

# Landscape Analysis of Tools to Address Antimicrobial Resistance

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MAY 2021



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1818 H Street NW, Washington DC 20433

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# Abbreviations

<b>AMR</b>	antimicrobial resistance
<b>ASEAN</b>	Association of Southeast Asian Nations
<b>CDC</b>	US Centers for Disease Control and Prevention
<b>FAO</b>	Food and Agriculture Organization of the United Nations
<b>GAP-AMR</b>	Global Action Plan on Antimicrobial Resistance
<b>GARP</b>	Global Antibiotic Resistance Partnership
<b>GDP</b>	gross domestic product
<b>GLASS</b>	Global Antimicrobial Resistance Surveillance System
<b>IPC</b>	infection prevention and control
<b>IHR</b>	International Health Regulations
<b>JPIAMR</b>	Joint Programming Initiative on Antimicrobial Resistance
<b>LIC</b>	low-income country
<b>LMICs</b>	low- and middle-income countries
<b>MDR</b>	multi-drug resistance
<b>NGO</b>	nongovernmental organization
<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>OIE</b>	World Organisation for Animal Health
<b>PVS</b>	Performance of Veterinary Services
<b>SDG</b>	Sustainable Development Goal
<b>SORT IT</b>	Structured Operational Research and Training Initiative
<b>STAR-IDAZ</b>	Strategic Alliance for Research on Infectious Diseases of Animals and Zoonoses
<b>TB</b>	tuberculosis
<b>WASH</b>	water, sanitation, and hygiene
<b>WHO</b>	World Health Organization
<b>XDR</b>	extensive drug resistance





# Executive Summary

**This report describes the current landscape of tools supporting the development and implementation of policies and interventions to address antimicrobial resistance (AMR).** A landscape analysis was undertaken to provide World Bank staff, teams, and clients with a repository of tools that can be used to address AMR. The analysis defined tools as frameworks, guidelines, documents, and strategy development guides with the primary purpose of supporting development and implementation of policies and interventions to address AMR. A secondary purpose of the report was to identify gaps in the existing landscape of tools and recommend areas for consideration by policy makers, donors, and implementers.

**A two-stage scoping review of existing tools was performed, drawing on the Global Action Plan on AMR as a reference for global guidance on AMR prevention and control (WHO 2015a).** In the first stage, landmark reports on AMR were reviewed to develop the approach to defining and identifying relevant tools, and to help define six programming domains for addressing AMR. These domains were (i) awareness raising, (ii) antimicrobial stewardship, (iii) surveillance, (iv) infection prevention and control in human and animal health, (v) the reduction of pathogen spread in the environment, and (vi) development of a national research agenda. In the second stage, a targeted search of gray and peer-reviewed literature and related websites was performed to identify tools containing intervention options for AMR action. Consultations were also conducted with experts across the One Health spectrum<sup>1</sup>, to seek guidance, validate findings, and source further tools.

**The scoping review identified 90 tools aimed at supporting a range of entities in establishing policies and implementing interventions to address AMR.** These tools are targeted at national governments (ministries of health, agriculture, environment), national centers for disease control, medical professionals, veterinarians, laboratory technicians, pharmacists, the private sector, producers and traders in agriculture, nongovernmental organizations, and the country offices of organizations such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) of the United Nations.

**Tools on implementation and surveillance predominate, but they are sparsely contextualized.** Of 90 tools identified, 47 focused on implementation, but they were rarely focused specifically on low-income regions. Though tools were developed to be adaptable, only six were developed for low-income countries, among them the WHO AMR Stewardship Programmes in Healthcare Facilities in Low- and Middle-Income Countries Toolkit (WHO 2019c); the Fleming Fund's AMR Surveillance in Low- and Middle-Income Settings: A Roadmap for Participation in the Global Antimicrobial Surveillance System (GLASS) tool (Fleming Fund 2016); and the Structured Operational Research and Training Initiative on AMR, coordinated by the Special Programme for Research and Training in Tropical Diseases (TDR) (UNICEF et al. 2019). Given that low- and middle-income countries (LMICs) face disproportionate human, animal, and economic impacts from AMR (World Bank 2017), this finding points to a significant gap and suggests that more can be done to provide tools to support actors in

<sup>1</sup> The One Health approach is explained in the last section of chapter 1.

LMICs, where implementation of activities to address AMR is likely more complex and challenging than in higher-income countries.

**Stand-alone tools to reduce pathogen spread, specifically related to environmental surveillance and management, are also limited.** Of the 90 tools identified, 13 provided some coverage of the mechanisms required for reducing or limiting the spread of pathogens in the environment. Of these, four tools that address domestic and agricultural solid waste and wastewater management specifically acknowledge the threat of pathogen dissemination into the natural environment. Tools such as the “Technical Brief on Water, Sanitation, Hygiene (WASH) and Wastewater Management to Prevent Infections and Reduce the Spread of Antimicrobial Resistance (AMR)” (WHO, FAO, and OIE 2020b) address WASH and wastewater management to limit dispersal via fecal sludge and liquid waste, silent transmission of resistant microorganisms, and release of other pollutants and antimicrobial compounds. The Review on Antimicrobial Resistance (2015) paper and the United Nations Environment Programme’s Frontiers report (UNEP 2017) provide an overview of the pathways of environmental transmission from water and food systems. It is important to note that this focus on the spread of pathogens into the environment entailed important search limitations. While not the focus of this review, a broader framework for the nexus between AMR, environment, and related issues such as climate change and zoonoses could be outlined and would result in a broader array of more indirect tools. For example, certain tools in the environmental sector are designed specifically to address climate change, but there is a high potential that these tools could also lead to benefits for AMR risk reduction. Making these linkages clearer and more visible will require more targeted investments to produce clearer guidance and to reinforce knowledge and other resources in the sector.

**More tools are needed to support costing AMR interventions, and on leveraging public and private finance to address AMR.** Of 90 tools reviewed, 3 were identified as potential costing mechanisms for AMR activities. One tool, the RAND Corporation (2014) methodology for estimating the economic costs of AMR, is focused on measuring the cost of AMR at the global level. For the national level, the PVS Gap Analysis tool (OIE 2020) provides a costing methodology for national veterinary services. The WHO is also in the process of developing a modular tool that will support countries with costing, budgeting, and prioritizing activities contained within their AMR National Action Plans (NAPs) (WHO 2021). The tool will facilitate budgeting gaps analyses and allow countries to advocate for additional funding for prioritized AMR activities. Given the economic limitations that countries in lower-income regions face, there is room to leverage national costing and economic burden studies for more effective AMR programming.

**There is a need for more tools on interventions that are focused at the community or individual level.** Only one tool, the WHO (2018c) Competency Framework for Health Workers’ Education and Training on Antimicrobial Resistance, focused on awareness raising interventions at the individual level. A second tool, “Antibiotic Prescribing and Resistance” (WHO and Antimicrobial Resistance Centre at the London School of Hygiene and Tropical Medicine 2017), highlights the perspectives of prescribers and health professionals in low-income settings. Recently articulated community engagement frameworks for AMR research and action (Mitchell et al. 2019) may form a foundation for the development of further tools in this area. However, the lack of tools to support implementing agencies in engaging with individuals and communities may be a knowledge and practice gap that is of interest to donors and policy makers.



## Chapter 1: Introduction

### Background: Why does antimicrobial resistance matter?

**Antimicrobial resistance (AMR)—the resistance of microbes to antimicrobials—continues to pose a significant threat to global health security (World Bank 2019).** AMR occurs when microbes (bacteria, fungi, viruses, and parasites) mutate in response to their exposure to antimicrobials. This natural development means that drugs that were previously effective in treating diseases become ineffective, making infections lethal or persistent. Pathogens may be resistant to several antimicrobials: multi-drug resistance (MDR) describes resistance to two or more antimicrobial agents in three or more antimicrobial classes; extensive drug resistance (XDR) describes resistance to at least one agent in all but one or two antimicrobial categories; and pan-drug resistance describes resistance to all agents in all antimicrobial categories. Microbes developing resistance to multiple drugs are sometimes referred to as “superbugs.” An infection caused by a superbug is harder to treat because fewer effective drugs are available. In some extreme cases, treatment may not even exist. Given the range of everyday medical interventions that are enabled by effective antimicrobials, the potential impact of losing the ability to use antimicrobials constitutes a “slow-moving tsunami” (WHO 2016a).

**Successive international declarations have acknowledged the global threat of AMR (UN General Assembly 2016).** While the devastating potential for the health sector has been widely documented, stakeholders have also recognized that the causes of resistance go well beyond the health sector, making it critical to draw on a One Health approach<sup>2</sup>.

Antimicrobials used to treat infectious diseases in animals are also used in humans, and resistant microorganisms arising in humans, animals, or the environment may spread across any of those boundaries (FAO, OIE, and WHO 2017).

**Failure to make progress on controlling AMR is a significant development challenge because of AMR’s disproportionate impact on low- and middle-income countries (LMICs), and specifically its negative impact on poverty reduction, food security, health and well-being, and inequality reduction.** AMR is estimated to cause 700,000 deaths annually, and deaths attributed to AMR are predicted to rise to 10 million annually by 2050 (Review on Antimicrobial Resistance 2016). The rise of drug-resistant tuberculosis (TB) highlights the potential impact of AMR for LMICs. The cost of treating MDR-TB or XDR-TB can be significantly more expensive than drug-sensitive TB. For example, in 2011 only 2 percent of South Africa’s TB cases were drug resistant. However, those cases consumed 32 percent of South Africa’s national budget for TB treatment.<sup>3</sup>

**In 2016, the World Bank analyzed the global economic impact of AMR and found that by 2050 AMR could negatively affect the global economy by as much as 3.8 percent of annual gross domestic product (GDP).** Two scenarios were considered. In a high-impact scenario, the world would lose 3.8 percent of annual GDP. Mild impacts would likely reduce GDP by 1.1 percent (World Bank 2017). These effects stand to be profound in two ways. First, they would be felt on an ongoing basis. Second, they would have a disproportionate impact on low-income countries (LICs), which would experience

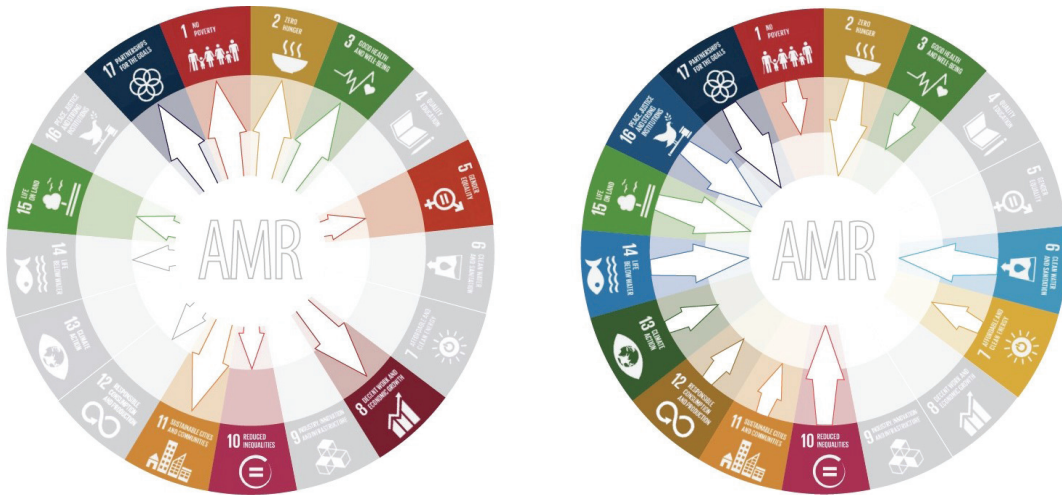
<sup>2</sup> The One Health approach is explained in the last section of this chapter.

<sup>3</sup> TB Alliance, “Drug Resistance: A Response to Antimicrobial Resistance Includes Tackling TB,” <https://www.tballiance.org/why-new-tb-drugs/antimicrobial-resistance>.

larger drops in economic growth than wealthy countries, in turn increasing global poverty and economic inequality. AMR thus has a two-way relationship with the Sustainable Development Goals (SDGs): the emergence and spread of AMR will

inhibit progress toward the SDGs (Figure 1), while a focus on the SDGs is also a way to contribute to containing AMR. For example, improved water management and sanitation will help limit infectious disease risks.

**FIGURE 1: THE TWO-WAY RELATIONSHIP BETWEEN THE SDGS AND AMR**



Source: World Bank 2019.

## Purpose and structure

**The purpose of this landscape analysis is to provide World Bank teams and clients with a repository of tools that can be used to address AMR through the development and implementation of policies and interventions.** A secondary purpose is to identify gaps and areas for further consideration and support by policy makers, donors, and implementers.

**Since the Global Action Plan on AMR (WHO 2015a) and the UN General Assembly's (2016) Political Declaration on Antimicrobial Resistance were issued, meetings and reports have documented the importance of AMR as a global threat.** These developments reflect a growing understanding of AMR as a technical issue, and a recognition of the threat posed by AMR to global health security and socio-economic well-being. Nevertheless, action to address AMR has been slower to materialize, in part because effective action can

require collaboration across sectors, as well as adaptive solutions that incentivize patients, farmers, medical professionals, companies, and industries to use antimicrobials differently (World Bank 2019).

**Within this wider context, this landscape analysis is intended to highlight the development of a range of tools and approaches that support programming and policy implementation to contain AMR at the global and national levels.** While gaps and blind spots remain, global- and national-level policy makers, ministries, and implementing institutions have a substantial foundation on which to draw. While the focus of this report remains technical, it is intended as a step toward the uptake of adaptive approaches. For example, while efforts to contextualize tools remain important, this landscape analysis demonstrates that a range of materials is available to support actors across

the One Health spectrum in addressing AMR, prioritizing investments, and implementing NAPs.

**The report is organized as follows.** The remainder of this chapter discusses how the analysis draws on a One Health approach. Chapter 2 explains the methodology used to define, search for, and select the tools, and lists key domains for action on AMR. Chapter 3 presents the findings from the review. Chapter 4 offers some conclusions concerning gaps and opportunities. Appendix A provides a list of the tools identified in the analysis, along with short descriptions and links. Appendix B offers further details on the methodology.

### **Drawing on a One Health approach**

**The World Bank (2018) Operational Framework for Strengthening Human, Animal, and Environmental Public Health Systems at their Interface highlights the**

**importance of a cross-sectoral approach to global health security.** It showcases how environmental changes, along with ecological and human dynamics, can amplify pressures at the interfaces between humans, animals, and the ecosystems they share. A growing number of drivers have increased the risk of infectious disease emergence and spread. AMR is one of these drivers. Addressing the emergence and spread of resistance requires a systems approach that includes the human, animal, and environmental dimensions. AMR has widely been acknowledged as a “quintessential” One Health issue (Robinson et al. 2016). The analysis sought to reflect the multidisciplinary and multisectoral approach associated with One Health by going beyond the confines of health and public health systems to consider tools and approaches being used in agriculture, water, and environmental programming.

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**“According to the World Bank (2018, 3), a One Health approach is: a collaborative approach for strengthening systems to prevent, prepare, detect, respond to, and recover from primarily infectious diseases and related issues such as antimicrobial resistance that threatens human health, animal health, and environmental health collectively, using tools such as surveillance and reporting with an endpoint of improving global health security and achieving gains in development.”**



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### How to Handwash

- 1. Wet your hands with clean, running water (warm or cold), rub hands together.
- 2. Apply soap.
- 3. Rub hands together for at least 20 seconds. Cover all surfaces of your hands: palm, back, between fingers, and under nails.
- 4. Rinse hands well with clean, running water.
- 5. Dry hands using a clean towel or air dryer.

## Chapter 2: Methodology

**A two-stage scoping review was conducted to examine the landscape of tools on AMR.** Building on the steps by the global community to strengthen the response to AMR after 2015, the first stage included a review of the landmark or seminal reports that are considered to have guided global AMR action over the last five years.<sup>4</sup> These reports, listed in Box 1, were selected based on their role in establishing a platform for action at the global level. From this initial review, a series of recurrent priority actions or domains through which to organize the

range of tools was identified; these are documented in Table 1. The six domains identified are (i) awareness raising; (ii) antimicrobial stewardship; (iii) surveillance, monitoring and research for national surveillance systems with a One Health approach; (iv) infection prevention and control in human and animal health; (v) reduction of the spread of pathogens into the environment; and (vi) the operational research agenda. Box 2 provides the definition of tools used for the purpose of this review.

### BOX 1: LANDMARK REPORTS USED TO INFORM DATA COLLECTION AND ORGANIZATION

- |  |   |
|--|---|
| <ul style="list-style-type: none"> <li>• WHO (World Health Organization). 2015. “Global Action Plan on Antimicrobial Resistance.”</li> <li>• “Review on Antimicrobial Resistance.” 2016. Tackling Drug-Resistant Infections Globally: Final Report and Recommendations. Review on Antimicrobial Resistance chaired by Jim O’Neill.</li> <li>• FAO (Food and Agriculture Organization of the United Nations). 2016. “The FAO Action Plan on Antimicrobial Resistance 2016–2020.”</li> </ul> | <ul style="list-style-type: none"> <li>• OIE (World Organisation for Animal Health). 2016. “The OIE Strategy on Antimicrobial Resistance and the Prudent Use of Antimicrobials.”</li> <li>• OECD (Organisation for Economic Co-operation and Development). 2018. “Stemming the Superbug Tide: Just a Few Dollars More.”</li> <li>• IACG (Interagency Coordination Group). 2019. “No Time to Wait: Securing the Future from Drug-Resistant Infections.”</li> </ul> |
|--|---|

<sup>4</sup> Seminal or landmark reports are sources that “initially presented an idea of great importance or influence within a particular discipline” and are frequently cited in other sources. Northcentral University Library, “Research Process: Finding Seminal Works,” <https://ncu.libguides.com/researchprocess/seminalworks>.



**TABLE 1: SIX DOMAINS TO GUIDE DATA COLLECTION AND ANALYSIS**

<b>Domain</b>	<b>Definition for the purpose of this report</b>
<b>Awareness raising</b>	Improve awareness, understanding, and knowledge of AMR through communication, education, and training at local, national, and regional levels
<b>Antimicrobial stewardship</b>	Promote the optimal use of antimicrobial agents through appropriate prescribing in diverse health care settings, especially in primary care
<b>Surveillance, monitoring and research for national surveillance systems with a One Health approach</b>	Under a One Health approach, strengthen knowledge and evidence through AMR and associated public health surveillance, monitoring, and research for national systems
<b>Infection prevention and control in human and animal health</b>	Reduce infections (including hospital- and community-acquired infections) in humans and animals
<b>Reduction of the spread of pathogens into the environment</b>	Monitor and regulate environmentally related activities or products that result in the spread of AMR pathogens
<b>Operational research agenda</b>	Strengthen and sustain operational research capacity for evidence-based decision-making to improve program performance

Source: World Bank.

**BOX 2: DEFINING TOOLS**

For the purpose of this report, tools are defined as frameworks, guidelines, documents, and implementation strategies and similar mechanisms that aim to support government in developing policies and implementing programs that address AMR.

This approach is not intended to be exhaustive. Evaluating the effectiveness of a given treatment, approach, or tool is not within scope of this report. Thus the analysis does not seek to comparatively or qualitatively assess the 90 tools identified. There are also many valuable tools that are outside the scope of this report, such as those that focus on diagnostics within health care settings or on specific treatments, therapies, or vaccines.

**The second stage of the search targeted peer-reviewed and gray literature as well as websites of international organizations, nongovernmental organizations (NGOs), government bodies, think tanks, and research institutions focused on AMR (Figure 2).**

The review of published and gray literature sought to identify tools that target antimicrobial resistance affecting human health, animal health (terrestrial and aquatic), and the environment. In combination with search terms related to antimicrobial resistance over the One Health spectrum, search terms were developed along the six domains for AMR programming (table 1). Three international databases—PubMed, Cochrane Library, and the FAO database AGRIS—were searched using the search terms as detailed in (appendix 3, table C.3). These databases were selected to be comprehensive and to cover a broad range of disciplines reflected in the six domains. The search terms for international publications were applied to title, abstract, keyword, and full text. The search of gray literature was conducted using Google’s search engine. The strategy also incorporated backward and forward reference searching to identify important sources, contextualize sources within current developments in the AMR landscape, and identify additional publications of relevance.<sup>5</sup>

**Supplementary searches were conducted on websites of relevant stakeholders and organizations.**

These included the CGIAR, the Fleming Fund, the Food and Agriculture Organization of the United Nations (FAO), the International Federation of Pharmaceutical Manufacturers and Associations (IFPMA), the Organisation for Economic Co-operation and Development (OECD), ReAct, the United Nations Children’s Fund (UNICEF), the US Centers for Disease Control and Prevention (CDC), the Wellcome Trust, World Health Organization (WHO), and the World Organisation for Animal Health (OIE).

**Studies were selected based on the abstracts and titles identified via electronic searches and were independently screened based on the specified inclusion criteria.**

The search of published literature yielded 122 potentially relevant citations after title and abstract screening. After data characterization, 17 relevant publications (containing 22 tools—8 listed and 14 contextual) remained and were included in the review. Between September and November 2020, the search targeting gray literature was conducted; this produced 226 potentially relevant publications and resulted in the addition of another 82 tools. In total, 90 tools were included in the analysis. The process from

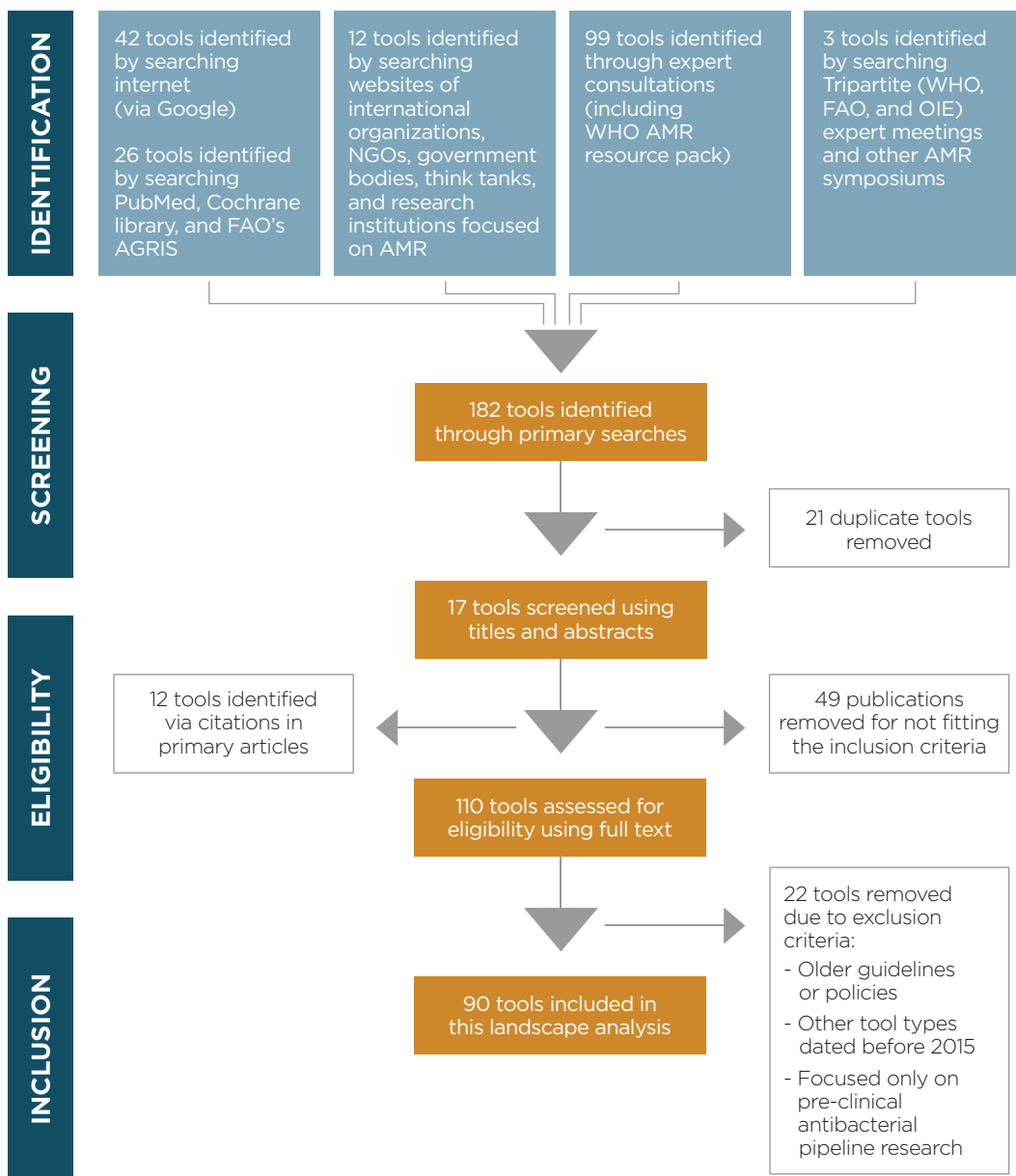
<sup>5</sup> For more information on the method used, see Tricco et al. (2015, 224).

identification to final inclusion of tools is represented in Figure 2.

**This search was supplemented by 12 consultations with experts across the One Health spectrum.** Consultations were conducted with purposively selected experts from the Tripartite organizations (WHO, FAO, and OIE), relevant interna-

tional agencies, academic institutions, and NGOs involved in AMR. The purpose of these consultations was to seek guidance on the methodological approach and the appropriateness of the list of tools identified and to address potential gaps and omissions. Appendix B lists experts who were consulted.

**FIGURE 2: SEARCH STRATEGY AND PROCESS**



Source: World Bank.

**Guided by the AACODS (authority, accuracy, coverage, objectivity, date, significance) approach (Tyndall 2010), inclusion and exclusion criteria were developed for the review of frameworks, guidelines, documents, and implementation strategies (Box 3).** Retrieved documents were excluded if they were published prior to 2015 and did not relate to AMR or to AMR program implementation, interventions, or policies. The search was restricted to peer-reviewed and gray literature in English because of limited resources for translation. The search sought to identify tools that target

control or mitigation strategies for antimicrobial resistance in human health, animal health (terrestrial and aquatic), and the environment. Publications that included tools on specific population groups, clinical research, point of care diagnostics, treatments, therapies, or vaccines were excluded from the review, as were studies that could not be electronically retrieved. Dissertations, theses, letters to the editor, opinion pieces, feature articles, and articles intended as marketing or advertising material were also excluded.

### BOX 3: INCLUSION AND EXCLUSION CRITERIA

Inclusion	Exclusion
<ul style="list-style-type: none"> <li>• Incorporate international and national guidance on AMR action</li> <li>• Assess documents associated with policy frameworks, monitoring and surveillance frameworks, and NAPs</li> <li>• Assess program implementation or interventions and policies on AMR action</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on or assess quality of AMR program implementation</li> <li>• Focus on specific point of care diagnostics, treatments, therapies, or vaccines</li> </ul>

Source: World Bank.

**Two spreadsheets were developed to confirm relevance and to extract data from published and gray literature.** Data extraction was based on the following: (i) characteristics of publications—i.e. author, year of publication, title, and related organization; (ii) potential tools categorized by intervention area (drawing on the six previously described domains) and intended audience; and (iii) publication source.

**After inclusion, documents underwent more detailed review and were categorized by intervention area, tool type, and intended audience.** The intervention areas drew on the six domains previously described. The tool types included the following: AMR policy, guidelines/recom-

mendations, implementation strategy, regional action plan, national action plan, regional surveillance program, national surveillance program, and research program. This selection was derived inductively from the range of tools selected. The primary audience was also noted and included governments, international organizations, NGOs, scientific bodies, research bodies, health professionals, veterinarians, human health facilities, surveillance personnel, and farmers, traders, and producers. Further details on the categorization are provided in tables B.1 and B.2 in appendix B.

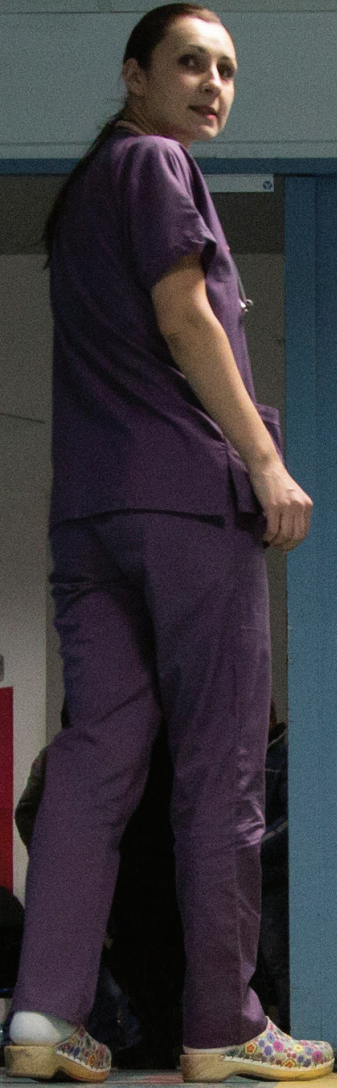
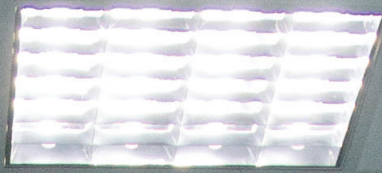
**The review has important limitations.**

First, it does not seek to be exhaustive but rather provides a repository of major tools and works that can support a diverse range of readers in understanding the landscape of existing materials. Second, it does not seek to assess the quality of included publications. In line with a scoping review, this analysis seeks to identify and map existing tools for antimicrobial resistance programming across the One Health spectrum.

**To provide a manageable scope of inquiry, this review focused primarily on AMR-specific interventions.**

AMR can be seen through two types of interventions: AMR-specific and AMR-sensitive solutions (Wellcome Trust 2020a). AMR-specific approaches and solutions have the primary goal of mitigating the development or transmission of resistant pathogens. AMR-sensitive solutions leverage other agendas for the benefit of addressing AMR, including the broader global health agenda related to (for example) improved hygiene and sanitation.



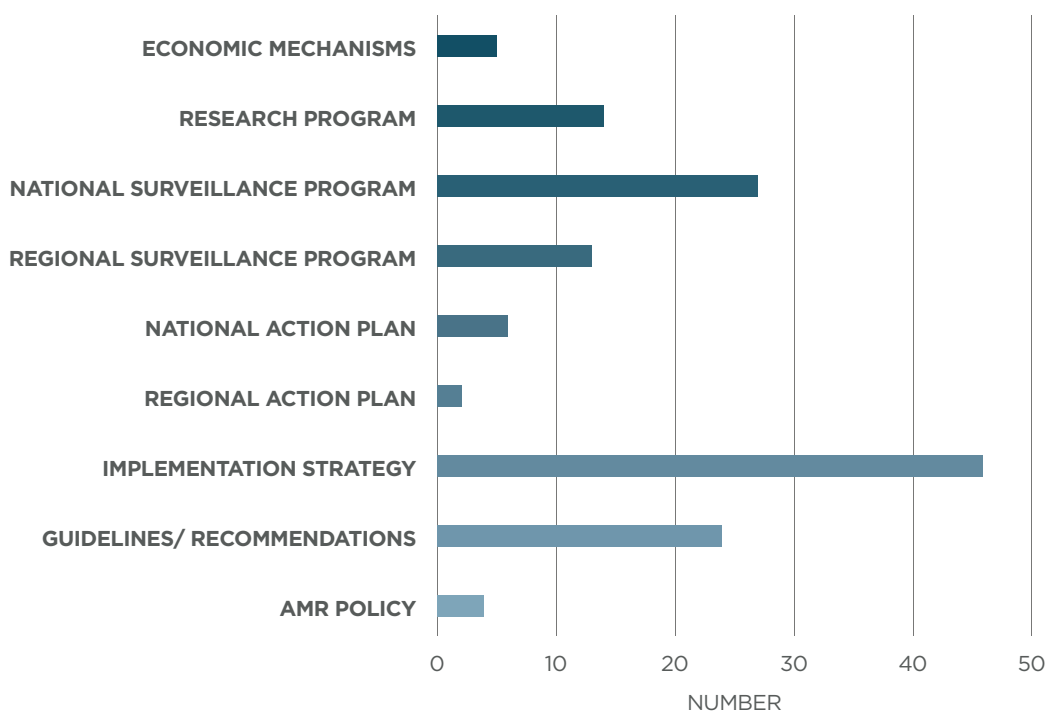


## Chapter 3: Findings and Analysis

The scoping review identified 90 tools that seek to support a range of interventions and are relevant in a range of contexts. This chapter discusses the characteristics of the tools reviewed, including the types of tools, their target audience, and their purpose. Table 2 provides a list of the tools by type and audience.

The chapter also provides findings on the tools, across six domains. Table 3 lists the 90 tools organized by domain. In the discussion of findings, each domain contains a brief definition and examples of tools through which various interventions and policies for AMR action are presented.

FIGURE 3: TOOL TYPE



Source: World Bank.

### Tool type

The 90 tools identified in the review were classified into nine categories. Fourteen tools highlighted efforts to develop and coordinate operational research programs for AMR, with only five tools (three specifically) outlining mechanisms for costing AMR interventions or evaluating their cost-effectiveness. The majority

of tools focused on implementation strategy (47), the provision of guidelines (26), policy (4), and support to national (28) and regional surveillance mechanisms (13). To highlight the low- to middle-income focus of this analysis, two NAPs in middle-income countries (Ghana and South Africa) and two NAPs in low-income

countries (Uganda and Malawi) were reviewed.<sup>6</sup> These countries were identified through initial research and internal World Bank consultations as potential case studies for AMR preparedness<sup>7</sup> relative to other LMICs.

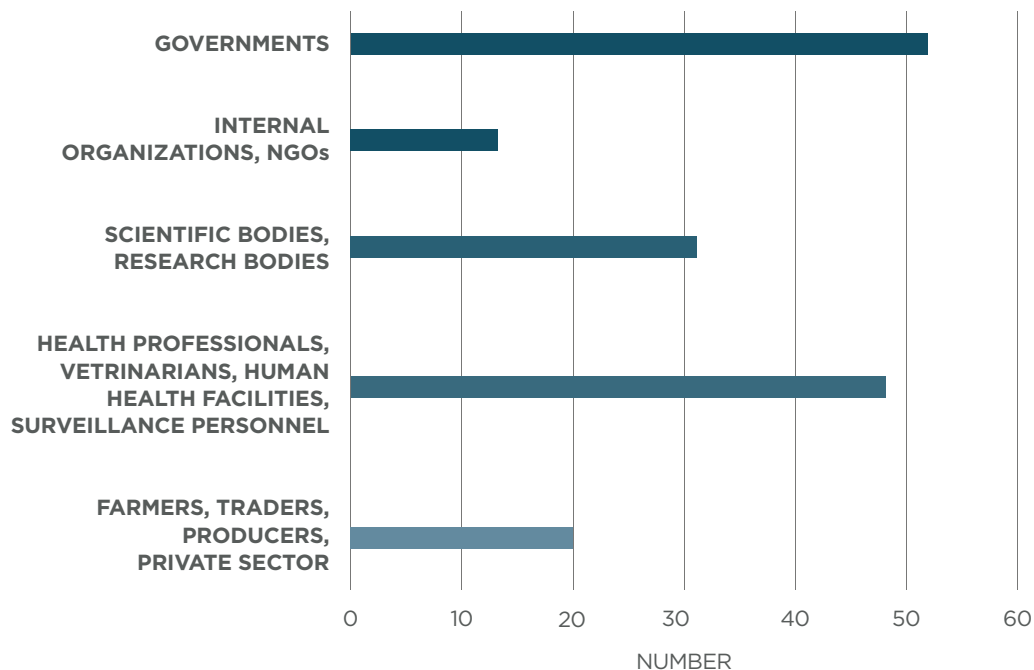
The Association of Southeast Asian Nations Regional Strategy (ASEAN 2016) and the Africa Centers for Disease Control's Antimicrobial Resistance Surveillance Networks (African Union and Africa CDC 2018) were categorized as regional action plans.

## Audience

**Most tools were developed to target more than one audience, including stakeholders within the public sector, academia, scientific bodies, and the private sector.**

Over half of the tools in the review (52) were focused at the national level and developed for adaptation by national governments (ministries of health, agriculture, environment). Over half (48) outlined intervention options for national health facilities, national veterinary services, medical doctors, and pharmacists. Thirty-one tools were developed for national centers for disease control and other national scientific bodies, and 20 tools outlined the roles and appropriate actions of stakeholders such as pharmaceutical companies and producers and traders in agriculture.

**FIGURE 4: AUDIENCE**



Source: World Bank.

<sup>6</sup> See Government of Ghana (2017); Government of South Africa (2018); Government of Uganda (n.d.). Outline of Malawi's National AMR Strategy accessed at: [https://cdn.southampton.ac.uk/assets/imported/transforms/content-block/UsefulDownloads\\_Download/C6C715AED6784622962EB30060C6B30C/A%20Munthali%20-%20Malawi%20AMR%20Strategy.pdf](https://cdn.southampton.ac.uk/assets/imported/transforms/content-block/UsefulDownloads_Download/C6C715AED6784622962EB30060C6B30C/A%20Munthali%20-%20Malawi%20AMR%20Strategy.pdf)

<sup>7</sup> WHO, FAO, and OIE, Country Progress in the Implementation of the Global Action Plan on Antimicrobial Resistance: WHO, FAO and OIE Global Tripartite Database, <https://www.who.int/antimicrobial-resistance/global-action-plan/database/en/>.

















TOOL	Tool Type									Audience				
	AMP Policy	Guidelines/recommendations	Implementation strategy	Regional action plan	National action plan	Regional surveillance program	National surveillance program	Research programs	Economic mechanisms	Governments	International organizations, NGOs	Scientific bodies, research bodies	Health professionals, veterinarians, human health facilities, surveillance personnel	Farmers, traders, producers, private sector
WHO Guidelines on Use of Medically Important Antimicrobials in Food-Producing Animals														
Draft WHO Costing and Budgeting Tool for National Action Plans on Antimicrobial Resistance														
Draft WHO Implementation Handbook for National Action Plans on Antimicrobial Resistance														
Draft FAO Situation Analysis of AMR Risks in the Food and Agriculture Sectors														
<sup>a</sup> Totals (90 tools in total)	5	26	47	2	7	13	28	15	5	52	14	31	48	20

## Discussion of the findings across domains

As indicated in chapter 2, six domains for actions and interventions were identified for this review based on a review of seminal reports: (i) awareness raising; (ii) antimicrobial stewardship; (iii) surveillance; (iv) infection prevention and control in human and animal health; (v) the reduction of pathogen spread in the environment; and (vi) development of a national research agenda. These domains cut across human, animal, and environmental health and key sectors (health, agriculture, and water, sanitation, and hygiene) and are part of a multisectoral One Health approach.

Three domains were well covered by the tools identified in the review. These were surveillance interventions (46 out of the 90 tools), infection prevention and control (34 out of 90), and stewardship policies and intervention options (34 out of 90). In contrast, only 13 tools considered the spread of pathogens in the environment in detail, with 5 tools providing detailed attention and 8 looking at broader issues related to this area.

### Domain 1: Awareness raising

Of the tools reviewed, 30 focused on increasing awareness and understanding of AMR and highlighted the importance

<sup>a</sup> The tools are listed in order of review.



**of improved understanding of the behavioral drivers among consumers, health professionals, veterinarians, farmers, animal owners, and the general public.**

At the global level, the Global Action Plan on Antimicrobial Resistance, or GAP-AMR (WHO 2015a) encourages the identification and prioritization of existing initiatives to improve understanding about AMR and appropriate antimicrobial use in settings across the One Health spectrum. The investigation and promotion of new initiatives to introduce AMR information and key messages to new audiences was also apparent. For example, the Reframing Resistance toolkit (Wellcome Trust 2019) was developed by the Wellcome Trust to tailor strategies for impact communication on AMR that would enable more effective communication for public AMR awareness. Through its Responsive Dialogue Toolkit, the Wellcome Trust has also developed participatory approaches to communication and program design

for action on AMR (Box 4). Other tools address improved evidence on the behavioral drivers for antimicrobial use and resistance in human and animal health, encouraging the development of resources for the promotion of appropriate antibiotic prescribing in primary health care and animal health settings. One such tool that is in development, an “antibiotic footprint” for countries and individuals (Limmathurotsakul et al. (2019), has been proposed as a global tool to communicate the scale of antibiotic use across human, animal, and environmental health. The tool would attribute antibiotic use across these sectors to specific activities, with the wider aim of contributing to global target setting for reductions in antibiotic use. A useful companion tool is ReAct’s (2016) AMR Stakeholder Mapping exercise conducted in 2016, which provides an overview of key actors across areas of intervention and related sectors for AMR.



**BOX 4: BUILDING AWARENESS AND ENGAGEMENT: THE WELLCOME TRUST'S RESPONSIVE DIALOGUE TOOLKIT**

To support engagement and activism on AMR, the Wellcome Trust developed a guide and toolkit for using the Responsive Dialogue framework, an approach that seeks to involve communities in the design, implementation, and enforcement of solutions and policies to address antimicrobial resistance. The approach is designed to enable policy makers, practitioners, the public, and other AMR stakeholders to co-create solutions that inform AMR policies. It centers on five principles:

**Inclusivity:** RDs [Responsive Dialogues] provide inclusive and open spaces where people can freely and comfortably express their views. They are designed to include vulnerable, marginalized, less vocal people and to understand a wide range of views, beliefs and knowledge systems.

**Accessibility:** RDs are informative with a range of people and experts providing evidence in accessible, balanced and unbiased ways.

**Community-based:** RDs work with community groups, networks and local citizens, involving people from all walks of life.

**Respectful:** RDs move beyond simply gathering views to building dialogue and reflection to genuinely co-design responses, considering people's views, practices and experiences

**Responsive:** RD processes are designed to be transparent and accountable, providing clear and open communication about the RDs to the public and commitment to act on recommendation arising from the dialogues (Wellcome Trust 2020b).

The toolkit has been piloted in two countries (Thailand and Malawi), where initial research and application focused on the connection between AMR and women's groups. The dialogues generated ideas on increased communication surrounding daily hygiene through food preparation, washing, and integration of hygiene facilities in schools.

**Tools within this domain also provide guidance on how to maximize the efficacy of antimicrobials.** For the human health sector, frameworks like the WHO's AWARe tool aim to improve knowledge on the judicious use of antibiotics among human and animal health professionals.<sup>9</sup> The AWARe tool classifies antibiotics into three groups—access, watch, and reserve—specifying categorizations to account for quality, shortages, access, and appropriate use. The FAO Action Plan on Antimicrobial Resistance (FAO 2016) and the Strategy on AMR and the Prudent Use of Antimicrobials (OIE 2016) set out strategies for amplifying knowledge and awareness of AMR in the animal and plant health sectors. Through annual World Antibiotic Awareness Weeks and subsequent accompanying monitoring and evaluation reports,<sup>10</sup> the OIE has sought to translate technical and biological concepts for applicability to a wide range of stakeholders in the agriculture, livestock, and fisheries sectors.

**Tools in the human and animal health sectors also set out guidance on education for health professionals.** The WHO Competency Framework for Health Workers' Education and Training on Antimicrobial Resistance (WHO 2018c), which is supplemented by the WHO Health Workers' Education and Training on Antimicrobial Resistance: Curricula Guide (WHO 2019b), provides guidelines for health professionals to better understand and increase their awareness of antimicrobial resistance. Tools such as the report "Antibiotic Prescribing and Resistance: Views from Low- and Middle-Income Prescribing and Dispensing Professionals" (WHO and Antimicrobial Resistance Centre at the London School of Hygiene and Tropical Medicine 2017) highlight the perspectives of prescribers and health professionals in low-income settings, providing a foundation for the development of context-specific tools. Even so, this review noted

gaps in the national- or context-specific tools that are needed to ensure updated curriculum outcomes and competencies for AMR-related training, especially for low-income settings.

## Domain 2: Antimicrobial stewardship

**AMR stewardship tools aim to promote mechanisms to measure appropriate antibiotic use, in part by ensuring that prescribing and dispensing practices are aligned with national prescribing guidelines for antibiotic use in human and animal health.** In this review, 34 tools show the importance of antimicrobial stewardship—the reduction of unnecessary or inappropriate use of microbials, predominantly in clinical settings—for addressing AMR. While antimicrobial stewardship is a standard practice in some clinical settings, the tools demonstrate that more needs to be done to integrate stewardship in other settings, such as interventions designed to improve adherence to prescribing guidelines.

**A series of international standards, set out in WHO and FAO documentation, also provide important reference points for stewardship programming.** In the report "International Instruments on the Use of Antimicrobials across the Human, Animal and Plant Sectors" (WHO, FAO, and OIE 2020a), the Tripartite organizations provide an overview of international instruments to assist national governments in adapting and adopting relevant international standards with implications for antimicrobial use. The most recent version of the WHO Model List of Essential Medicines (WHO 2019d) is a reference point for categorizing antibiotics and organizing stewardship recommendations (namely identification, testing, and implementation of stewardship interventions in general practice). The WHO list of Critically Important Antimicrobials for Human Medicine (WHO 2019a) can be utilized to formulate risk management strategies for

<sup>9</sup> World Health Organization, "Adopt AWARe: Handle Antibiotics with Care," <https://adoptaware.org/>.

<sup>10</sup> See for example WHO (2018d).

containing AMR due to nonhuman antimicrobial use. Frameworks such as the WHO (2019c) AMR Stewardship Programmes in Healthcare Facilities and LMICs Toolkit and the US Centers for Disease Control and Prevention's Core Elements of Human Antibiotic Stewardship Programs in Resource-Limited Settings tool (CDC 2018) provide guidance on the core national- and facility-level requirements for effective stewardship interventions in low-resource countries.

**Beyond human health, a range of normative documents led by the OIE and FAO provide guidance on responsible and prudent antimicrobial use in animal health and agriculture.** The OIE's standards on responsible and prudent use outline responsibilities and appropriate activities for many actors. These standards are part of the OIE Strategy on AMR and the Prudent Use of Antimicrobials (OIE 2016) and provide guidance across the value chain of antimicrobials for the terrestrial and aquatic animal health sectors. Tools such as the FAO's FAOLEX legal database (<http://www.fao.org/faolex/en/>) facilitate the identification of policies and regulatory and legislative mechanisms that might impact AMR at the national level. Additionally, the FAO (2019) Good Practices for Biosecurity in the Pig Sector recommend that greater attention be directed toward the development of country-level best-practice antimicrobial use within animal husbandry and food production systems. There is also a focus on the identification of enablers and barriers to the implementation of national standards in human health and livestock production settings, and a call to investigate approaches to monitor compliance with best-practice antimicrobial stewardship. While tools like the FAO (2019) Good Practices for Biosecurity in the Pig Sector make recommendations applicable to "developing and transition countries," this review noted a gap in animal health and agriculture tools developed specifically for low-income settings.

### **Domain 3: Surveillance, monitoring, and research for national surveillance systems with a One Health approach**

**Surveillance tools aim to facilitate the development of national and regional surveillance systems, as well as the coordination of existing programs and data collections.** They also encourage cross-sectoral collaboration and integration and sharing of expertise to improve One Health surveillance data. Forty-six tools address the approaches for generating data needed to inform policies and actions that address AMR through surveillance of resistance and health care-associated infections. For surveillance across the human, animal, and agriculture sectors, the recommendations of GAP-AMR (WHO 2015) focus on building and strengthening systems to reflect the broad outputs of the Global Health Security Agenda, its related 2024 Framework and AMR action package (Global Health Security Agenda 2021), and the Joint External Evaluation Process. With these recommendations as a benchmark, this review identified tools for advancing adaptable and relevant approaches for responding to national and regional AMR challenges. The Joint External Evaluation tool (WHO 2018b) is an appropriate starting point. It outlines three relevant and related technical areas—AMR, surveillance, and zoonoses—to guide implementation of country-level International Health Regulations (IHR) and assist national evaluation processes for AMR preparedness. Regional and national monitoring plans are encouraged to align with the Global Antimicrobial Resistance Surveillance System (GLASS) (WHO 2020) as a standardizing mechanism to identify indicators and set targets to monitor progress toward the GAP-AMR across human health, animal health, and agriculture. Several tools serve as facilitating mechanisms for LMICs looking to contextualize and optimize GLASS standards; examples include the Fleming Fund's (2016) AMR Surveillance in Low- and Middle-Income Settings: A Roadmap For Participation in the Global Antimicrobial Surveillance System (GLASS) and

the Wellcome Trust's Clinically-Oriented Antimicrobial Resistance Surveillance Network (ACORN) (Turner et al. 2020), which aims to develop efficient clinically oriented AMR surveillance systems for LMIC contexts.

**The tools in this domain provide guidance on establishing baseline measurements against which future targets can be set, in line with a systems-building approach.** Tools also recommend that monitoring and evaluation activities be designed to monitor the progress of various stakeholders within the AMR ecosystem. At the global level, tools such as the Monitoring and Evaluation of the Global Action Plan on Antimicrobial Resistance: Framework and Recommended Indicators (WHO, FAO, and OIE 2019) outline a multilevel framework for globally led and country-led monitoring of NAPs. The Tripartite AMR Country Self-Assessment Survey (TrACSS)<sup>11</sup> is a multisectoral self-assessment questionnaire that aims to capture country information on capacity, coverage, and performance on key aspects of the GAP-AMR.

**In the animal health and agriculture sectors, the FAO has led on capacity building around diagnostic training, sample collection, and quality assurance.** The FAO Assessment Tool for Laboratories and Surveillance Systems (FAO-ATLASS) (FAO 2020), the Laboratory Mapping Tool (LMT) (FAO 2014), and the FAO Surveillance Evaluation Tool (SET) (FAO 2018) have been useful instruments for assessing national laboratory capacities and evaluating animal disease surveillance systems (as well as priority zoonotic diseases). While tools in this domain address the national and regional specificities of systems building for surveillance, this review noted gaps in LIC-specific tools in this area. The 2015 version of the WHO Guide for the Stepwise Laboratory Improvement Process Towards Accreditation in the African Region (WHO 2015b) comprises the

only LIC-specific quality assurance tool in this domain.

#### **Domain 4: Infection prevention and control (IPC) in human and animal health**

**Tools in this domain aim to strengthen national evidence-based or good-practice IPC standards for human health, and to develop national IPC standards for different animal sectors.** They also share a common focus on facilitating access to and disseminating national IPC guidelines for human and animal health through a One Health lens. A total of 34 tools focused on infection prevention and control. Tools in this domain outline approaches for addressing the cause of infections in animals and humans by reducing the transmission of multidrug-resistant organisms, with a focus on clinical and hand hygiene, wastewater management, coordination, and continuous surveillance.

**The tools identified in this domain provide guidance on settings with different risk profiles.** Recognizing that some settings pose a higher infection risk than others, WHO has developed frameworks such as the Guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level (WHO 2017c) and the WHO Global Guidelines on the Prevention of Surgical Site Infection (2016b) for clinical settings. A supplementary tool in this area is the Guidelines for the Prevention and Control of Carbapenem-Resistant Enterobacteriaceae, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* in Healthcare Facilities (WHO 2017b), a technical guidelines document that provides procedural support for the prevention of these bacteria, which contribute to the incidence of health care-associated infections. For other settings, WHO, FAO, OIE (2020b) have developed a "Technical Brief on Water, Sanitation, Hygiene (WASH) and Wastewater Management to Prevent Infections and

<sup>11</sup> The most recent survey is available on the WHO website at [https://www.who.int/publications/m/item/tripartite-amr-country-self-assessment-survey-\(tracss\)-2020-2021](https://www.who.int/publications/m/item/tripartite-amr-country-self-assessment-survey-(tracss)-2020-2021).

Reduce the Spread of AMR.” This brief highlights strategies for strengthening national evidence-based or best-practice IPC standards for human health, outlining actions that can be taken by households and communities and in animal and plant production, manufacturing of antimicrobials, and health care facilities.

**In conjunction with the Performance of Veterinary Services (PVS) tool and Joint External Evaluation tool, a well-developed corpus of standards provides important guidance across the animal and human health sectors.** The OIE’s (2019c) Performance of Veterinary Services (PVS) Pathway sets out minimum requirements to guide infection prevention for food an-

imal production. Within this tool, the OIE has developed standards to guide updated legislation processes for national veterinary services. The OIE and FAO/WHO (through the Codex Alimentarius) have articulated codes and standards to facilitate the identification and management of risks associated with antimicrobial resistance in food-producing animals and along the food chain (Box 5). While these codes do not form a part of this analysis, given its defined methodology, they are pertinent to the normative context. This standard-setting process is supplemented by the OIE’s evaluation, planning, and cost estimation process, which is an extension to the PVS Gap Analysis tool (OIE 2020).



**BOX 5: OIE AND FAO/WHO INTERNATIONAL STANDARDS TO CONTROL ANTIMICROBIAL RESISTANCE**

To promote the responsible and prudent use of antimicrobial agents in terrestrial and aquatic animals, the OIE Working Group on Antimicrobial Resistance has developed a wide range of standards and guidelines to aid identification and management of risks associated with antimicrobial resistance. These standards are supplemented by the OIE List of Antimicrobial Agents of Veterinary Importance (2018) as well as methodologies to address the risk of the emergence or spread of resistant bacteria resulting from the use of antimicrobial agents in food-producing animals (contained within the Manual of Diagnostic Tests and Vaccines for Terrestrial Animals) (OIE, 2019b).

Similarly, the FAO and the WHO have developed Codex Alimentarius texts to address key issues associated with foodborne antimicrobial resistance. Through the establishment of a Task Force on AMR in 2006, Codex sought to develop science-based guidance on the assessment and management of risks to human health stemming from antimicrobial-resistant microorganisms' presence in and transmission through food and feed. Since its reactivation in 2017, the Task Force has sought to develop science-based guidance for the systematic management of AMR along the food chain. Other texts in the Codex that focus on veterinary drugs and related residues, as well as on food hygiene and animal feed, might also be applied to AMR response. The OIE and Codex standards are as follows:

**OIE Terrestrial Animal Health Code (OIE 2019d)**

**Chapter 6.7:** Introduction to the recommendations for controlling antimicrobial resistance

**Chapter 6.8:** Harmonization of national antimicrobial resistance surveillance and monitoring programmes

**Chapter 6.9:** Monitoring of the quantities and usage patterns of antimicrobial agents used in food-producing animals

**Chapter 6.10:** Responsible and prudent use of antimicrobial agents in veterinary medicine

**Chapter 6.11:** Risk analysis for antimicrobial resistance arising from the use of antimicrobial agents in animals

**OIE Aquatic Animal Health Code (OIE 2019a)**

**Chapter 6.1:** Introduction to the recommendations for controlling antimicrobial resistance

**BOX 5: OIE AND FAO/WHO INTERNATIONAL STANDARDS TO CONTROL ANTIMICROBIAL RESISTANCE (CONTINUED)**

**Chapter 6.2:** Principles for responsible and prudent use of antimicrobial agents in aquatic animals

**Chapter 6.3:** Monitoring of the quantities and usage patterns of antimicrobial agents used in aquatic animals

**Chapter 6.4:** Development and harmonization of national antimicrobial resistance surveillance and monitoring programmes for aquatic animals

**Chapter 6.5:** Risk analysis for antimicrobial resistance arising from the use of antimicrobial agents in aquatic animals

**FAO/WHO Codex Alimentarius texts on AMRa**

Guidelines for Risk Analysis of Foodborne Antimicrobial Resistance

Code of Practice to Minimize and Contain Antimicrobial Resistance (under revision)

Guidelines on Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance (in development)

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A. Codex Alimentarius texts on AMR can be found at FAO and WHO, "Codex Alimentarius International Food Standards: Antimicrobial Resistance," <http://www.fao.org/fao-who-codexalimentarius/thematic-areas/antimicrobial-resistance/en/>



### **Domain 5: Reduction of the spread of pathogens in the environment**

#### **Tools in this domain aim to develop and increase mechanisms for monitoring and regulating environmentally related activities or products that influence the spread of AMR pathogens.**

The importance of strengthening surveillance around the emergence of pathogens in LICs was highlighted in the UK Government report (Review of Antimicrobial Resistance 2016) and has been echoed in 13 tools focused on or related to reduction of pathogen spread in the environment. Through a dedicated paper, “Antimicrobials in Agriculture and the Environment: Reducing Unnecessary Use and Waste” (Review on Antimicrobial Resistance 2015), the UK Government’s review sets out three broad interventions for the reduction of pathogen spread into the environment: reducing global levels of antibiotic use in agriculture, developing minimum standards to reduce antimicrobial waste released into the environment, and improving the monitoring and regulation of environmentally related activities.

#### **As a supplement, some platforms are helping to shed more light on the sources and drivers of the environmental components of AMR.**

One example is Environment as a Driver of Antibiotic Resistance (CARE 2020), an initiative of the Centre for Antibiotic Resistance Research (CARE), which is housed within the University of Gothenburg’s Swedish Research Council. While not contained among the tools listed in this review, the United States Department of Agriculture’s Agricultural Antibiotic Resistance (AgAR) project and Tufts University’s International Surveillance of Reservoirs of Antibiotic Resistance (ISRAR [Muloi 2020]) may constitute similarly useful mechanisms for emerging standard setting around the measurement of resistance in agriculturally impacted soil, water, air, and food. This review has highlighted tools on food safety, soil-borne resistance, waste man-

agement, drinking water, and wastewater belonging primarily to the stewardship, surveillance, and IPC domains that briefly acknowledge the threat of pathogen dissemination in the environment. The WHO, FAO, and OIE (2020b) “Technical brief on Water, Sanitation, Hygiene and Wastewater Management to Prevent Infections and Reduce the Spread of Antimicrobial Resistance” and the UK Government paper (Review on Antimicrobial Resistance 2015) were the only tools identified in the analysis that made specific recommendations on limiting the emergence and spread of pathogens through the environment.

#### **Another approach may be to leverage existing capacity in surveillance systems.**

The WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance (WHO-AGISAR) was established in 2008 (with updated guidance on surveillance in foodborne bacteria developed in 2017; see WHO [2017d]) to minimize the impact of AMR associated with the use of antimicrobial agents in all food-producing animals. This approach may be aligned with ongoing efforts by WHO and FAO (e.g., through expert meetings<sup>12</sup>) to highlight scientific advice on the transmission of antimicrobial-resistant bacteria from environmental sources to foods and feeds of plant and aquatic animal origin.

### **Domain 6: Operational research agenda**

#### **Tools in this domain aim to outline and explore opportunities to increase cross-disciplinary initiatives on AMR research, including efforts to increase support for priority and neglected research areas such as social/operational research.**

Thirteen tools identified research and development priorities in the human, animal, and environmental sectors. For example, the WHO Global Priority List of Antibiotic-Resistant Bacteria to Guide Research, Discovery, and Development of New Antibiotics (2017) and the Antibacterial Agents in Clinical Development (WHO

<sup>12</sup> See for example FAO and WHO (2018).

2017a)—an analysis of the antimicrobial clinical development pipeline, including for tuberculosis—focus on the pipeline for new medicines, vaccines, and diagnostics for combatting AMR.

**This review also sought to identify tools that emphasize the development, refinement, and implementation of evidence-based practices to limit the emergence and spread of AMR.** Tools such as GLASS (Fleming Fund 2016) and the AMR Framework for Action Supported by the IACG (IACG 2017) describe strategies for basic research on AMR, which can be adapted to low-income settings. Additionally, initiatives such as the Global Research on AntiMicrobial Resistance (GRAM) Project<sup>13</sup> (a strategic partnership between the University of Oxford’s Big Data Initiative and the Institute for Health Metrics and Evaluation) aim to address the lack of data on the incidence, prevalence, and burden of AMR in LMICs in order to improve understanding and better target interventions. In this vein, HERD International and the University of Leeds has developed an innovative framework for a community-based and participatory research tool for AMR in 2019 (Mitchell et al. 2019), outlining seven principles and values (clarity, creativity, being evidence-led, equity, interdisciplinarity, sustainability, and flexibility). This tool could form the basis for the development of further tools advancing a community engagement approach.<sup>14</sup>

**As these tools continually develop for wider adaptability in low-income regions, joint programming, as well as multidisciplinary partnerships for AMR (Box 6) can be useful in developing cross-sectoral research systems when funds are very limited.** Platforms such as the Joint Pro-

gramming Initiative on Antimicrobial Resistance (JPIAMR 2019), which was established in 2011 and comprises 19 European member countries, provide an actionable template for the type of joint strategic research agenda (and public-private funding) that can impact AMR at the national level. The Joint Programming Initiative on Antimicrobial Resistance outlines six areas (diagnostics, therapeutics, surveillance, transmission, environment, and interventions) that provide a national-level framework for research on AMR action. Though not included in the listing of tools in this analysis, USP’s Quality Institute highlights cross-disciplinary research on the links between substandard antimicrobials and the proliferation of AMR.<sup>15</sup>

**Two tools—the Strategic Alliance for Research on Infectious Diseases of Animals and Zoonoses (STAR-IDAZ) International Research Consortium<sup>16</sup> and the Structured Operational Research and Training Initiative (SORT IT) on AMR (UNICEF et al. 2019)—seek to build country-level capacity for operational research.** The STAR-IDAZ International Research Consortium coordinates research activities and public-private funding for research on animal health. By establishing expert working groups and systematically conducting research gap analyses, the global network contributes to the development and improvement of animal disease control tools (namely vaccine strategies, animal health products and procedures, and scientific inputs to support risk analysis). In 2019, a Structured Operational Research and Training Initiative on AMR, coordinated by the Special Programme for Research and Training in Tropical Diseases (TDR), was piloted in five LMICs (Ghana, Uganda, Sierra Leone, Myanmar, and Nepal). The SORT IT approach seeks to build

13 See the Oxford BDG Group, “Our Research,” <https://www.bdi.ox.ac.uk/oxfordgbdgroup/research>.

14 In 2015, the INDEPTH Network initiated the ABACUS study (<http://www.indepth-network.org/projects/abacus>), which sought to assess and compare the drivers of antibiotic consumption and access in six LMICs in Africa and Asia. Once available, the results of this study could be used to further inform community-based interventions for rational use in LMICs.

15 USP, “Quality Institute: Antimicrobial Resistance Research,” <https://www.usp.org/our-impact/quality-institute/antimicrobial-research>.

16 See the STAR-IDAZ International Research Consortium on Animal Health website at <https://www.star-idaz.net/>.

sustainable operational research capacity by enabling countries to conduct operational research around their self-identified priority areas. This approach encourages

ownership and can help to close gaps in the understanding of how AMR develops and spreads and how best to prevent and contain it in LICs.

**BOX 6: MULTIDISCIPLINARY PARTNERSHIPS FOR AMR: THE GLOBAL ANTIBIOTIC RESISTANCE PARTNERSHIP (GARP) AND THE CGIAR ANTIMICROBIAL RESISTANCE HUB**

**The Global Antibiotic Resistance Partnership (GARP)** (<https://cddep.org/projects/global-antibiotic-resistance-partnership/>) was created to support the development of actionable policy proposals on antibiotic resistance in low- and middle-income countries. Supported by the Bill and Melinda Gates Foundation and an independent public policy grant from Merck & Co., GARP has helped to establish national working groups on AMR in nine LMIC countries that highlight human health and agriculture-associated AMR risks through research and integrated activities on antibiotic use.

Hosted and led by the Center for Disease Dynamics, GARP has supported the development of strategies (through the national working groups) that target the use of antibiotics in human health and livestock production and aim to reduce the demand for antibiotics by reducing the incidence of infections in hospitals and communities.

**The CGIAR Antimicrobial Resistance Hub** (<https://amr.cgiar.org>) is hosted and led by the International Livestock Research Institute (ILRI) in partnership with the International Food Policy Research Institute (IFPRI), World Fish, and the International Water Management Institute (IWMI). The hub's research and development activities are driven by the CGIAR AMR strategy, which is aligned to the efforts of the Tripartite organizations (WHO, FAO, OIE) and the United Nations Environment Programme on AMR.

The hub supports the efforts of LMICs to control agriculture-associated AMR risks by promoting and facilitating transdisciplinary partnerships. Through the application of a One Health approach, the hub implements activities in five critical areas to address AMR: antimicrobial use, research on AMR transmission, interventions for the effective use of antimicrobials, support for evidence-based policy dialogue, and capacity building for scaling solutions.

**TABLE 3:** SUMMARY OF 90 TOOLS: DOMAINS

Tool	Domain					
	Awareness raising	Antimicrobial stewardship	Surveillance	Infection prevention and control in human and animal health	Reduction of the spread of pathogens in the environment	Operational research agenda
Global Action Plan on AMR (GAP-AMR)						
Strategy on AMR and the Prudent Use of Antimicrobials						
FAO Action Plan on Antimicrobial Resistance						
FAO Assessment Tool for Laboratories and Surveillance Systems (FAO-ATLASS)						
Progressive Management Pathway for AMR (FAO-PMP AMR)						
FAO Surveillance Evaluation Tool (SET)						
FAO Laboratory Mapping Tool (LMT)						
WHO AMR Stewardship Programmes in Healthcare Facilities and LMICs Toolkit						
Global Antimicrobial Resistance Surveillance System (GLASS)						
AWaRe tool						
AMR Framework for Action Supported by the IACG						
WHO Situation Analysis						
Antimicrobial Resistance: A Manual for Developing National Action Plans						
Country Progress on the Implementation of the Global Action Plan on Antimicrobial Resistance: WHO, FAO and OIE Global Tripartite Database						
WHO Competency Framework for Health Workers' Education and Training on Antimicrobial Resistance						
Strategic Research Agenda: Joint Programming Initiative on Antimicrobial Resistance						
Technical Brief on Water, Sanitation, Hygiene (WASH) and Wastewater Management to Prevent Infections and Reduce the Spread of Antimicrobial Resistance (AMR)						

Tool	Domain					
	Awareness raising	Antimicrobial stewardship	Surveillance	Infection prevention and control in human and animal health	Reduction of the spread of pathogens in the environment	Operational research agenda
Guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level						
FAO Resource Package on Good Hygiene Practices						
FAO Good Practices for Biosecurity in the Pig Sector						
Antimicrobials in Agriculture and the Environment: Reducing Unnecessary Use and Waste						
Monitoring and Evaluation of the Global Action Plan on Antimicrobial Resistance: Framework and Recommended Indicators						
Tripartite AMR Country Self-Assessment Survey (TrACSS)						
FAOSTAT						
FAOLEX (electronic collection of national laws, regulations, and policies on food, agriculture, and natural resources management)						
Methodology to Analyze AMR-Relevant Legislation in the Food and Agriculture Sector						
WHO Benchmarks for IHR Capacities						
Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS)						
AMR Benchmark						
WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene						
WHO Hand Hygiene Self-Assessment Framework, and the WHO Infection Prevention and Control Assessment Framework						
OIE PVS Pathway						
PVS Gap Analysis Tool						
STAR-IDAZ International Research Consortium						
WHO Model List of Essential Medicines: 20th List						

Tool	Domain					
	Awareness raising	Antimicrobial stewardship	Surveillance	Infection prevention and control in human and animal health	Reduction of the spread of pathogens in the environment	Operational research agenda
ReAct Online Toolbox for National Action Plans						
Declaration by the Pharmaceutical, Biotechnology and Diagnostics Industries on Combating Antimicrobial Resistance						
Tackling Antimicrobial Resistance: Ensuring Sustainable R&D						
World Antibiotic Awareness Week 2018: Monitoring & Evaluation Report						
Guidelines for the Prevention and Control of Carbapenem-Resistant Enterobacteriaceae, Acinetobacter baumannii and Pseudomonas aeruginosa in Healthcare Facilities						
Global Framework for Development & Stewardship to Combat Antimicrobial Resistance: Draft Roadmap						
WASH in Health Care Facilities: Practical Steps to Achieve Universal Access to Quality Care						
WASH in Health Care Facilities: Global Baseline Report 2019						
Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines						
Ghana National Action Plan						
South African Antimicrobial Resistance Strategy Framework: A One Health Approach						
Global Priority List of Antibiotic-Resistant Bacteria to Guide Research, Discovery, and Development of New Antibiotics						
Diagnostic Stewardship: A Guide to Implementation in Antimicrobial Resistance Surveillance Sites						
Africa CDC Antimicrobial Resistance Surveillance Network (AMRSNET)						
ASEAN Regional Strategy on AMR Communication and Advocacy						

Tool	Domain					
	Awareness raising	Antimicrobial stewardship	Surveillance	Infection prevention and control in human and animal health	Reduction of the spread of pathogens in the environment	Operational research agenda
Estimating the Economic Costs of Antimicrobial Resistance: Model and Results						
Antibacterial Agents in Clinical Development: An Analysis of the Antibacterial Clinical Development Pipeline, Including Tuberculosis						
Resistance Map						
Health Workers' Education and Training on Antimicrobial Resistance: Curricula Guide						
The Structured Operational Research and Training Initiative on AMR, coordinated by the Special Programme for Research and Training in Tropical Diseases (TDR)						
Integrated Surveillance of Antimicrobial Resistance						
The 4th Annual OIE Report on Antimicrobial Agents Intended for Use in Animals						
Tackling Antimicrobial Resistance Together (Working Paper 5.0): Enhancing the Focus on Gender and Equity						
Summary Report of the FAO/WHO Expert Meeting on Foodborne Antimicrobial Resistance: Role of Environment, Crops and Biocides						
The Environment as a Driver of Antibiotic Resistance						
Frontiers 2017: Emerging Issues of Environmental Concern						
Preventing the Next Pandemic: Zoonotic Diseases and How to Break the Chain of Transmission						
Reframing Resistance						
Gulf-Middle East-North Africa Antimicrobial Stewardship Network						

Tool	Domain					
	Awareness raising	Antimicrobial stewardship	Surveillance	Infection prevention and control in human and animal health	Reduction of the spread of pathogens in the environment	Operational research agenda
Tackling Antimicrobial Resistance Together (Working Paper 1.0): Multisectoral Coordination						
An Analysis of the Animal/Human Interface with a Focus on Low- and Middle-Income Countries						
The AWaRe Campaign: “Adopt AWaRe. Handle Antibiotics with Care”						
Antibiotic Prescribing and Resistance: Views from Low- and Middle-Income Prescribing and Dispensing Professionals						
Uganda Antimicrobial Resistance National Action Plan (2018–2023)						
Malawi National AMR Strategy (2017–2022)						
The Joint External Evaluation Tool						
The Global Research on AntiMicrobial Resistance Project (GRAM)						
International Instruments on the Use of Antimicrobials across Human, Animal and Plant Sectors						
US CDC Laboratory Assessment of AMR Testing Capacity (LAARC)						
Guidelines for the Development of National Action Plan for Health Security						
Industry Alliance against AMR Progress Report						



Tool	Domain					
	Awareness raising	Antimicrobial stewardship	Surveillance	Infection prevention and control in human and animal health	Reduction of the spread of pathogens in the environment	Operational research agenda
Industry Roadmap for Progress on Combatting Antimicrobial Resistance						
Time Is Running Out Technical Note						
OIE Data Collection Template						
Core Elements of Human Antibiotic Stewardship Programs in Resource-Limited Settings						
ACORN (Clinically-Oriented Antimicrobial Resistance Surveillance Network)						
AMR Surveillance in Low- And Middle-Income Settings: A Roadmap for Participation in the Global Antimicrobial Surveillance System (GLASS)						
Critically Important Antimicrobials for Human Medicine: 5th Revision						
WHO Guide for the Stepwise Laboratory Improvement Process Towards Accreditation in the African Region						
WHO Global Guidelines on the Prevention of Surgical Site Infection						
Infection Control in Healthcare Personnel: Infrastructure and Routine Practices for Occupational Infection Prevention and Control Services						
WHO Guidelines on Use of Medically Important Antimicrobials in Food-Producing Animals						
Draft WHO Costing and Budgeting Tool for National Action Plans on Antimicrobial Resistance						
Draft WHO Implementation Handbook for National Action Plans on Antimicrobial Resistance						
Draft FAO Situation Analysis of AMR Risks in the Food and Agriculture Sectors						
Totals (90 tools in total)	30	34	46	34	13	13



## Chapter 4: Conclusions

**The review identified several tools to support implementation and surveillance, but these were rarely contextualized.** Of 90 tools reviewed, 47 focused on implementation, but they were rarely context-specific for low-income regions. Though tools were developed to be adaptable, only six were developed specifically for LICs, among them the WHO AMR Stewardship Programmes in Healthcare Facilities and LMICs Toolkit (WHO 2019c) the Fleming Fund's AMR Surveillance in Low- and Middle-Income Settings: A Roadmap For Participation in the Global Antimicrobial Surveillance System (GLASS) tool (Fleming Fund 2016); and the Structured Operational Research and Training Initiative on AMR, coordinated by the Special Programme for Research and Training in Tropical Diseases (TDR) (UNICEF et al. 2019). LICs face disproportionate human, animal, and economic impacts from AMR (World Bank 2017). This finding is, in part, driven by the need for global guidance to provide broad instruments that can be contextualized into action at the national level. Nevertheless, the development of region-specific tools may help drive utilization and implementation.

**While the link between the AMR and the environment has been established, comparatively few tools exist on the reduction of pathogen spread through environmental pathways.** The United Nations Environment Programme Frontiers report (UNEP 2017) and the upcoming National Academies of Sciences, Engineering and Medicine report "Examining the Long-term Health and Economic Effects of Antimicrobial Resistance in the United States"<sup>17</sup> outline the role of environmental components in amplifying resistance, highlighting the threat posed by the dissemination of antimicrobial compounds and discharged antibiotic-resistant bacteria. Nevertheless, stand-alone tools on the reduction of pathogen spread, specifically around

environmental surveillance and management, are limited. Of 90 tools reviewed, 13 tools touched broadly on the mechanisms required for reducing or limiting the spread of pathogens into the environment, with four tools—for example, "Antimicrobials in Agriculture and the Environment: Reducing Unnecessary Use and Waste" (Review on Antimicrobial Resistance 2015)—touching specifically on this aspect of AMR programming. For lower-income countries, existing surveillance tools like GLASS need to better align to often-limited national surveillance contexts, given that these countries are unlikely to have the resources for full implementation of GLASS components. Work by the UK Government Review on AMR highlighted the need to better link data on AMR across the human health, animal, food, agriculture, and environment sectors in low-resource settings, even while common denominators across these sectors remain a challenge (Review on Antimicrobial Resistance 2014). A constructive starting point may be around capacity building for early detection of pathogen emergence; this could be a more cost-effective approach than transmission control. Additionally, while it is not the focus of this review, a broader framework for the nexus between AMR, the environment, and related issues such as climate change and zoonoses could be outlined and would result in a broader array of more indirect tools. For example, certain tools in the environmental sector are designed specifically to address climate change, but there is a high potential that these tools could also lead to benefits for AMR risk reduction. Making these linkages clearer and more visible will require more targeted investments to produce additional tools and to reinforce knowledge and other resources in the sector.

17 For more information see National Academy of Sciences, Engineering and Medicine, "Examining the Long-term Health and Economic Effects of Antimicrobial Resistance in the United States," <https://www.nationalacademies.org/our-work/examining-the-long-term-health-and-economic-effects-of-antimicrobial-resistance-in-the-united-states>.

**More tools are needed to support costing and prioritizing of AMR interventions.**

Of 90 tools reviewed, 3 tools were identified as potential costing mechanisms for AMR activities. One tool, the methodology for Estimating the Economic Costs of Anti-microbial Resistance: Model and Results (RAND Corporation 2014), is focused on measuring the cost of AMR at the global level. At the national level, the PVS Gap Analysis tool (OIE 2020) provides costing methodology for national veterinary services. The World Health Organization is developing a modular tool that will support countries with costing, budgeting, and prioritizing activities contained within their AMR NAPs (WHO 2021). To remedy the lack of planning and financing that many LMICs highlight as an obstacle for AMR programming (Box 7), the tool will facilitate budgeting gap analyses and allow countries to advocate for additional funding for prioritized AMR activities. Given the economic limitations that countries in lower-income regions face, there is room to leverage national costing and economic burden studies for more effective AMR programming.

**There is a need for more tools on interventions that are focused at the community or individual levels.**

Only one tool, the WHO Competency Framework for Health Workers' Education and Training on Antimicrobial Resistance (WHO 2018c), focused on awareness-raising interventions at the individual level. A second tool, "Antibiotic Prescribing and Resistance: Views from Low- and Middle-Income Prescribing and Dispensing Professionals" (WHO and Antimicrobial Resistance Centre at the London School of Hygiene and Tropical Medicine 2017), highlights the perspectives of prescribers and health professionals in low-income settings. Recently articulated community engagement frameworks for AMR action (Mitchell et al. 2019) may form a foundation for the development of further tools in this area. However, the lack of more individually focused tools indicates that there might still be knowledge and practice gaps at the individual level and in community settings.

If so, there is more room to describe population-level interventions to reduce the development and transmission of community-associated AMR.

**Expert consultations highlighted the importance of considering equity in AMR programming, which is not often facilitated by the tools that are mainstreamed.**

The scope of this review was limited and did not include extensive engagement with country-level actors. However, through consultations, experts highlighted the importance of considering equity in AMR programming. For example, a systematic review on patient-related determinants of adherence to antibiotic treatment identified an important gender differential. Men were identified to be less likely to adhere to a treatment protocol. Socioeconomic status, income, education, and living context were also determinants of adherence (Zanichelli et al. 2019). A study in the Netherlands also identified gender differences in prescribing practices, specifically finding that female doctors may be more likely than male doctors to wait before prescribing antibiotics (Eggermont et al. 2018). Thus, differences in norms, attitudes, and the potential impact of AMR on different populations could be better considered in AMR tools.

**Consultations also stressed the importance of facilitating tools' use within and adaptability to specific country contexts.**

While many tools are available at the global level, participants highlighted a disconnect between global and country-level programming. This review had a global focus and was limited in its ability to engage in depth at the country level; however, consultations raised the issue of tools not being easily adapted to country contexts. Specifically, participants pointed to the challenge of adapting tools to specific country or regional contexts, where implementation modalities and options can vary significantly. Adaptability was identified as a key challenge in facilitating the utilization of tools and merits further work and research. To some extent, this challenge can be mitigated by involving national players and relevant organizations early in the process of identifying needs and developing tools.

**BOX 7: NAPS: LESSONS FROM GHANA, SOUTH AFRICA, UGANDA, AND MALAWI**

**One of the primary recommendations of the GAP-AMR (WHO 2015a) was the development and implementation of national action plans.** This recommendation has been echoed in tools such as the WHO, FAO, and OIE (2016) AMR manual for developing NAPs and the FAO Progressive Management Pathway for AMR (FAO-PMP AMR).<sup>a</sup> Additionally, the forthcoming WHO implementation handbook for NAPs on antimicrobial resistance will provide comprehensive, practical guidance along the continuum for implementing NAPs. This tool provides guidance and self-assessment criteria for the development and implementation of a multisector One Health-led national action plan.

**However, national action plan development and implementation remains a challenge, especially in low-to-middle-income settings.** This is a significant risk for a context in which antibiotics are among the most prescribed medicines, and in which many countries report the presence of resistant strains of bacteria. In the Africa region, 33 countries have NAPs for AMR in place,<sup>b</sup> though only two countries have mobilized funding and are in the process of implementation. To date, national surveillance systems that routinely generate dynamic data on antimicrobial use and resistance are limited, although a few countries have implemented pilot surveillance projects.

**In Ghana, activities to control AMR have been largely implemented by donors and development partners, even as the country's health financing system continues to shift toward a reliance on public funds.** The country's AMR policy and national action plan were published in 2017, although many gaps remain in terms of implementation and resource mobilization. Implementation progress became visible once AMR-related activities were mainstreamed into SDG plans (WHO 2018a). South Africa has costed its national action plan, which has been important for political buy-in. Ensuring that national action plan activities are planned in alignment with the budget cycles of the ministries of health and agriculture has been significant for implementation momentum (EPN and ReAct 2017).

**Uganda has published a national action plan for the period 2018 to 2023.** To date, only two out of five strategic objectives are being implemented (around awareness raising and antibiotic use); this is largely a symptom of the lack of costing for all proposed activities in the plan (CDDEP 2019). In Malawi, limitations around human and financial resources have entailed constraints for comprehensive implementation of the country's national action plan. In 2017, the estimated cost of implementing Malawi's plan was \$6.7 million, against an annual Ministry of Health budget of \$24,000 for AMR.<sup>c</sup>

**While all NAPs reviewed are compliant with the Global Action Plan, major gaps persist around surveillance and monitoring, comprehensive implementation, and funding.** Additional bottlenecks revolve around governance or regulatory responsibility for operationalization and budgeting. Achievement of the objectives outlined in a national action plan requires a coordinated effort from a wide range of implementation partners. Clear lines of responsibility and accountability at the international, national, jurisdictional, and local levels are needed to support progress.

a. See FAO, <http://www.fao.org/antimicrobial-resistance/resources/tools/fao-pmp-amr/en/>.

b. Mirfin Mpundu, "Moving from Paper to Action: The status of National AMR Action Plans in African countries," AMR Insights, <https://revive.gardp.org/moving-from-paper-to-action-the-status-of-national-amr-action-plans-in-african-countries/>.

c. ReAct and Ecumenical Pharmaceutical Network. "Moving Beyond Antimicrobial Resistance National Action Plans Development to Implementation," [https://www.reactgroup.org/wp-content/uploads/2017/10/RAN\\_Conference-2017-Report.pdf](https://www.reactgroup.org/wp-content/uploads/2017/10/RAN_Conference-2017-Report.pdf).

**To reinforce the One Health focus of this review, it is useful to outline the ways in which individual tools might be strengthened by a stronger cross-sectoral approach.** For example, AMR fostered by drug use in animals can negatively impact human well-being and vice versa. This nexus is outlined in the WHO-commissioned report “Antibiotic Prescribing and Resistance: Views from Low- and Middle-Income Prescribing and Dispensing Professionals” (WHO and Antimicrobial Resistance Centre at the London School of Hygiene and Tropical Medicine 2017), which aims to situate the awareness of AMR and knowledge of antibiotics among human and veterinary health professionals. A useful additional perspective for inclusion may be around the use of antibiotics in plant agriculture, for example, and the related development of resistant plant

pathogens (Stockwell and Duffy 2012). In a similar vein, “Analysis of the Animal/Human Interface with a Focus on Low- and Middle-Income Countries” (Fleming Fund and Wellcome Trust 2016) outlines how antimicrobial use and AMR in live-stock and farmed aquatic species for food systems in LMICs interact with the pharmaceutical industry and people involved in antimicrobial use, and the potential environmental impacts that might result from these interactions. Citing sufficient coverage, this tool does not include a perspective on the effects of irrational use on human health; however, this perspective may be useful for grounding a holistic understanding of complex potential exposures to antimicrobial-resistant organisms from multiple sources, and to promote cross-sectoral antimicrobial stewardship.



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## Appendix A: Summary Of Tools

Tool	Description	Organization	Source
<b>Global Action Plan on AMR (GAP-AMR)</b>	This benchmark tool enables countries to devise a context-specific national action plan on AMR.	World Health Organization	<a href="https://www.who.int/antimicrobial-resistance/publications/global-action-plan/en/">https://www.who.int/antimicrobial-resistance/publications/global-action-plan/en/</a>
<b>Strategy on AMR and the Prudent Use of Antimicrobials</b>	This tool presents a top-level OIE-specific strategy on actions to combat AMR.	World Organisation for Animal Health	<a href="https://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PortailAMR/EN_OIE-AMRstrategy.pdf">https://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PortailAMR/EN_OIE-AMRstrategy.pdf</a>
<b>FAO Action Plan on Antimicrobial Resistance</b>	The FAO-specific plan supports the food and agriculture sectors in implementing GAP-AMR.	Food and Agriculture Organization	<a href="http://www.fao.org/3/a-i5996e.pdf">http://www.fao.org/3/a-i5996e.pdf</a>
<b>FAO Assessment Tool for Laboratories and Surveillance Systems (FAO-ATLASS)</b>	This tool assesses laboratories and antimicrobial resistance surveillance systems at national and regional levels.	Food and Agriculture Organization	<a href="http://www.fao.org/antimicrobial-resistance/resources/tools/fao-atlass/en/">http://www.fao.org/antimicrobial-resistance/resources/tools/fao-atlass/en/</a>
<b>Progressive Management Pathway for AMR (FAO-PMP AMR)</b>	This self-assessment tool provides guidance for countries in developing and implementing a multisector One Health national action plan.	Food and Agriculture Organization	<a href="http://www.fao.org/antimicrobial-resistance/resources/tools/fao-pmp-amr/en/">http://www.fao.org/antimicrobial-resistance/resources/tools/fao-pmp-amr/en/</a>
<b>FAO Surveillance Evaluation Tool</b>	The tool was developed by FAO to provide countries with a comprehensive and standardized way to evaluate animal disease surveillance systems, including zoonoses.	Food and Agriculture Organization	<a href="http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/1129356/">http://www.fao.org/emergencies/resources/documents/resources-detail/en/c/1129356/</a>
<b>FAO Laboratory Mapping Tool (LMT)</b>	This tool assesses the functionality of veterinary laboratories.	Food and Agriculture Organization	<a href="http://www.fao.org/ag/againfo/programmes/en/empres/news_130514.html">http://www.fao.org/ag/againfo/programmes/en/empres/news_130514.html</a>

Tool	Description	Organization	Source
<b>WHO AMR Stewardship Programmes in Healthcare Facilities and LMICs Toolkit</b>	The toolkit provides guidance on core elements and structures that need to be in place at the national and facility level in low-resource countries to establish and support antimicrobial stewardship interventions.	World Health Organization	<a href="https://apps.who.int/iris/bitstream/handle/10665/329404/9789241515481-eng.pdf">https://apps.who.int/iris/bitstream/handle/10665/329404/9789241515481-eng.pdf</a>
<b>Global Antimicrobial Resistance Surveillance System (GLASS)</b>	GLASS was developed to facilitate and encourage a standardized approach to AMR surveillance globally and in turn support the implementation of the Global Action Plan on Antimicrobial Resistance.	World Health Organization	<a href="https://apps.who.int/iris/bitstream/handle/10665/188783/9789241549400_eng.pdf?sequence=1">https://apps.who.int/iris/bitstream/handle/10665/188783/9789241549400_eng.pdf?sequence=1</a>
<b>AWaRe tool</b>	The tool classifies antibiotics into three groups—access, watch, and reserve—and categorizes antibiotics in terms of common and serious infections, availability in the health care system, and sparing or last-resort use.	World Health Organization	<a href="https://adoptaware.org">https://adoptaware.org</a>
<b>The AWaRe Campaign: “Adopt AWaRe. Handle Antibiotics with Care.”</b>	This advocacy material accompanies the AWaRe tool for implementers and policy makers.	World Health Organization	<a href="https://adoptaware.org">https://adoptaware.org</a>
<b>Antibiotic Prescribing and Resistance: Views from Low- and Middle-Income Prescribing and Dispensing Professionals</b>	This report deals with awareness of AMR and knowledge of antibiotics within prescribing and dispensing settings across LMIC contexts.	World Health Organization and Antimicrobial Resistance Centre at the London School of Hygiene and Tropical Medicine	<a href="https://www.who.int/antimicrobial-resistance/LSHTM-Antibiotic-Prescribing-LMIC-Prescribing-and-Dispensing-2017.pdf?ua=1">https://www.who.int/antimicrobial-resistance/LSHTM-Antibiotic-Prescribing-LMIC-Prescribing-and-Dispensing-2017.pdf?ua=1</a>

Tool	Description	Organization	Source
<b>AMR Framework for Action Supported by the IACG</b>	Tool aims to support and accelerate the implementation of the GAP.	Interagency Coordination Group on Antimicrobial Resistance	<a href="https://www.who.int/antimicrobial-resistance/interagency-coordination-group/20170818_AMR_FfA_v01.pdf?ua=1">https://www.who.int/antimicrobial-resistance/interagency-coordination-group/20170818_AMR_FfA_v01.pdf?ua=1</a>
<b>WHO Situation Analysis</b>	Document provides an analysis of initiatives currently being implemented in all six WHO regions to combat AMR.	World Health Organization	<a href="https://www.who.int/drugresistance/documents/situationanalysis/en/">https://www.who.int/drugresistance/documents/situationanalysis/en/</a>
<b>Antimicrobial Resistance: A Manual for Developing National Action Plans</b>	Manual enables countries to devise a context-specific national action plan on AMR.	World Health Organization, Food and Agriculture Organization, and World Organisation for Animal Health	<a href="https://apps.who.int/iris/handle/10665/204470">https://apps.who.int/iris/handle/10665/204470</a>
<b>Country Progress on the Implementation of the Global Action Plan on Antimicrobial Resistance: WHO, FAO, and OIE Global Tripartite Database</b>	This tool collects data on GAP-AMR and national action plan implementation progress.	World Health Organization, Food and Agriculture Organization, and World Organisation for Animal Health	<a href="https://www.who.int/antimicrobial-resistance/global-action-plan/database/en/">https://www.who.int/antimicrobial-resistance/global-action-plan/database/en/</a>
<b>WHO Competency Framework for Health Workers' Education and Training on Antimicrobial Resistance</b>	AMR-related reference guide deals with training, skills, and knowledge for health professionals.	World Health Organization, Food and Agriculture Organization, and World Organisation for Animal Health	<a href="https://www.who.int/hrh/resources/WHO-HIS-HWF-AMR-2018.1/en/">https://www.who.int/hrh/resources/WHO-HIS-HWF-AMR-2018.1/en/</a>
<b>Strategic Research Agenda: Joint Programming Initiative on Antimicrobial Resistance</b>	This platform coordinates programming research on AMR.	Joint Programming Initiative on AMR	<a href="https://www.jpiamr.eu/">https://www.jpiamr.eu/</a>

Tool	Description	Organization	Source
<b>Technical Brief on Water, Sanitation, Hygiene (WASH) and Wastewater Management to Prevent Infections and Reduce the Spread of Antimicrobial Resistance (AMR)</b>	This paper explains WASH and wastewater management for infection prevention.	World Health Organization, Food and Agriculture Organization, and World Organization for Animal Health	<a href="http://www.fao.org/documents/card/en/c/ca9120en">http://www.fao.org/documents/card/en/c/ca9120en</a>
<b>Guidelines on Core Components of Infection Prevention and Control Programmes at the National and Acute Health Care Facility Level</b>	This tool provides guidance to policy makers and facility-level administrators on infection prevention and control programs and on infection prevention in clinical settings.	World Health Organization	<a href="https://apps.who.int/iris/handle/10665/251730">https://apps.who.int/iris/handle/10665/251730</a>
<b>FAO Resource Package on Good Hygiene Practices</b>	This set of resources provides prescriptive guidance on good hygiene practices across food production sectors.	Food and Agriculture Organization	<a href="http://www.fao.org/food/food-safety-quality/publications-tools/food-safety-tools/en/">http://www.fao.org/food/food-safety-quality/publications-tools/food-safety-tools/en/</a>
<b>FAO Good Practices for Biosecurity in the Pig Sector</b>	FAO paper treats biosecurity risks in developing countries and ways to mitigate these risks along pig production and marketing chains.	Food and Agriculture Organization	<a href="http://www.fao.org/3/i1435e/i1435e00.htm">http://www.fao.org/3/i1435e/i1435e00.htm</a>
<b>Antimicrobials in Agriculture and the Environment: Reducing Unnecessary Use and Waste</b>	This paper proposes three broad interventions to reduce the use of antibiotics in food production and to curtail the consequential dispersion of resistant bacteria (through animal waste) into the environment.	The Review on Antimicrobial Resistance	<a href="https://amr-review.org/">https://amr-review.org/</a>



Tool	Description	Organization	Source
<b>Monitoring and Evaluation of the Global Action Plan on Antimicrobial Resistance: Framework and Recommended Indicators</b>	This tool aims to provide a manageable system that can facilitate the generation, collection, and analysis of standardized data to assess the success of the GAP-AMR and inform operational and strategic decision-making on AMR for the next 5-10 years at the national and global levels.	World Health Organization, Food and Agriculture Organization, and World Organisation for Animal Health	<a href="http://www.fao.org/3/ca4650en/ca4650en.pdf">http://www.fao.org/3/ca4650en/ca4650en.pdf</a>
<b>Tripartite AMR Country Self-Assessment Survey (TrACSS)</b>	This tool collects data on GAP-AMR and national action plan implementation progress.	World Health Organization, Food and Agriculture Organization, and World Organisation for Animal Health	<a href="https://cdn.who.int/media/docs/default-source/anti-microbial-resistance/amr-spc-npm/tracss/tripartite-amr-country-self-assessment-survey-2019-20-questionnaire-english.pdf?sfvrsn=f-657c75_1&amp;download=true">https://cdn.who.int/media/docs/default-source/anti-microbial-resistance/amr-spc-npm/tracss/tripartite-amr-country-self-assessment-survey-2019-20-questionnaire-english.pdf?sfvrsn=f-657c75_1&amp;download=true</a>
<b>FAOSTAT</b>	This database collects and provides free access to food and agriculture data.	Food and Agriculture Organization	<a href="http://www.fao.org/faostat/en/#home">http://www.fao.org/faostat/en/#home</a>
<b>FAOLEX</b>	This comprehensive and up-to-date legislative and policy database contains one of the world's largest electronic collections of national laws, regulations, and policies on food, agriculture, and natural resources management.	Food and Agriculture Organization	<a href="http://aims.fao.org/activity/blog/faolex-national-laws-regulations-and-policies-food-agriculture-one-click">http://aims.fao.org/activity/blog/faolex-national-laws-regulations-and-policies-food-agriculture-one-click</a>
<b>FAO Methodology to Analyze AMR-relevant legislation in the food and agriculture sectors</b>	This tool provides guidance for legislators to identify and analyze existing legislation relevant to AMR in a national legal system – highlighting a list of regulatory areas with an impact on AMR.	Food and Agriculture Organization	<a href="http://www.fao.org/3/cb1121en/cb1121en.pdf">http://www.fao.org/3/cb1121en/cb1121en.pdf</a>

Tool	Description	Organization	Source
<b>WHO Benchmarks for IHR Capacities</b>	This tool lists benchmarks and corresponding actions to improve International Health Regulations capacities for health security and to integrate multi-sectoral concerns at subnational (local and regional/provincial) and national levels.	World Health Organization	<a href="https://apps.who.int/iris/bitstream/handle/10665/311158/9789241515429-eng.pdf?sequence=1">https://apps.who.int/iris/bitstream/handle/10665/311158/9789241515429-eng.pdf?sequence=1</a>
<b>Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS)</b>	The objective of GLAAS is to provide policy makers and decision-makers at all levels with a reliable, easily accessible, comprehensive, and global analysis of the investments and enabling environment to facilitate informed decisions for sanitation, drinking water, and hygiene.	World Health Organization	<a href="https://www.who.int/water_sanitation_health/monitoring/investments/glaas/en/">https://www.who.int/water_sanitation_health/monitoring/investments/glaas/en/</a>
<b>AMR Benchmark</b>	This benchmark is used to rank and guide pharmaceutical company action on drug resistance.	Access to Medicines Foundation	<a href="https://accessmedicinefoundation.org/amr-benchmark">https://accessmedicinefoundation.org/amr-benchmark</a>
<b>WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene</b>	This is a global portal for global WASH data.	World Health Organization and United Nations Children's Fund	<a href="https://washdata.org/">https://washdata.org/</a>
<b>WHO Hand Hygiene Self-Assessment Framework, and the WHO Infection Prevention and Control Assessment Framework</b>	Tool allows situation analysis of hand hygiene promotion and practices within an individual health care facility, according to a set of indicators; it also acts as a diagnostic tool, identifying key issues requiring attention and improvement.	World Health Organization	<a href="https://www.who.int/infection-prevention/tools/hand-hygiene/hhsa_framework/en/">https://www.who.int/infection-prevention/tools/hand-hygiene/hhsa_framework/en/</a>

Tool	Description	Organization	Source
<b>OIE PVS Pathway</b>	Toolkit promotes the sustainable improvement of national veterinary services by providing them with a comprehensive understanding of their strengths and weaknesses using a globally consistent methodology.	World Organisation for Animal Health	<a href="https://www.oie.int/solidarity/pvs-pathway/">https://www.oie.int/solidarity/pvs-pathway/</a>
<b>STAR-IDAZ International Research Consortium</b>	This platform coordinates animal health research globally to accelerate delivery of disease control tools and strategies.	International Research Consortium on Animal Health	<a href="https://www.star-idaz.net/">https://www.star-idaz.net/</a>
<b>WHO Model List of Essential Medicines: 20th List</b>	This report presents recommendations made by the WHO Expert Committee on the Selection and Use of Essential Medicines for the 2019 Essential Medicines Lists.	World Health Organization	<a href="http://www.who.int/medicines/publications/essentialmedicines/en/">www.who.int/medicines/publications/essentialmedicines/en/</a>
<b>ReAct Online Toolbox for National Action Plans</b>	This resource package supports countries in the development and implementation of NAPs, utilizing a One Health approach.	ReAct	<a href="http://www.reactgroup.org/toolbox-a-guide-for-national-action-plans">www.reactgroup.org/toolbox-a-guide-for-national-action-plans</a>
<b>Declaration by the Pharmaceutical, Biotechnology and Diagnostics Industries on Combating Antimicrobial Resistance</b>	The declaration, signed by 85 companies and nine industry associations, deals with priority actions against drug resistance, partnerships, and push/pull incentives for sustainable antibiotic market models.	International Federation of Pharmaceutical Manufacturers and Associations	<a href="https://www.ifpma.org/wp-content/uploads/2016/01/Industry_Declaration_on_Combating_Antimicrobial_Resistance_UPDATED-SIGNATORIES_MAY_2016.pdf">https://www.ifpma.org/wp-content/uploads/2016/01/Industry_Declaration_on_Combating_Antimicrobial_Resistance_UPDATED-SIGNATORIES_MAY_2016.pdf</a>

Tool	Description	Organization	Source
<b>Tackling Antimicrobial Resistance: Ensuring Sustainable R&amp;D</b>	This paper discusses potential actions (and G7/G20 roles) to amplify sustainable research and development for antimicrobial therapies.	Organisation for Economic Co-operation and Development, World Health Organization, Food and Agriculture Organization, and World Organisation for Animal Health	<a href="https://www.oecd.org/els/health-systems/G20-AMR-Final-Paper-2017.pdf">https://www.oecd.org/els/health-systems/G20-AMR-Final-Paper-2017.pdf</a>
<b>World Antibiotic Awareness Week 2018: Monitoring &amp; Evaluation Report</b>	The report deals with the country- and regional-level outcomes of the 2018 World Antibiotic Awareness Week.	World Health Organization	<a href="http://www.searo.who.int/entity/antimicrobial_resistance/waaw-2018-monitoring-and-evaluation-report.pdf?ua=1">http://www.searo.who.int/entity/antimicrobial_resistance/waaw-2018-monitoring-and-evaluation-report.pdf?ua=1</a>
<b>Guidelines for the Prevention and Control of Carbapenem-resistant Enterobacteriaceae, Acinetobacter baumannii and Pseudomonas aeruginosa in Healthcare Facilities</b>	These are global guidelines for the prevention and control of carbapenem-resistant Enterobacteriaceae (CRE), Acinetobacter baumannii (CRAB), and Pseudomonas aeruginosa (CRPsA), which are an emerging cause of health care-associated infections.	World Health Organization	<a href="https://www.who.int/infection-prevention/publications/guidelines-cre/en/">https://www.who.int/infection-prevention/publications/guidelines-cre/en/</a>
<b>Global Framework for Development &amp; Stewardship to Combat Antimicrobial Resistance: Draft Roadmap</b>	This tool outlines the current situation around AMR and provides a roadmap for establishing a global framework on the development, control, and use of antimicrobial medicines, diagnostics, and other interventions.	World Health Organization	<a href="https://www.who.int/antimicrobial-resistance/global-action-plan/UpdatedRoadmap-Global-Framework-for-Development-Stewardship-to-combat-AMR_2017_11_03.pdf?ua=1">https://www.who.int/antimicrobial-resistance/global-action-plan/UpdatedRoadmap-Global-Framework-for-Development-Stewardship-to-combat-AMR_2017_11_03.pdf?ua=1</a>

Tool	Description	Organization	Source
<b>WASH in Health Care Facilities: Practical Steps to Achieve Universal Access to Quality Care</b>	This tool presents eight practical actions that governments can take at the national and subnational levels to improve WASH services in health care facilities.	World Health Organization	<a href="https://apps.who.int/iris/bitstream/handle/10665/311618/9789241515511-eng.pdf?ua=1">https://apps.who.int/iris/bitstream/handle/10665/311618/9789241515511-eng.pdf?ua=1</a>
<b>WASH in Health Care Facilities: Global Baseline Report 2019</b>	This tool establishes national, regional, and global baseline estimates for WASH services in health care facilities.	World Health Organization and the United Nations Children's Fund	<a href="https://apps.who.int/iris/bitstream/handle/10665/311620/9789241515504-eng.pdf?ua=1">https://apps.who.int/iris/bitstream/handle/10665/311620/9789241515504-eng.pdf?ua=1</a>
<b>Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines</b>	Paper presents estimates of population with access to "safely managed" drinking water and sanitation services.	World Health Organization and the United Nations Children's Fund	<a href="https://www.unicef.org/publications/files/Progress_on_Drinking_Water_Sanitation_and_Hygiene_2017.pdf">https://www.unicef.org/publications/files/Progress_on_Drinking_Water_Sanitation_and_Hygiene_2017.pdf</a>
<b>Ghana National Action Plan</b>	This is the national action plan on AMR developed by the Government of Ghana.	Government of Ghana	<a href="https://www.fleming-fund.org/wp-content/uploads/67e760a03f8424d543159d2de50a9db5.pdf">https://www.fleming-fund.org/wp-content/uploads/67e760a03f8424d543159d2de50a9db5.pdf</a>
<b>South African Antimicrobial Resistance Strategy Framework: A One Health Approach</b>	This is the national strategy and framework for tackling AMR within the South African context; it utilizes a One Health approach.	Government of South Africa	<a href="https://www.knowledgehub.org.za/elibrary/south-african-antimicrobial-resistance-national-strategy-framework-one-health-approach">https://www.knowledgehub.org.za/elibrary/south-african-antimicrobial-resistance-national-strategy-framework-one-health-approach</a>
<b>Global Priority List of Antibiotic-Resistant Bacteria to Guide Research, Discovery, and Development of New Antibiotics</b>	This tool outlines a global priority pathogens list of antibiotic-resistant bacteria as a useful input for research on and development of antibiotic treatments.	World Health Organization	<a href="https://www.who.int/medicines/publications/global-priority-list-antibiotic-resistant-bacteria/en/">https://www.who.int/medicines/publications/global-priority-list-antibiotic-resistant-bacteria/en/</a>

Tool	Description	Organization	Source
<b>Diagnostic Stewardship: A Guide to Implementation in Antimicrobial Resistance Surveillance Sites</b>	This GLASS companion tool supports microbiological diagnosis, including antimicrobial susceptibility testing.	World Health Organization	<a href="https://apps.who.int/iris/bitstream/handle/10665/251553/WHO-DGO-AMR-2016.3-eng.pdf?sequence=1&amp;isAllowed=y">https://apps.who.int/iris/bitstream/handle/10665/251553/WHO-DGO-AMR-2016.3-eng.pdf?sequence=1&amp;isAllowed=y</a>
<b>Africa CDC Antimicrobial Resistance Surveillance Network (AMRSNET)</b>	This Africa-specific regional approach to surveillance aims to improve mechanisms to monitor, delay emergence of, and limit transmission of AMR.	Africa CDC	<a href="https://africacdc.org/download/africa-cdc-framework-for-antimicrobial-resistance/">https://africacdc.org/download/africa-cdc-framework-for-antimicrobial-resistance/</a>
<b>ASEAN Regional Strategy on AMR Communication and Advocacy</b>	This ASEAN (Association of Southeast Asian Nations)-specific regional approach to advocacy and communication on AMR has a particular focus on prudent use and animal husbandry practices.	Food and Agriculture Organization, ASEAN	<a href="https://asean.org/storage/2012/05/15.-ASEAN-Regional-AMR-Communication-and-Strategy.pdf">https://asean.org/storage/2012/05/15.-ASEAN-Regional-AMR-Communication-and-Strategy.pdf</a>
<b>Estimating the Economic Costs of Antimicrobial Resistance: Model and Results</b>	This global economic burden study addresses the costs and impacts (direct and indirect) of AMR.	RAND Corporation Independent Review on AMR	<a href="https://www.rand.org/pubs/research_reports/RR911.html">https://www.rand.org/pubs/research_reports/RR911.html</a>
<b>Antibacterial Agents in Clinical Development: An Analysis of the Antibacterial Clinical Development Pipeline, Including Tuberculosis</b>	This annual review considers the alignment of the clinical antibacterial pipeline to the WHO priority pathogens list.	World Health Organization	<a href="http://apps.who.int/iris/bitstream/10665/258965/1/WHO-EMP-IAU-2017.11-eng.pdf?ua=1">http://apps.who.int/iris/bitstream/10665/258965/1/WHO-EMP-IAU-2017.11-eng.pdf?ua=1</a>
<b>PVS Gap Analysis Tool</b>	This is a companion planning and costing tool for the PVS Pathway tool.	World Organisation for Animal Health	<a href="https://www.oie.int/solidarity/pvs-gap-analysis/pvs-gap-analysis-tool/">https://www.oie.int/solidarity/pvs-gap-analysis/pvs-gap-analysis-tool/</a>

Tool	Description	Organization	Source
<b>Resistance Map</b>	This collection of charts and maps summarizes national and subnational data on antimicrobial use and resistance globally.	The Center for Disease Dynamics, Economics & Policy	<a href="https://resistancemap.cddep.org">https://resistancemap.cddep.org</a>
<b>Health Workers' Education and Training on Antimicrobial Resistance: Curricula Guide</b>	This is an AMR-related curricula guide on training, skills, and knowledge for health professionals.	World Health Organization	<a href="https://apps.who.int/iris/bitstream/handle/10665/329380/9789241516358-eng.pdf?sequence=1&amp;isAllowed=y">https://apps.who.int/iris/bitstream/handle/10665/329380/9789241516358-eng.pdf?sequence=1&amp;isAllowed=y</a>
<b>The Structured Operational Research and Training Initiative on AMR, Coordinated by the Special Programme for Research and Training in Tropical Diseases (TDR)</b>	The SORT IT Program on AMR is currently implementing 36 operational research studies in five countries (Ghana, Uganda, Sierra Leone, Myanmar, and Nepal).	United Nations Children's Fund, United Nations Development Programme, World Bank, and World Health Organization	<a href="https://www.who.int/tdr/capacity/strengthening/sort/en/#:~:text=The%20Structured%20Operational%20Research%20and,TDR%20and%20implemented%20with%20partners">https://www.who.int/tdr/capacity/strengthening/sort/en/#:~:text=The%20Structured%20Operational%20Research%20and,TDR%20and%20implemented%20with%20partners</a>
<b>Integrated Surveillance of Antimicrobial Resistance</b>	This guidance document addresses efforts to minimize the impact of AMR associated with the use of antimicrobials in food animals.	World Health Organization	<a href="https://apps.who.int/iris/handle/10665/255747">https://apps.who.int/iris/handle/10665/255747</a>
<b>The 4th Annual OIE Report on Antimicrobial Agents Intended for Use in Animals</b>	This is annual report on global data related to the use of antimicrobial agents in animals.	World Health Organization	<a href="https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/A_Fourth_Annual_Report_AMR.pdf">https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/A_Fourth_Annual_Report_AMR.pdf</a>
<b>Tackling Antimicrobial Resistance Together (Working Paper 5.0): Enhancing the Focus on Gender and Equity</b>	The paper outlines gender and equity considerations as countries address AMR.	World Health Organization	<a href="https://www.who.int/antimicrobial-resistance/national-action-plans/workingpaper5enhancingthefocusongenderandequity/en/">https://www.who.int/antimicrobial-resistance/national-action-plans/workingpaper5enhancingthefocusongenderandequity/en/</a>

Tool	Description	Organization	Source
<b>Summary Report of the FAO/WHO Expert Meeting on Foodborne Antimicrobial Resistance: Role of Environment, Crops and Biocides</b>	Report outlines scientific advice on the transmission of antimicrobial-resistant bacteria from environmental sources to foods and feeds of plant and aquatic animal origin.	Food and Agriculture Organization, World Health Organization	<a href="https://www.who.int/foodsafety/areas_work/antimicrobial-resistance/FAO_WHO_AMR_Summary_Report_June2018.pdf?ua=1">https://www.who.int/foodsafety/areas_work/antimicrobial-resistance/FAO_WHO_AMR_Summary_Report_June2018.pdf?ua=1</a>
<b>The Environment as a Driver of Antibiotic Resistance</b>	This is a platform for coordinated research on AMR and the environment focused on sources and drivers and mitigation.	The Centre for Antibiotic Resistance (CARE), the University of Gothenburg, the Swedish Research Council	<a href="https://www.gu.se/en/care/the-environment-as-a-driver-of-antibiotic-resistance-edar">https://www.gu.se/en/care/the-environment-as-a-driver-of-antibiotic-resistance-edar</a>
<b>Frontiers 2017: Emerging Issues of Environmental Concern</b>	This report touches on key emerging issues for consideration, including the environmental dimension of AMR.	United Nations Environment Programme	<a href="https://www.unenvironment.org/resources/frontiers-2017-emerging-issues-environmental-concern">https://www.unenvironment.org/resources/frontiers-2017-emerging-issues-environmental-concern</a>
<b>Preventing the Next Pandemic: Zoonotic Diseases and How to Break the Chain of Transmission</b>	This report addresses the root causes of emergence and spread of zoonoses.	United Nations Environment Programme	<a href="https://www.unenvironment.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and">https://www.unenvironment.org/resources/report/preventing-future-zoonotic-disease-outbreaks-protecting-environment-animals-and</a>
<b>Reframing Resistance</b>	This is a toolkit on impact communications for AMR (for experts, communicators, and practitioners).	Wellcome Trust	<a href="https://wellcome.org/reports/reframing-antimicrobial-resistance-antibiotic-resistance">https://wellcome.org/reports/reframing-antimicrobial-resistance-antibiotic-resistance</a>
<b>Gulf-Middle East-North Africa Antimicrobial Stewardship Network</b>	This is a MENA (Middle East and North Africa)-specific educational platform for antimicrobial stewardship and related resources.	British Society for Antimicrobial Chemotherapy	<a href="http://mena-ams.com/">http://mena-ams.com/</a>
<b>Tackling Antimicrobial Resistance Together (Working Paper 1.0): Multisectoral Coordination</b>	The paper offers practical guidance on establishing and sustaining multisectoral coordination in the implementation of NAPs for AMR.	World Health Organization	<a href="https://www.who.int/antimicrobial-resistance/publications/workingpaper1multisectoralcoordination-AMR/en/">https://www.who.int/antimicrobial-resistance/publications/workingpaper1multisectoralcoordination-AMR/en/</a>



Tool	Description	Organization	Source
<b>An Analysis of the Animal/Human Interface with a Focus on Low- and Middle-Income Countries</b>	The report outlines antimicrobial use and AMR in livestock and farmed aquatic species in LMICs, and includes recommendations for surveillance and research.	The Fleming Fund, Wellcome Trust	<a href="https://www.fleming-fund.org/publications/animal-human-interface/">https://www.fleming-fund.org/publications/animal-human-interface/</a>
<b>Antimicrobial Resistance National Action Plan (2018–2023)</b>	This national action plan on AMR was developed by the Government of Uganda.	Government of Uganda	<a href="https://cddep.org/wp-content/uploads/2018/12/GoU_AMR-NAP.pdf">https://cddep.org/wp-content/uploads/2018/12/GoU_AMR-NAP.pdf</a>
<b>Malawi National AMR Strategy (2017–2022)</b>	This national action plan on AMR was developed by the Government of Malawi.	Government of Malawi	<a href="cdn.southampton.ac.uk/assets/imported/forms/content-block UsefulDownloads_Download/C6C715AED6784622962EB-300C/A%20Munthali%20-%20Malawi%20AMR%20Strategy.pdf">cdn.southampton.ac.uk/assets/imported/forms/content-block UsefulDownloads_Download/C6C715AED6784622962EB-300C/A%20Munthali%20-%20Malawi%20AMR%20Strategy.pdf</a>
<b>Joint External Evaluation</b>	Tool assesses country capacities and capabilities relevant to the 19 technical areas of joint external evaluation, providing baseline data and recommendations to improve public health security and comply with the International Health Regulations, including AMR components.	World Health Organization	<a href="https://apps.who.int/iris/bitstream/handle/10665/259961/9789241550222-eng.pdf;jsessionid=A71AD-97883319FBA12E-74297798158C6?sequence=1">https://apps.who.int/iris/bitstream/handle/10665/259961/9789241550222-eng.pdf;jsessionid=A71AD-97883319FBA12E-74297798158C6?sequence=1</a>
<b>Global Research on AntiMicrobial Resistance (GRAM) Project</b>	Project facilitates the generation of accurate and timely evidence of AMR burden globally.	University of Oxford Big Data Institute–Institute for Health Metrics and Evaluation (IHME) Strategic Partnership	<a href="http://www.healthdata.org/gram">http://www.healthdata.org/gram</a>
<b>International Instruments on the Use of Antimicrobials across the Human, Animal and Plant sectors</b>	Developed by the Tripartite organizations, the tool provides an overview and analysis of international instruments that outline standards related to the use of antimicrobials across the human, animal, and plant sectors.	World Health Organization, Food and Agriculture Organization, and World Organisation for Animal Health	<a href="https://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PortailAMR/EN_OIE%20Triparite%20AMU%20Joint%20Instruments_V5_WEB.pdf">https://www.oie.int/fileadmin/Home/eng/Media_Center/docs/pdf/PortailAMR/EN_OIE%20Triparite%20AMU%20Joint%20Instruments_V5_WEB.pdf</a>

Tool	Description	Organization	Source
<b>US CDC Laboratory Assessment of AMR Testing Capacity (LAARC)</b>	This laboratory assessment tool is used in clinical bacteriology laboratories in low- and middle-income countries to help laboratories identify and correct practices that contribute to inaccurate antibiotic resistance data.	US Centers for Disease Control and Prevention	<a href="https://www.cdc.gov/drugresistance/intl-activities/laarc.html">https://www.cdc.gov/drugresistance/intl-activities/laarc.html</a>
<b>Guidelines for the Development of National Action Plan for Health Security</b>	The tool outlines a three-step approach to help countries plan and implement priority actions to attain health security; it builds on and refers to all existing policies, agreements, strategies, and frameworks at the national, regional, and global levels to facilitate a multisectoral approach.	World Health Organization	<a href="https://www.who.int/ihr/publications/WHO-WHE-CPI-2018.52/en/">https://www.who.int/ihr/publications/WHO-WHE-CPI-2018.52/en/</a>
<b>Industry Alliance against AMR Progress Report</b>	The report describes the life sciences industry's efforts to meet global commitments and take action to tackle the rise of AMR in the areas of research and science, access, appropriate use, and environmental manufacturing.	AMR Industry Alliance	<a href="https://www.amrindustryalliance.org/progress-report/">https://www.amrindustryalliance.org/progress-report/</a>
<b>The Industry Roadmap for Progress on Combating Antimicrobial Resistance</b>	Roadmap lays out key commitments to combatting AMR and consolidating stewardship of antibiotics.	International Federation of Pharmaceutical Manufacturers and Associations	<a href="https://www.ifpma.org/resource-centre/industry-roadmap-for-progress-on-combating-antimicrobial-resistance/">https://www.ifpma.org/resource-centre/industry-roadmap-for-progress-on-combating-antimicrobial-resistance/</a>
<b>Time Is Running Out Technical Note</b>	This technical note outlines UNICEF's AMR-related programming and related partnerships with governments and other stakeholders.	United Nations Children's Fund	<a href="https://www.unicef.org/documents/time-running-out">https://www.unicef.org/documents/time-running-out</a>

Tool	Description	Organization	Source
<b>OIE Data Collection Template and Related Guidance<sup>18</sup></b>	This is a template for collecting data on antimicrobial agents intended for use in animals.	World Organisation for Animal Health	Template: <a href="https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/A_AMUse_Template_2018.xls">https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/A_AMUse_Template_2018.xls</a>
<b>Core Elements of Human Antibiotic Stewardship Programs in Resource-Limited Settings</b>	This tool provides a template (core elements) to optimize antibiotic prescription in resource-limited hospital settings.	US Centers for Disease Control and Prevention	<a href="https://www.cdc.gov/antibiotic-use/core-elements/resource-limited.html">https://www.cdc.gov/antibiotic-use/core-elements/resource-limited.html</a>
<b>ACORN (Clinically-Oriented Antimicrobial Resistance Surveillance Network)</b>	This project aims to develop an efficient clinically orientated AMR surveillance system, implemented alongside routine clinical care in hospitals in LMIC settings.	Wellcome Trust, University of Oxford	<a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7250055/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7250055/</a>  <a href="https://figshare.com/articles/online_resource/ACORN_Participant_Information_Sheet/11676453/1">https://figshare.com/articles/online_resource/ACORN_Participant_Information_Sheet/11676453/1</a>
<b>AMR Surveillance in Low- and Middle-Income Settings: A Roadmap for Participation in the Global Antimicrobial Surveillance System (GLASS)</b>	This tool aims to facilitate AMR surveillance and participation in GLASS for LMICs; it outlines an approach that allows the independent development of each component of surveillance to build a comprehensive system.	The Fleming Fund	<a href="https://wellcome-openresearch.s3.amazonaws.com/supplementary/12527/99f63366-743d-473c-b3ad-e96403e4ab3e.pdf">https://wellcome-openresearch.s3.amazonaws.com/supplementary/12527/99f63366-743d-473c-b3ad-e96403e4ab3e.pdf</a>
<b>Critically Important Antimicrobials for Human Medicine: 5th Revision</b>	The WHO Advisory Group on Integrated Surveillance of Antimicrobial Resistance (AGISAR) reviews and updates the WHO list of critically important antimicrobials for human medicine every two years; it ranks medically important antimicrobials for risk management of antimicrobial resistance due to nonhuman use.	World Health Organization	<a href="https://www.who.int/foodsafety/publications/antimicrobials-sixth/en/">https://www.who.int/foodsafety/publications/antimicrobials-sixth/en/</a>

<sup>18</sup> See guidance on how to use the OIE Data Collection Template on the OIE website - [https://www.oie.int/fileadmin/Home/eng/Our\\_scientific\\_expertise/docs/pdf/AMR/2020/ENG\\_AMUse\\_Guidance\\_Final\\_2020.pdf](https://www.oie.int/fileadmin/Home/eng/Our_scientific_expertise/docs/pdf/AMR/2020/ENG_AMUse_Guidance_Final_2020.pdf)

Tool	Description	Organization	Source
<b>WHO Guide for the Stepwise Laboratory Improvement Process Towards Accreditation in the African Region</b>	The tool offers practical guidance to improve laboratory services, infrastructure, and quality assurance, with a focus on the African region.	World Health Organization	<a href="https://www.afro.who.int/sites/default/files/2017-06/guide-for-the-slipta-in-the-african-region071115.pdf">https://www.afro.who.int/sites/default/files/2017-06/guide-for-the-slipta-in-the-african-region071115.pdf</a>
<b>WHO Global Guidelines on the Prevention of Surgical Site Infection</b>	This tool includes a list of 29 evidence-based recommendations for patients and health systems to address health care-associated infections.	World Health Organization	<a href="https://www.who.int/gpsc/ssi-guidelines/en/">https://www.who.int/gpsc/ssi-guidelines/en/</a>
<b>Infection Control in Health-care Personnel: Infrastructure and Routine Practices for Occupational Infection Prevention and Control Services</b>	This tool provides information and recommendations for health care professionals on preventing transmission of infectious diseases among health care personnel and patients.	US Centers for Disease Control and Prevention	<a href="https://www.cdc.gov/infectioncontrol/pdf/guidelines/infection-control-HCP-H.pdf">https://www.cdc.gov/infectioncontrol/pdf/guidelines/infection-control-HCP-H.pdf</a>
<b>WHO Guidelines on Use of Medically Important Antimicrobials in Food-Producing Animals</b>	This tool offers guidelines on use of medically important antimicrobials in food-producing animals, recommending that farmers and the food industry stop routine use of antibiotics to promote growth and prevent disease in healthy animals.	World Health Organization	<a href="https://www.who.int/foodsafety/areas_work/antimicrobial-resistance/cia_guidelines/en/">https://www.who.int/foodsafety/areas_work/antimicrobial-resistance/cia_guidelines/en/</a>

Tool	Description	Organization	Source
<b>Draft WHO Costing and Budgeting Tool for National Action Plans on Antimicrobial Resistance</b>	<p>This modular tool to support countries with the costing and budgeting of prioritized activities included in their NAPs on AMR allows staff to cost prioritized activities. It also allows decision makers to identify different funding flows and existing budget gaps to implement NAPs, and to use dashboards to advocate for additional resources where needed.</p>	<p>World Health Organization</p>	<p><b>To be completed September 2021</b></p>
<b>Draft WHO Implementation Handbook for National Action Plans on Antimicrobial Resistance</b>	<p>The implementation handbook provides comprehensive stepwise guidance for national action plan implementation within the human health sector. It collates and summarizes existing WHO tools and resources to support countries with readiness assessments, governance and multi-sectoral coordination, activity prioritization, and implementation of tools across the strategic objectives of the global action plan on AMR.</p>	<p>World Health Organization</p>	<p><b>To be completed December 2021</b></p>
<b>Draft FAO Situation Analysis of AMR Risks in the Food and Agriculture Sectors</b>	<p>This tool, designed by Regional Office for Latin America and the Caribbean, focuses on the need of LMIC to organize their baseline information on the national AMR situation and its associated risks and gaps to define mitigation measures with a multisectoral approach, coordinated between actors from animal health, public health and the environment.</p>	<p>Food and Agriculture Organization</p>	<p><b>To be completed 2021</b></p>

## Appendix B: Further Details On Methodology

**Table B.1: Overview of the Classification of Tools by Type**

Tool type	Definition	Include if	Exclude if
<b>AMR policy</b>	Formalized process at global, regional, or country level that outlines roles, responsibilities, and expectations for AMR-related programming	Publication type (reports, frameworks, and manuals) outlines high-level AMR-related actions that address interventions including surveillance, infection prevention, responsible use, universal access, innovation, and research and development as the main policy goals to tackle AMR	Publication type does not include description of policy intervention; includes duplicated policies, or older versions of included policies, or is a journal article on policy
<b>Guidelines/ recommendations</b>	Consensus and evidence-based guidance for improving various aspects of AMR program design, developed as a part of WHO/FAO/OIE strategies to prevent current and future AMR-related threats	Publication type (reports and manuals) is a clinical or community practice guidance document consistent with this definition: “provides complete coverage of a health topic or disease... It would be expected to include recommendations in relation to all aspects of the topic (e.g. surveillance, public health and clinical interventions) and to be fully based on systematic reviews of the evidence for each aspect” (WHO 2014)	Systematic review, meta-analysis, consensus conference document, duplicated guidelines, older versions of included guidelines, guidelines not related to AMR, journal article on guidelines
<b>Implementation strategy</b>	Roadmap by which AMR-related strategy can be translated into action	Publication type (mainly reports) outlines goals, indicators, and major projects/initiatives for AMR-related implementation	Publication documents various aspects of AMR without intervention or implementation; does not include description of AMR intervention implementation; is journal article on implementation strategy or position statement

Tool type	Definition	Include if	Exclude if
<b>Regional action plan</b>	Steps outlining regional-level activities, allocation of resources, action items, and progress reporting for optimal AMR programming	Publication type (mainly operational reports, frameworks) or platform outlines regional-level actions on AMR in low-income settings	National action plan; regionally focused study on AMR that is not action plan-focused or enacted by a regional body; journal article on regional AMR action
<b>National action plan</b>	Steps outlining national-level activities, allocation of resources, action items, and progress reporting for optimal AMR programming	Publication type (mainly operational reports) outlines government-led, national level actions on AMR	Regional or global action plan; country-related study on AMR that is not action plan-focused or enacted by a government authority; journal article on national AMR action
<b>Regional surveillance program</b>	System for measuring and monitoring AMR burden at the regional level	Publication type (reports, frameworks, assessments, manuals) or platform outlines standards and methodology for AMR surveillance to strengthen evidence and drive action at the regional level	Publication type or platform does not provide description of integrated monitoring systems and approaches; describes only national approaches to surveillance and monitoring; is a journal article on regional surveillance
<b>National surveillance program</b>	System for measuring and monitoring AMR burden at the national level	Publication type (reports, frameworks, assessments, manuals) or platform articulates standards and methodology for AMR surveillance to strengthen evidence and drive action at the national level	Publication type or platform does not provide description of national monitoring systems and approaches; describes only regional approaches to surveillance and monitoring; is a journal article on national surveillance

Tool type	Definition	Include if	Exclude if
<b>Research program</b>	Research agenda or initiative to strengthen evidence on the links between antibiotic use and resistance, alternatives to antibiotics, and the transfer of resistant bacteria between people, animals, food, and the environment	Publication type (reports, manuals), network, or platform outlines operational AMR-related research (i.e., improving the quality of AMR surveillance data, understanding antibiotic consumption patterns and guiding rational use, preventing infection in health facilities, and addressing AMR in the agriculture and environment sectors using the One Health approach)	Publication type, platform, or network focuses only on the preclinical antibacterial pipeline; does not provide description of operational AMR research (i.e., improving the quality of AMR surveillance data, understanding antibiotic consumption patterns, preventing infection in health facilities, and addressing AMR in the agriculture and environment sectors using the One Health approach); is journal article on operational research
<b>Economic mechanism</b>	Strategy or approach for measuring the economic impact of AMR and financing AMR action	Publication type (reports, plans, or models) outlines methodologies for costing the impact of AMR and public-private financing for AMR response	Publication type does not outline methodology for costing AMR burden, interventions, related actions, or cost of AMR for key pathogens at the global level, and within individual or grouped LICs



**Table B.2: Overview of the Classification of Tools by Audience**

<b>Audience</b>	<b>Definition and/or example</b>
<b>Governments</b>	Government personnel and senior staff at ministries of health, agriculture, and environment coordinating national human, animal, and environmental health and AMR-related activities
<b>International organizations, NGOs</b>	International organizations (such as WHO, FAO, and OIE) and nonprofit entities (such as ReAct) taking action to minimize the emergence and spread of AMR
<b>Scientific bodies, research bodies</b>	Scientific and research entities conducting and disseminating research on AMR
<b>Health professionals, veterinarians, human health facilities personnel, surveillance personnel</b>	Personnel involved in antimicrobial stewardship and conservation, and facilities and networks developing and coordinating AMR and public health surveillance and other AMR-related activities
<b>Farmers, traders, producers</b>	Key stakeholders in the production, dissemination, and use of antimicrobials who can play roles to limit the emergence and spread of AMR

Table B.3: Search Terms

Antibiotics/ antimicrobial resistance	Tools	Awareness raising	Antimicrobial stewardship
<p><b>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Antibacterial agent OR resistance OR drug resistance OR multi-drug resistance</b></p> <p><b>AND</b></p> <p>“awareness*” OR “stewardship*” OR “surveillance*” OR “infection, prevention and control*” OR “pathogen spread*” OR “research agenda*” OR “costing*” OR “One Health*”</p> <p><b>AND</b></p> <p>“low- and middle-income country” OR “LMIC” OR “resource-limited setting” OR “national” OR “regional” OR “international”</p> <p><b>AND</b></p> <p>plan OR report OR guideline OR recommendation OR program* OR intervention OR standards</p> <p><b>AND</b></p> <p>Framework* OR approach OR initiative OR model OR methodology OR system* OR network OR policy OR strategy OR mechanism OR platform</p>	<p>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Antibacterial agent OR resistance OR drug resistance OR multi-drug resistance</p> <p><b>AND</b></p> <p>“awareness*” OR “stewardship*” OR “surveillance*” OR “infection, prevention and control*” OR “pathogen spread*” OR “research agenda*” OR “costing*” OR “One Health*”</p> <p><b>AND</b></p> <p>“low- and middle-income country” OR “LMIC” OR “resource-limited setting” OR “national” OR “regional” OR “international”</p> <p><b>AND</b></p> <p>plan OR report OR guideline OR recommendation OR program* OR intervention OR standards</p> <p><b>AND</b></p> <p>Framework* OR approach OR initiative OR model OR methodology OR system* OR network OR policy OR strategy OR mechanism OR platform</p>	<p>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Antibacterial agent OR resistance OR drug resistance OR multi-drug resistance</p> <p><b>AND</b></p> <p>“knowledge*” OR “awareness campaign*” OR “training” OR “antibiotic prescription” OR “training” OR “education” OR “communication”</p> <p><b>AND</b></p> <p>“prescriber” OR “human health professional” OR “community health center” OR “animal health professional” OR “general practice”</p> <p><b>AND</b></p> <p>stewardship OR “inappropriate prescribing” OR “antibiotic overuse” OR guideline OR program* OR standards</p> <p><b>AND</b></p> <p>Framework OR approach OR plan OR model OR system OR policy OR strategy</p>	<p>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Antibacterial agent OR resistance OR drug resistance OR multi-drug resistance</p> <p><b>AND</b></p> <p>“prescribing*” OR “antibiotic therapy” OR “antibiotic treatment” OR “antibiotic prescription”</p> <p><b>AND</b></p> <p>“primary care” OR “primary health care” OR “primary health-care” OR outpatients”</p> <p>OR “community health center*” OR “general practice” OR “veterinary health” OR “aquaculture” OR “agriculture” OR “plant agriculture”</p> <p><b>AND</b></p> <p>stewardship OR “inappropriate prescribing” OR “antibiotic overuse” OR “restrictive strategy” OR</p> <p>“restrictive policy” OR optimization OR guideline OR program OR standards</p> <p><b>AND</b></p> <p>Framework OR approach OR plan OR model OR system OR policy OR strategy</p>

Surveillance, monitoring, and research for national surveillance systems	Infection prevention and control	Reduction of the spread of pathogens into the environment	Operational research agenda
<p>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Anti-bacterial agent OR resistance OR drug resistance OR multi-drug resistance</p> <p>AND</p> <p>“surveillance*” OR “clinical surveillance” OR “antibiotic use” OR “antimicrobial susceptibility testing” OR “isolate identification” OR “epidemiology” OR “monitoring” OR “data collection” OR “data management”</p> <p>AND</p> <p>“health facilities” OR “laboratory services” OR “quality control” OR “quality assurance”</p> <p>OR “sentinel site” OR “national reference center” OR “community health center” OR “inpatient and outpatient”</p> <p>AND</p> <p>stewardship OR network OR guideline OR program* OR standards</p> <p>AND</p> <p>Framework* OR approach OR plan OR model OR system* OR policy OR strategy OR mechanism</p>	<p>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Antibacterial agent OR resistance OR drug resistance OR multi-drug resistance</p> <p>AND</p> <p>“Infection, prevention and control*” OR “prevention” OR “antibiotic use” OR “sanitation” OR “hygiene” OR “intervention”</p> <p>AND</p> <p>“health facilities” OR “primary care” OR “primary health care” OR “primary health-care” OR outpatients”</p> <p>OR “community health center*” OR “general practice”</p> <p>AND</p> <p>stewardship OR guideline OR program* OR standards</p> <p>AND</p> <p>Framework* OR approach OR plan OR model OR system* OR policy OR strategy OR mechanism</p>	<p>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Antibacterial agent OR resistance OR drug resistance OR multi-drug resistance</p> <p>AND</p> <p>“pathogen spread*” OR “antibiotic residue” OR “resistant microbes” OR “terrestrial” OR “aquatic” OR “environment” OR “waste management”</p> <p>AND</p> <p>stewardship OR guideline OR program* OR standards</p> <p>AND</p> <p>Framework* OR approach OR plan OR model OR system* OR policy OR strategy OR mechanism</p>	<p>Antibacterial* OR Anti-bacterial* OR Antibiotic* OR Anti-biotic* OR Antimicrobial* OR Anti-microbial OR Antibacterial drug OR Antibacterial agent OR resistance OR drug resistance OR multi-drug resistance</p> <p>AND</p> <p>“research agenda*” OR “implementation research” OR “evidence” OR “capacity” OR “gaps”</p> <p>AND</p> <p>“low- and middle-income country” OR “LMIC” OR “resource-limited setting”</p> <p>AND</p> <p>stewardship OR “inappropriate prescribing” OR “antibiotic overuse” OR guideline OR program* OR standards</p> <p>AND</p> <p>Framework* OR approach OR plan OR model OR system* OR policy OR strategy OR mechanism</p>

## Appendix C: Expert Consultations

**We are grateful for the guidance provided by the following experts, who generously provided time and technical guidance.**

- Anand Balachandran, Unit Head, National Action Plans and Monitoring and Evaluation Unit, AMR Division, World Health Organization
- Arshnee Moodley, Team Leader, International Livestock Research Institute, AMR Hub, CGIAR
- Breeda Hickey, Technical Officer, National Action Plans and Monitoring and Evaluation Unit, AMR Division, World Health Organization
- Clara L. Davis, Science and Technology Advisor, USAID
- Constanza Vergara, Veterinarian and Agricultural Economist, Chilean Ministry of Agriculture
- Elizabeth Tayler, Team Lead, National Action Plans and Monitoring and Evaluation Unit, AMR Division, World Health Organization
- Javiera Cornejo Kelly, Assistant Professor, Faculty of Animal and Veterinary Sciences, University of Chile
- Jing Xu, Animal Production and Health Division, Animal Health Service, Food and Agriculture Organization
- Jorge Pinto Ferreira, Deputy Head, AMR and Veterinary Products Department, World Organisation for Animal Health
- Nobuko Ichikawa, Principal Environmental Economist/Environmental Advisor, European Bank for Reconstruction and Development
- Olga B. Jonas, Research Associate, Department of Health Policy and Management, Harvard University T. H. Chan School of Public Health
- Renzo Guinto, Associate Professor of Global Public Health, St. Luke's Medical Center College of Medicine
- Sarah Paulin, Technical Officer, National Action Plans and Monitoring and Evaluation Unit, AMR Division, World Health Organization





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