboratories. The AMR Secretariat within the Ministry of Health could serve as the national coordination node, with the Veterinary Services Directorate, EPA, and Fisheries Commission as key implementing partners.

Evidence of impact

The benefits of an integrated national surveillance system were supported by at least eight scoping reviews and two primary studies to include early detection, better quality AMR data, and improved One Health collaboration of AMR-related activities as highlighted in **Table 3**.

Table 3. Summary of key findings from literature/scoping reviews and primary studies relevant to policy option 1

Category	Key findings
<p>Benefits</p>	<ul style="list-style-type: none"> ● At least three literature reviews and one primary study showed that NISS provides comprehensive data on AMR trends, allows for real-time detection of resistant strains and easy access to real-time information by health-care providers resulting in improved health outcomes (15,34,35,37). ● At least two reviews found that NISS allows for the provision of quality data for AMR policy decision-making, including antimicrobial use restrictions and infection prevention (36,38). ● Development of a NISS aligns with international standards such as the Global Antimicrobial Resistance and Use Surveillance System (GLASS), Study for Monitoring Antimicrobial Resistance Trends (SMART) and Fleming Fund-supported models (15). ● A conceptual framework indicated that NISS will improve One Health collaboration of AMR-related activities (39). ● One scoping review and conceptual framework each indicated that a NISS strengthens laboratory systems, surveillance network and IT infrastructure (40,41). ● A scoping review and primary study indicated reduced empirical prescribing, cost savings from

	<p>early containment, and improved policy precision as some of the long-term benefits of a NISS (15,25).</p>
Potential harms	<ul style="list-style-type: none"> • There are data gaps due to uneven implementation or lack of interoperability (27). • Ethical/legal issues may occur with data-sharing across the public and private sectors (21). • High implementation complexity is required and a need for technical expertise (40). • There is a risk of data misinterpretation or misuse if not properly managed (42,43).
Cost and/or cost–effectiveness in relation to the status quo	<ul style="list-style-type: none"> • Upfront investment is needed in laboratory upgrades, cloud-based dashboards, genomic sequencing equipment and human capacity development (44). • Initial investment in infrastructure, training and technology can be high (43). • Potential exists for funding support from international organizations (45). • It is more cost-effective than fragmented, uncoordinated surveillance efforts (45).
Uncertainty regarding benefits and potential harms	<ul style="list-style-type: none"> • Effectiveness depends on sustained funding, trained personnel and enforcement. Requires robust monitoring and evaluation mechanisms to track data quality and usage (44). • Effectiveness depends on level of collaboration among the different health sectors (43). • Effectiveness depends on the quality and timeliness of data collection and reporting (46,47). • Variability in implementation across regions could affect outcomes. Requires continuous evaluation to adapt to emerging AMR trends (46,48).
Stakeholders’ views	<ul style="list-style-type: none"> • Public sector: advocates stronger regulation, integrated One Health governance and cross-sectoral data exchange (49). • Pharmaceutical industry stakeholders might have mixed views depending on the implications of

antibiotic use as their aim is to drive use/sales leading to more profit (50).

- Private laboratories: seek technical guidance, conduct capacity-building and install data capture systems, e.g., WHONET integration (27).
- There is a need for sustained funding to support national surveillance programmes (46,51).
- Public health authorities and health-care providers generally support improved AMR surveillance (30,49).
- International Health Organizations (WHO, Food and Agriculture Organization [FAO], World Organisation for Animal Health [WOAH]) advocate for integrated AMR surveillance (30,52).
- Civil society and consumer advocacy groups may push for greater transparency in AMR data (53).

Proposed Implementation Roadmap

- Advocate for the passing of the national One Health policy which integrates the AMR policy and other One Health-related issues
- Establish an inter-ministerial AMR Surveillance Task Force under the One Health Platform.
- Integrate WHONET/GLASS modules within national laboratory information systems.
- Introduce routine data-sharing agreements between public and private laboratories.
- Develop a sustainability plan integrating an AMR surveillance budget line within MoH, MoFA and MEST annual plans.

Policy option 2

Establish an AMR laboratory network (sentinel sites and reference laboratories) to enhance surveillance from the environment, human health and animal health sectors

Overview and context

The absence of a laboratory network of existing laboratories continues to perpetuate the fragmentation of AMR surveillance. Evidence suggests that the establishment of a laboratory network not only ensures standardization but also the availability of quality AMR data to guide policy (40,54).

The network should adopt a tiered structure composed of a National Reference Laboratory, regional sentinel laboratories, and district peripheral facilities. This hierarchy would facilitate quality assurance, mentorship, and regular data flow to the NISS. Participation in regional External Quality Assessment schemes should be institutionalized to ensure comparability and reliability of results.

Evidence of impact

Table 4 shows the findings from two literature reviews, one primary study and two research commentaries that provide evidence of the benefits in establishing an AMR laboratory network.

Table 4. Summary of key findings from the literature review, research commentaries and primary study relevant to policy option 2

Category	Key findings
Benefits	<ul style="list-style-type: none">• A primary study shows that the establishment of a laboratory network ensures the availability and continuous generation of quality AMR data from selected laboratories for AMR surveillance (54).• A network ensures the availability of quality One Health AMR data across the animal, environmental and human health sectors to guide policy as shown by one literature review and two research commentaries (40,55,56).• The establishment of a laboratory network that includes guidance from a national reference laboratory ensures standardization of procedures across all selected laboratories,

	<p>as evidenced by one research commentary and one primary study (40,54).</p> <ul style="list-style-type: none"> • One primary study showed that the establishment of a laboratory network enables timely feedback to clinicians, leading to informed treatment choices and promotes appropriate antibiotic use to limit the development of resistance (57).
Potential harms	<ul style="list-style-type: none"> • There is poor harmonization of AMR laboratory techniques within and across different sectors (54,58). • Disparity exists in the availability of resources needed for routine AMR surveillance across the different sectors (24,41). • There are differences in priority pathogens from sector to sector (26). • The northern portions of the country contribute poorly due to relatively low capacity (59).
Cost and/or cost-effectiveness in relation to the status quo	<ul style="list-style-type: none"> • Investment is needed in laboratory upgrades and human capacity development (24,44).
Uncertainty regarding benefits and potential harm	<ul style="list-style-type: none"> • Effectiveness depends on the quality and timeliness of data collection and reporting (46,47). • Variability in implementation across sectors could affect outcomes (24,41).
Stakeholders' views	<ul style="list-style-type: none"> • Private laboratories: they are concerned about technical guidance, capacity-building and data integration (27). • Stakeholders across One Health sectors recommend the establishment of a functional subcommittee to steer and coordinate the laboratory network (60). • Empower local authorities in animal health surveillance (60). • Improve public-private partnerships for the surveillance network (60).

Policy option 3

Establish harmonized/standardized surveillance protocols

Overview and context

The fragmented nature of AMR surveillance in Ghana means that there is a lack of standardized surveillance protocols, which undermines representativeness, reliability and integration of AMR data (3). Additionally, the use of harmonized protocols will aid the detection of gaps across surveillance sites (61).

Harmonization of protocols should align with Quadripartite (FAO, WHO, WOA, United Nations Environment Programme [UNEP]) guidance and monitoring tools to enable comparability at regional and global levels. Cross training sessions for laboratory and surveillance officers from all sectors should accompany the adoption of new protocols.

Evidence of impact

Table 5 shows the findings from one systematic review, three literature reviews and three primary studies that portray the benefits in establishing harmonized/standardized surveillance protocols.

Table 5. Summary of key findings from systematic/literature reviews and primary studies relevant to policy option 3

Category	Key findings
Benefits	<ul style="list-style-type: none">• Two primary studies indicated that standardized protocols improve the consistency and comparability of AMR data across sectors and regions (27,28).• Surveillance protocols facilitate integration into national and global surveillance systems like GLASS (47).• Two reviews showed that the establishment of standardized protocols enhances the ability to detect resistance trends, enabling a timely response (15,30).• Standardized protocols promote multisectoral collaboration by establishing common standards and methods (26).• Evidence for policy and public health decision-making is strengthened (36).• Enables accurate data aggregation and analysis for targeted interventions (54).

	<ul style="list-style-type: none"> • A systematic review and narrative review showed the cost-effectiveness of the use of standardized surveillance protocols through reduced duplication, improved coordination and improved quality of data (30,45).
Potential harms	<ul style="list-style-type: none"> • There is a possibility of excluding small laboratories due to their inability to meet protocols, leading to data gaps (28). • There may be overreliance on standardized data while neglecting contextual differences (42).
Cost and/or cost-effectiveness in relation to the status quo	<ul style="list-style-type: none"> • Moderate costs are needed for developing national protocols, validation, training and dissemination (27,54). • The costs are lower than establishing new infrastructure; this builds on existing systems (29,51). • Potential for international funding support is there if aligned with One Health and GLASS (51).
Uncertainty regarding benefits and potential harms	<ul style="list-style-type: none"> • Impact depends on enforcement of adherence to protocols across the public and private sectors (41). • Variability in uptake and technical readiness of laboratories could hinder standardization (30). • There is a need for robust monitoring to evaluate protocol compliance and effectiveness (44,46). • Lack of quality control mechanisms in some laboratories may undermine data reliability (13).
Stakeholders' views	<ul style="list-style-type: none"> • Public health authorities are supportive of standardization to improve surveillance quality (37). • Veterinary and environmental sectors support harmonization but request cross-training (23). • Private laboratories: they are concerned about cost and capacity to comply with new protocols (27). • International partners (WHO, FAO, WAOH/OIE) are strongly supportive due to alignment with global standards (52). • Donors and technical partners are willing to fund initiatives with structured implementation frameworks (51).

Policy option 4

Develop feedback forums to share surveillance data and influence public health decisions and outcomes

Overview and context

Feedback forums exist at institutional levels for the human health, animal health and environment sectors where AMR data are shared at meetings such as clinical meetings, antimicrobial stewardship (AMS) committee meetings and infection prevention and control (IPC) meetings. These have been shown to promote better prescribing practices and responsible use of antimicrobials (3,62,63). However, for data to inform national public health decisions and outcomes, a system for data-sharing from a One Health perspective must be encouraged (64).

A national feedback mechanism should be anchored in the AMR Secretariat and linked to the National One Health Committee and the AMR Platform. Regular quarterly data-sharing meetings can be institutionalized between human, veterinary, and environmental surveillance units, with outputs disseminated through clinical meetings, dashboards, and national bulletins.

Evidence of impact

Evidence was found from three systematic reviews and five primary studies on the benefit of developing feedback forums that influence public health decisions and outcomes (**Table 6**).

Table 6. Summary of key findings from systematic/literature reviews and primary studies relevant to policy option 4

Category	Key findings
Benefits	<ul style="list-style-type: none">• A systematic review showed that dissemination of Ghana's AMR surveillance data to prescribers can guide them to prescribe antibiotics that are effective against locally prevalent resistant strains. This reduces empirical prescribing and promotes precision medicine, especially in rural areas where resistance rates are high due to limited education and access (3).• Ghana's AMR surveillance data can guide the development and review of treatment guidelines for the animal health sector (65).

	<ul style="list-style-type: none"> ● One systematic review and one primary study showed that the development of feedback forums through data-driven prescribing, peer learning and policy reinforcement could help bridge the gap between surveillance data and clinical practice (62,66). ● Two systematic reviews showed that feedback based on guidelines through surveillance can significantly reduce antimicrobial use (AMU) levels and shift patterns toward more responsible use in livestock, companion animals and change farm personnel's behaviour from the use of antibiotics for non-therapeutic purposes (63,67). ● AMR surveillance feedback forums can tailor public campaigns using real data to address misconceptions and promote responsible antibiotic use (68). ● One systematic review and one primary study indicated that Ghana's One Health AMR platform can use feedback forums to integrate surveillance data from all sectors, improving national coordination (3,69).
Potential harms	<ul style="list-style-type: none"> ● Quality or incomplete data risk: inaccurate or missing data can lead to flawed conclusions, resulting in inappropriate AMU policies or treatment guidelines (70,71). ● Inaccurate or incomplete surveillance data, overgeneralization from narrow datasets and delayed updates can lead to misguided treatment guidelines and AMU policies. When hospital-based data are applied to community settings without proper adjustments, or when resistance trends are not promptly reflected in guidelines, interventions risk being misaligned and treatments rendered ineffective (72). ● Clinical risks such as restricted access to necessary antimicrobials, undertreatment or reliance on less effective alternatives can arise from antimicrobial stewardship programme (ASP) interventions. While reviews of ASPs generally report positive average outcomes, they also caution against unintended safety issues, particularly treatment delays associated with preauthorization requirements (71-73).
Cost and/or cost-effectiveness in relation to the status quo	<ul style="list-style-type: none"> ● Financial investment is needed in setting up and maintaining feedback forums and communication channels (74). ● Training costs are needed for stakeholders in interpreting and applying surveillance data (75).

Uncertainty regarding benefits and potential harms	<ul style="list-style-type: none">● Effectiveness depends on the quality and timeliness of surveillance data (49).
Stakeholders' views	<ul style="list-style-type: none">● Health-care providers may welcome improved guidance but could be cautious about changes to prescribing practices (76).● Policymakers are likely to support evidence-based interventions but concerned about cost and sustainability (77).● The pharmaceutical sector may express mixed views due to potential reduction in antibiotic sales (78).

4. IMPLEMENTATION CONSIDERATIONS

Successful implementation of the proposed policy options will require coordinated multi-sectoral planning, sustainable domestic financing, and robust monitoring and evaluation (M&E) mechanisms. The following tables present the key barriers that may influence implementation and the corresponding counter strategies.

Policy option 1

Develop a robust national integrated AMR surveillance system, including genomic surveillance

Table 7. Barriers to policy option 1 and corresponding counter strategies

Level	Barriers	Counterstrategies
Patient/ Farmer	<ul style="list-style-type: none"> • There may be pressure from patients demanding antibiotics and high use of antibiotics by farmers in animal feed (79-81). • Overreliance may be placed on empirical treatment due to limited diagnostic tools (82). 	<ul style="list-style-type: none"> • Conduct public education campaigns using radio, TV and social media (83). • Improve diagnostic capacity with rapid testing kits (84). • Carry out community-based interventions to promote rational antibiotic use (85).
Professional	<ul style="list-style-type: none"> • There is weak enforcement of antibiotic regulations in pharmacies and hospitals, and the veterinary sector (86). • Funding for AMR surveillance and control programmes is limited (87,88). • Data collection is fragmented, and reporting systems are poor (45). 	<ul style="list-style-type: none"> • Conduct continuing medical education programmes on AMR and responsible prescribing (89). • Enforce strict guidelines for antibiotic prescriptions (90).
Organization	<ul style="list-style-type: none"> • Weak governance and coordination among the health sectors (91). • The supply of quality-assured antibiotics is insufficient (92). 	<ul style="list-style-type: none"> • Strengthen regulatory frameworks with penalties for non-compliance (93).

	<ul style="list-style-type: none"> Laboratory infrastructure for AMR surveillance is limited (30,59). 	<ul style="list-style-type: none"> Increase government and donor funding for AMR programmes (94). Develop standardized data collection systems and reporting mechanisms (54).
System	<ul style="list-style-type: none"> Weak governance and coordination among health sectors (91,95). Insufficient supply of quality-assured antibiotics (92). Limited laboratory infrastructure for AMR surveillance (30,59). 	<ul style="list-style-type: none"> Establish a national AMR task force to coordinate policies (31). Implement supply chain management systems to prevent shortages (93). Invest in laboratory capacity-building and diagnostic technologies (59).

Policy option 2

Establish an AMR laboratory network (sentinel sites and reference laboratories) to enhance surveillance from the environment, human health and animal health sectors

Table 8. Barriers to policy option 2 and corresponding counter strategies

Level	Barriers	Counterstrategies
Patient/ Farmer	<ul style="list-style-type: none"> There is poor patronage of laboratory services by individuals and farmers (59). 	<ul style="list-style-type: none"> Encourage patronage of laboratory services with awareness creation campaigns and introduction of laboratory subsidies for groups of interest (21,59). Improve public accessibility to data to encourage interest in AMR surveillance (21,59).

Professional	<ul style="list-style-type: none"> • There are challenges in capacity-building and training (21). 	<ul style="list-style-type: none"> • Invest in laboratory capacity-building and diagnostic technologies (21,59).
Organization	<ul style="list-style-type: none"> • Governance and coordination among health sectors is weak (91). • There are challenges with supply chain management of necessary laboratory reagents (30,82). • Laboratory quality management standards among sectors are poor (41). • Data collection and reporting systems are weak (54). 	<ul style="list-style-type: none"> • Establish a national AMR task force to coordinate policies (31). • Implement supply chain management systems to prevent shortages (93). • Invest in a laboratory quality management system geared towards accreditation (59). • Develop standardized data collection systems and reporting mechanisms (54).
System	<ul style="list-style-type: none"> • Weak governance and coordination among health sectors (91,95). • Laboratory infrastructure for AMR surveillance is limited (30,59). 	<ul style="list-style-type: none"> • Establish a national AMR task force to coordinate policies (31). • Invest in laboratory capacity-building and diagnostic technologies (59).

Policy option 3

Establish harmonized/standardized surveillance protocols

Table 9. Barriers to policy option 3 and corresponding counter strategies

Level	Barriers	Counterstrategies
Patient/ General public	<ul style="list-style-type: none"> • There are limited awareness of AMR and its implications (96). • There are misconceptions about the purpose of AMR surveillance (e.g. fear of data misuse) (97). 	<ul style="list-style-type: none"> • Conduct community-focused education using radio and TV in the local languages (83). • Involve community leaders and civil society in advocacy (53,99).

	<ul style="list-style-type: none"> ● Trust is low in public institutions managing surveillance data (98). 	<ul style="list-style-type: none"> ● Incorporate AMR into routine public health education and outreach programmes (100).
Professional	<ul style="list-style-type: none"> ● Training is limited to standardized protocols and tools (e.g. WHONET) (30). ● There is resistance from stakeholders to transition to new standardized procedures (41). ● There is resistance to increased reporting demands without incentives (101). ● Communication and feedback mechanisms are poor between national surveillance teams and frontline staff (30). 	<ul style="list-style-type: none"> ● Provide continuous professional development and on-site mentorship (30,89). ● Engage with stakeholders early in the policy development process. Provide training and continuous medical education on the importance of AMR and the new protocols. Offer incentives or technical support to encourage compliance and participation (102). ● Establish feedback mechanisms linking surveillance data to local decision-making (41).
Organization	<ul style="list-style-type: none"> ● Infrastructure is inadequate (e.g. unstable power supply, poor Internet connection, lack of equipment) (30). ● Disparities exist in laboratory capacity and IT systems across regions (30). ● There is a lack of internal coordination between the human, animal and environmental departments (30). 	<ul style="list-style-type: none"> ● Upgrade laboratory infrastructure and connectivity in underserved areas (29). ● Standardize tools and reporting formats across all sectors (26). ● Promote internal multisectoral collaboration through One Health technical working groups (26).
System	<ul style="list-style-type: none"> ● No legal mandate requires reporting of AMR data by private or veterinary laboratories (86). ● Governance is fragmented and vertical programmes are driven by donors (45). 	<ul style="list-style-type: none"> ● Enact regulations making standardized AMR surveillance mandatory across sectors (21). ● Establish a national coordination platform with a clear mandate to align donor support and integrate

<ul style="list-style-type: none"> • AMR surveillance is not prioritized in the national budget or health strategy (103). • There is a lack of political will and financial sustainability (102). 	<p>AMR surveillance into national planning (51).</p> <ul style="list-style-type: none"> • Institutionalize harmonized protocols in the AMR National Action Plan with multisectoral leadership (104). • Advocate for the inclusion of AMR surveillance in national health agendas and action plans. Secure dedicated, long-term funding from government budgets and international partners (93,94).
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Policy option 4

Develop feedback forums to share surveillance data and influence public health decisions and outcomes

Table 10. Barriers to policy option 4 and corresponding counter strategies

Level	Barriers	Counterstrategies
Patient/ Farmers	<ul style="list-style-type: none"> • With limited foundational knowledge on AMR, patients and farmers may not engage meaningfully in feedback forums or adopt responsible AMU behaviours (3,68). • Economic constraints, cost of health care and antibiotics lead to self-medication or incomplete treatment (65,105). • There is a high rate of self-medication/over the counter (OTC) antibiotic access in Ghana, therefore updated guidelines or 	<ul style="list-style-type: none"> • Enhance public education and tailor it to simplify technical language and use culturally relevant communication strategies (3). • Strengthen regulation/enforcement for pharmacies and chemical sellers and consider targeted training and accreditation programmes for OTC medicine sellers, so that they dispense appropriately (65).

	<p>surveillance messages will not reach or change patients' behaviour unless OTC supply is addressed (65,106).</p>	
<p>Professional</p>	<ul style="list-style-type: none"> ● There are insufficient knowledge and inadequate awareness of AMS among professionals and there are still gaps in their ability to put knowledge into practice leading to poor uptake of guidelines (107). ● There are behavioural change limitations despite the training of health-care professionals (108). ● Professionals who are ambassadors for a certain brand of drugs and receiving incentives may not be willing to accept new guidelines and push public education effectively (109,110). ● Some health-care professionals may perceive stewardship feedback as restrictive, undermining clinical autonomy or creating tensions among colleagues (e.g. between infectious disease specialists and others), further disincentivizing engagement (111). ● Trust issues, increased workload and resistance from stakeholders or political actors can hinder the success of ASPs and feedback forums. Surveys and systematic reviews have shown that clinicians often express concerns about losing autonomy, feeling that interventions are imposed from the top down, and question the acceptability of new guidelines (112,113). 	<ul style="list-style-type: none"> ● Design multifaceted training interventions that improve professional knowledge capacities and competence in AMS and improve adherences to guidelines (108). ● Include behaviour-change strategies in educational interventions (108). ● Enforce regulation of professionals on being ambassadors for brands by regulatory authorities (114,115). ● Provide feedback and share findings during clinical meetings and ward rounds, as this leads to productive discussions about AMS interventions, facilitating engagement rather than resistance (116).

Organization	<ul style="list-style-type: none"> • Pharmaceutical companies sabotage the implementation of new treatment guidelines to save their investment (117). • Weak laboratory and surveillance infrastructure lead to limited uneven AMR surveillance data (13,87). • Inadequate commitment from hospital or health system management leads to low prioritization of AMS and surveillance-based feedback mechanisms, hampering implementation and sustainability (118). 	<ul style="list-style-type: none"> • Keep companies informed during the process of review of treatment guidelines and developing a roadmap to phase out old practices and drugs (119). • Conduct phased strengthening of sentinel laboratories, invest in basic microbiology and use simpler, standardized reporting templates while building technical capacity (87).
System	<ul style="list-style-type: none"> • Delays in communication and an underdeveloped reporting and management system will affect data dissemination and professionals' full involvement (120). • There are weak governance and coordination among the health sectors (95). 	<ul style="list-style-type: none"> • Ensure that the management and reporting system in human health and animal health system are well developed to ensure timely intervention (121). • Establish a national AMR task force to coordinate policies (31).

Sustainability and monitoring

To ensure the longevity and impact of AMR surveillance beyond donor support,

- Activities should be institutionalized within national systems through the establishment of dedicated budget lines for AMR surveillance within the annual plans of the MoH and MoFA.
- AMR indicators should be integrated into the national Health Sector Monitoring and Evaluation Framework and routine TrACSS reporting to track progress and accountability.
- Periodic joint evaluations should be conducted to assess data quality, completeness, timeliness, and the effectiveness of feedback mechanisms.
- In addition, partnerships with academic and research institutions should be strengthened to analyze AMR trends, generate operational evidence, and facilitate the translation of data into policy and practice.

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ANNEXES

Annex 1: Documentation and search strategy for problem statement¹

Name of databases searched	Search terms used	Number of relevant studies retrieved
PubMed	("antimicrobial resistance" OR "antibiotic resistance" OR "multidrug resistance" OR "drug resistance" OR "multi-drug resistance") AND ("One health" OR "one medicine" OR "inter-sectoral" OR "planetary health" OR "integrated health" OR "eco health" OR "intersectoral" OR "integrated") AND ("Surveillance" OR "monitoring" OR "surveillance system*" OR "observation*" OR "vigilance" OR "assessment*" OR "intervention*" OR "framework*" OR "integrated surveillance" OR "integrated approach*") AND ("Strength*" OR "enhanc*" OR "improv*" OR "develop*" OR "promot*")	2131
Epistemonikos	("antimicrobial resistance" OR "antibiotic resistance" OR "multidrug resistance" OR "drug resistance" OR "multi-drug resistance") AND ("One health" OR "one medicine" OR "inter-sectoral" OR "planetary health" OR "integrated health" OR "eco health" OR "intersectoral" OR "integrated") AND ("Surveillance" OR "monitoring" OR "surveillance system*" OR "observation*" OR "vigilance" OR "assessment*" OR "intervention*" OR "framework*" OR "integrated surveillance" OR "integrated approach*") AND ("Strength*" OR "enhanc*" OR "improv*" OR "develop*" OR "promot*")	938
Cochrane Library	Search strategy used in PubMed was used.	4
Social Systems Evidence	Search strategy used in PubMed was used.	0

¹ Total 46 systematic/literature reviews were used in this document.

Health Systems Evidence	Search strategy used in PubMed was used.	0
Total articles retrieved		3073
Duplicates removed		586
Total records screened by abstract		2487
Included studies for full-text screening		88
Final included studies		31

Annex 2: Documentation and search strategy for policy options and implementation considerations¹

Name of databases searched	Search terms used	Number of relevant studies retrieved
Manual search	Not applicable	90

¹ Total 46 systematic/literature reviews were used in this document.