Stopping the Grand Pandemic: A Framework for Action
Addressing Antimicrobial Resistance through World Bank Operations

Summary Report
May 2024
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Foreword

In 1928, when Sir Alexander Fleming made the serendipitous discovery of penicillin, few could imagine how antimicrobials would transform societies, save lives, and enable livelihoods across the globe. Able to prevent a simple cut from becoming a death sentence and to support sustainable agricultural and food systems across the world, antimicrobials are powerful public goods and essential infrastructure. Importantly, they are a powerful tool for health security and economic development. They support communities around the world, many of whom are battling complex and multifaceted crises across the human health, climate, and environment nexus.

Yet the fight to preserve these powerful tools is being lost and a “Grand Pandemic” is already here. In 2019, antimicrobial resistance (AMR) was associated with close to 5 million deaths globally. That’s more than the number attributed to HIV/AIDS or malaria—making AMR the world’s third leading underlying killer. AMR impacts every community and every country, but the data show that those in low-income settings are disproportionately impacted. As the drugs stop working, we will lose our ability to treat diseases and perform life-enhancing surgeries, let alone to treat emerging pathogens of pandemic potential. As resistance is not confined to one pathogen but characterizes an increasing number of pathogens for which we have no medical countermeasures, the compounded impact of AMR on health, social, and economic outcomes across countries and regions stands to be staggering. Meanwhile, tackling AMR will save millions of lives, help our world to realize the Sustainable Development Goals, build resilient and sustainable societies, and increase human capital and productivity.

Much like COVID-19, AMR knows no borders. Addressing the spread of AMR requires improving health and animal systems at the local, regional, and country levels, and ensuring that those systems are connected. The experience of the COVID-19 pandemic made clear the importance of sustainable investments in health systems in pursuit of eradicating poverty and boosting shared prosperity on a livable planet.

A new and actionable consensus—one that recognizes the importance of preventive action and specific investments to improve human, animal, and environmental health systems—is essential. Each country should help avert the Grand Pandemic. This Framework for Action is intended to support countries in designing and implementing interventions to address AMR. It provides options across the health, water, and agricultural sectors, evidence on how to shape those interventions, and examples of what has worked in multiple settings. This report showcases actions that have been and can be taken to address AMR. Moreover, the World Bank will support countries—with financing and technical assistance—in implementing these actions. The World Bank is currently supporting more than 60 operations that address AMR and remains committed to ensuring that communities all over the world have sustainable access to life-saving antimicrobials. The discovery of antimicrobials was one of the most important public health advances of the 20th century, and we hope to ensure that generations to come can benefit from these powerful tools.
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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AGF</td>
<td>Agriculture and Food (refers to the World Bank Global Practice)</td>
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<tr>
<td>AMC</td>
<td>antimicrobial consumption</td>
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<td>AMR</td>
<td>antimicrobial resistance</td>
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<td>AMU</td>
<td>antimicrobial use</td>
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<tr>
<td>ARG</td>
<td>antibiotic-resistant gene/antimicrobial-resistant gene</td>
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<tr>
<td>CDC</td>
<td>Centers for Disease Control and Prevention</td>
</tr>
<tr>
<td>ENB</td>
<td>Environment, Natural Resources and the Blue Economy (World Bank Global Practice)</td>
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<tr>
<td>ESS</td>
<td>Environmental and Social Standard</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agriculture Organization</td>
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<td>GP</td>
<td>Global Practice (organizational division of the World Bank)</td>
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<td>HIC</td>
<td>high-income country</td>
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<tr>
<td>HNP</td>
<td>Health, Nutrition and Population (World Bank Global Practice)</td>
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<tr>
<td>LMICs</td>
<td>low- and middle-income countries</td>
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<td>MDR</td>
<td>multidrug resistance</td>
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<tr>
<td>NAP</td>
<td>National Action Plan</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
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<tr>
<td>PDR</td>
<td>pan-drug resistance</td>
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<tr>
<td>SF</td>
<td>substandard and falsified</td>
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<tr>
<td>TB</td>
<td>tuberculosis</td>
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<tr>
<td>UNEP</td>
<td>United Nations Environment Programme</td>
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<tr>
<td>WASH</td>
<td>water, sanitation, and hygiene</td>
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<td>WHO</td>
<td>World Health Organization</td>
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<td>WOAH</td>
<td>World Organisation for Animal Health</td>
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<td>XDR</td>
<td>extensive drug resistance</td>
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All dollar amounts are US dollars unless otherwise indicated.
Executive Summary

Antimicrobial resistance (AMR) is a global health security and development challenge that poses a threat to public health and economic prosperity. It is a challenge that is often overlooked. As antimicrobials have become part of the infrastructure of modern society, it has become all too easy to take them for granted; but their longevity is under threat. Antimicrobials and antibiotics are widely used for health, industrial, and agricultural purposes. In health care, they are inextricably linked to the advances in modern public health that societies have witnessed in recent decades. They have become a go-to medication for a variety of infections, from strep throat to sepsis. They have also become essential to agricultural and food systems and are used in crop and livestock management. Nevertheless, inappropriate use of antimicrobials threatens their sustainability, and the devastating impact of this development, in which the drugs we know and rely on cease to work, is already emerging. In 2019, an estimated 4.95 million deaths were associated with bacterial AMR, more than the number of deaths attributed to AIDS, HIV, and malaria—making AMR one of the world’s biggest killers (Antimicrobial Resistance Collaborators 2022). The impact of AMR is not limited to human health. In 2017, the World Bank estimated that by 2050, unchecked AMR could wipe away 3.8 percent of global gross domestic product each year and push 28 million people into poverty (World Bank 2017).

In the face of this challenge, the World Bank stands ready to support governments in designing and implementing approaches to preserve antimicrobials with financing and technical assistance. This Framework for Action (Framework) aims to support World Bank task teams and clients in designing interventions that address AMR, with a focus on low- and middle-income countries (LMICs), which stand to be disproportionately impacted. This Framework outlines 20 intervention areas across the health, agriculture, and water sectors that can serve as starting points for discussions to develop sustainable systems addressing AMR at the national and regional levels. Tackling AMR is crucial to achieving universal health coverage, promoting good health, and attaining the Sustainable Development Goals (SDGs). To the challenge of addressing AMR, the World Bank brings operational expertise, finance, and the ability to mobilize additional resources for multisectoral programs through its operations and technical support.

The challenge posed by AMR is not universally intractable; from improving handwashing in health care settings to banning the use of antimicrobials as growth promoters in agriculture, there is much that can be done. The perceived complexity of AMR, lack of awareness about the steps that can be taken to address the issue, and insufficient financing have been identified as barriers to investing in relevant interventions. However, based on a review of existing evidence, the World Bank has identified several key intervention areas to highlight in the design and development of World Bank operations. These are shown in Table 1. This list is not exhaustive or intended to imply that other interventions are not as valuable, but rather aims to provide a starting point for action.
### Table 1. Intervention Areas

#### Health

<table>
<thead>
<tr>
<th>#</th>
<th>Intervention Area</th>
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<tbody>
<tr>
<td>1</td>
<td>Improving infection prevention and control in health care settings</td>
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<tr>
<td>2</td>
<td>Improving prescribing practices through guidelines for health care workers</td>
</tr>
<tr>
<td>3</td>
<td>Conducting public awareness campaigns</td>
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<tr>
<td>4</td>
<td>Increasing human health laboratory capacity and access to diagnostics</td>
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<tr>
<td>5</td>
<td>Strengthening surveillance of antimicrobial use (AMU) and AMR in human populations</td>
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#### Water and environment

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<tr>
<td>12</td>
<td>Improving infrastructure to provide access to water and sanitation in health care centers</td>
</tr>
<tr>
<td>13</td>
<td>Implementing effective treatment and disposal of sewage and wastewater</td>
</tr>
<tr>
<td>14</td>
<td>Improving waste management practices in agricultural and aquaculture production/processing</td>
</tr>
<tr>
<td>15</td>
<td>Improving safe disposal of unused antimicrobials</td>
</tr>
<tr>
<td>16</td>
<td>Monitoring presence of antimicrobial residues and antibiotic-resistant bacteria and genes in water and sanitation systems</td>
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#### Agriculture and food

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<th>Intervention Area</th>
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<tr>
<td>6</td>
<td>Increasing oversight of AMU by veterinarians</td>
</tr>
<tr>
<td>7</td>
<td>Monitoring AMU, surveillance of AMR, and increasing oversight in plant/crop production</td>
</tr>
<tr>
<td>8</td>
<td>Improving animal husbandry practice and biosecurity</td>
</tr>
<tr>
<td>9</td>
<td>Monitoring sales and use of antimicrobials and surveillance of AMR in animals</td>
</tr>
<tr>
<td>10</td>
<td>Promoting behavior change campaigns in animal production</td>
</tr>
<tr>
<td>11</td>
<td>Increasing veterinary laboratory capacity and access to diagnostics</td>
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#### Multisectoral

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<th>Intervention Area</th>
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<tbody>
<tr>
<td>17</td>
<td>Detecting and deterring substandard and falsified antimicrobials (customs/ law enforcement/health/agriculture)</td>
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<tr>
<td>18</td>
<td>Improving human and animal nutrition (health/agriculture)</td>
</tr>
<tr>
<td>19</td>
<td>Expanding vaccination coverage in humans and animals (health/ agriculture)</td>
</tr>
<tr>
<td>20</td>
<td>Using closed water systems in aquaculture (agriculture/environment)</td>
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While AMR is a multisectoral issue, sector-specific entry points are important for mobilizing prompt action. The driving forces behind AMR are shaped by actions in multiple sectors, but entry points for addressing AMR can be sector-specific. Several World Bank Global Practices—Health, Nutrition and Population (HNP), Agriculture and Food (AGF), Environment, Natural Resources and Blue Economy (ENB), and Water—and their relevant sectors can all play an important role, and their respective leadership is critical to ensuring that action is taken.

Each of the intervention areas can also be viewed as part of broader, comprehensive programming, and this report offers and discusses four thematic areas to enable countries to make informed choices about prioritizing and staging their approach to AMR management. The four thematic areas are reducing infections; strengthening monitoring and surveillance of AMR and antimicrobial use (AMU); improving the rational use of antimicrobials; and strengthening sectoral and multisectoral coordination and governance. Countries are at different states of readiness to address AMR, so a comprehensive approach may not always be feasible; however, a broader vision of the range of options can help maximize the effectiveness and sustainability of any given intervention. In instances where there is greater readiness, and where a strong enabling environment and political consensus to address AMR are present, comprehensive programming will be more feasible. In other settings, programming may need to be more opportunistic and targeted. Nevertheless, across different states of readiness, a vision of the range of options remains important, as it offers a window to ensuring that financial and nonfinancial resources are utilized well and sustainably. In all states of readiness, actions can be taken to address AMR.

References


A Primer on AMR

What are antimicrobials and what is antimicrobial resistance?

Antimicrobials, a broad range of products that prevent the growth of or destroy bacteria, fungi, parasites, and even certain viruses, are essential tools that underpin modern society. Antimicrobials are critical to human and animal health systems as well as to the sustainability of food systems. They are widely used to prevent and treat diseases in humans and animals and to manage crop production. Antimicrobials are a global public good. All countries can benefit from the successful management of antimicrobial resistance (AMR) because if left unchecked, the world will confront a reality where many infectious diseases have "no cure and no vaccine" (World Bank 2017). No one has an interest in antimicrobials being exhausted. However, the world's collective response as each actor pursues short-term goals is leading to the loss of this vital global public good.

AMR refers to the ability of microbes and other infective organisms (e.g., fungi) and parasites (e.g., malaria) to grow in the presence of substances specifically designed to kill, inactivate, or slow their growth. AMR occurs when microbes change in ways that reduce or eliminate the effectiveness of drugs, chemicals, or other agents used to prevent or cure the infections they cause. When antimicrobial treatments stop working, as many have already, we lose the ability to treat infections effectively and quickly and, in some cases, entirely. Pathogens, which are microbes that can cause disease, can also become resistant to multiple antimicrobials, leading to multidrug resistance (MDR), extensive drug resistance (XDR), and pan-drug resistance (PDR). MDR occurs when a pathogen is resistant to two or more antimicrobial agents in three or more antimicrobial classes. XDR occurs when a pathogen is resistant to at least one agent in all but two or fewer antimicrobial categories (i.e., bacterial isolates remain susceptible to only one or two categories). PDR is defined as resistance to all agents in all antimicrobial categories. Microbes that are resistant to multiple drugs can be referred to as "superbugs." An infection caused by a superbug is harder to treat because fewer drugs are effective against it. In some extreme cases, treatment for superbugs may not even exist.

Why does AMR matter for people, animals, plants, and human and animal health systems?

We rely on antimicrobials to save lives, bolster the resilience of health systems, protect the sustainability of food systems, and safeguard livelihoods—both people’s ability to work and agricultural economies more broadly. AMR matters because the more it grows, the greater the risk to life worldwide. In 2019, drug-resistant infections were a significant contributor to mortality, with an estimated 4.95 million people losing their lives due to such infections. Out of these deaths, 1.27 million were directly attributable to AMR. AMR was one of the world’s biggest killers, responsible for more deaths than AIDS, HIV, and Malaria (Antimicrobial Resistance Collaborators 2022). At an individual level, the more intensive and prolonged treatment regimens required for AMR infections can lead to prolonged hospital stays for patients. As a result, there is a higher risk of catastrophic health expenditure, meaning that more people are vulnerable to poverty due to infections that were previously simpler and cheaper to treat.
People who live in poverty are also more susceptible to infectious diseases, enabling a harmful cycle that is complicated by AMR. At a health system level, AMR substantially increases the financial and nonfinancial resources needed to treat and manage diseases. The efficacy of antimicrobials is essential to the sustainability of livelihoods in the livestock and poultry sectors, as well as the agriculture and food sectors, especially in low- and middle-income countries (LMICs) where biosecurity and animal husbandry systems are still being developed.

What causes AMR?

AMR is driven by actions in multiple sectors, and the misuse and overuse of antimicrobials drives the emergence and spread of resistance. AMR is a naturally occurring phenomenon that results from the mutations in and transfers of genetic material between different microbes. Any use of antimicrobials can result in AMR. Misuse and overuse of antimicrobials—for example, when people take substandard antibiotics for viral infections and when antibiotics are used as growth promoters in animals—increases the likelihood of resistance because it offers more opportunities for pathogens, bacteria, and parasites to overcome antimicrobials. Equally, when people cannot access the antimicrobials they need because they are not available, unaffordable or no longer effective, this makes infections difficult to treat and adds to the burden on healthcare systems.

Misuse and overuse of antimicrobials, a major driver of AMR, is shaped by actions in multiple areas, as shown in Figure 1. The spread of microbes resistant to antimicrobials can occur between people, animals, and plants and across the environment (in water, soil, and air). As highlighted by the World Health Organization (WHO), poor hygiene and infection control, inadequate sanitary conditions, and inappropriate food handling all contribute to the spread of AMR. AMR drivers operate through a range of causal pathways that lead to high-risk conditions for AMR emergence and spread. For example, inadequate regulation of antimicrobials in health and agriculture, or inadequate enforcement of legislation, can be a driver of AMR. The pathways related to regulation include overuse and inappropriate use of antimicrobials in health care settings, the widespread presence of substandard and falsified antimicrobials, the availability of over-the-counter antimicrobials (i.e., those dispensed without a prescription), and the lack of new antimicrobial treatments being approved and become available. In the agricultural and food sectors, antimicrobials are widely used to enhance animal growth, raise animal productivity, and prevent diseases in crops. The lack of good animal husbandry practices, lack of space for isolating sick animals, and lack of veterinary expertise contribute to the inappropriate reliance on antimicrobials to bolster animal health systems.

The pathways that result in AMR are often complex and multifaceted; however, actions can be taken across all sectors to reduce the misuse and overuse of antimicrobials. The Framework for Action describes and provides guidance on 20 intervention areas that can be supported through World Bank operations. The perceived complexity of AMR, lack of awareness about the steps that can be taken to address the issue, and insufficient financing have been identified as barriers to investing in relevant interventions. Chapter 3 describes intervention areas of varying scope and scale that contribute to broader programming areas, as well as findings from a review of evidence to support task teams and clients. This list is not exhaustive or intended to imply that other interventions are not as valuable, but rather aims to provide a starting point for action.
Figure 1. Drivers of Antimicrobial Resistance

Humans
Misuse and overuse of antimicrobials; poor access to quality, affordable medicines, vaccines and diagnostics; lack of awareness and knowledge; population movement

Water, sanitation and hygiene
Lack of access to clean water, sanitation and hygiene; poor infection and disease prevention and control in health care facilities and farms

Environment
Discharge of waste from health care facilities, pharmaceutical manufacturing and farms

Risks to food and feed production, businesses and trade; interaction with climate change

Increased morbidity and mortality in humans and animals

Economic damage, loss of productivity and increased health care expenditures

Terrestrial and aquatic animals
Misuse and overuse of antimicrobials; poor access to quality, affordable medicines, vaccines and diagnostics; lack of awareness and knowledge; movement of animals

Food and feed
Poor infection and disease prevention and control; transmission of resistant pathogens in food production, storage, distribution and preparation

Plants and crops
Misuse and overuse of antimicrobials; poor infection and disease prevention and control

Source: IACG 2019.
What sectors are relevant to AMR?

AMR is a problem that affects and is driven by interconnected factors related to people, animals, plants, and ecosystems across a range of sectors, including health, agriculture, food, water and sanitation, and the environment. These sectors are all relevant to mitigating the rising tide of AMR. Actors within each of these sectors can each take on leadership in addressing AMR. In the health sector, for example, improved prescription practices and vaccination programming can mitigate AMR. Collaborations between sectors can also be powerful and effective. For example, improving sanitation and hygiene through improved infrastructure for clean water in hospital settings can reduce the emergence and spread of disease and reduce the need for antibiotics.

Given the connections between sectors, AMR has been described as a “One Health” issue, and this concept is important for understanding how approaches to addressing AMR can be optimized. One Health is defined as “an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, and ecosystems” (WHO 2021). In terms of practice, a One Health approach involves collaboration and integrated programming and recognizes the interconnected nature of human, animal, and ecosystem health in managing global health security threats. Coordinated One Health action can optimize scarce resources to minimize the emergence and spread of AMR. For example, a disease surveillance system that can monitor the use and rise of resistance in both the animal and human health sectors stands to be more effective than a single-sector surveillance system, given that similar antimicrobials are used in both sectors.

However, it is recognized that relying on coordination across sectors can stifle action, so single-sector actions that are cognizant of multisectoral links can be a critical first step. The challenge of coordinating across different sectors, each of which can have competing demands, budgets, and interests, can lead to inaction. Therefore, while multisectoral programming is often an excellent way to optimize scarce resources and is advised, each sector should also understand how its leadership can advance action to address AMR and how such action can enable current or future action in other sectors. For example, a disease surveillance system in the human health sector can be designed and implemented with an understanding of how it will connect with—and engage with stakeholders in—the veterinary and animal health sector.

What types of interventions are there to address AMR?

**Box 1. Definitions: AMR-Sensitive and AMR-Specific Interventions**

**AMR-specific interventions** have as their main purpose the reduction of AMR emergence and spread. An example is the promulgation and enforcement of regulations to ensure people can obtain antimicrobial medicines only with a valid prescription.

**AMR-sensitive interventions** have other primary purposes (such as improved animal husbandry or a reduction in disease incidence through vaccination) but contribute indirectly to addressing emergence and spread of AMR. They can be designed and delivered to maximize their impact on AMR.

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1. In the context of the World Bank, these sectors are housed under two vice presidencies: Human Development and Sustainable Development. Human Development includes the Health, Nutrition and Population (HNP) Global Practice (GP). Sustainable Development includes the Agriculture and Food (AGF) GP and the Water GP. These GPs work together in areas of crossover; for example, HNP and Water often collaborate on sanitation and hygiene projects.

2. The definition was developed by the One Health High Level Expert Panel (OHHLEP), which is the advisory panel of the Food and Agriculture Organization of the United Nations, World Organisation for Animal Health, United Nations Environment Programme, and World Health Organization.
Actions to address AMR can be divided into two categories: AMR-specific and AMR-sensitive (see Box 1). AMR-specific interventions led by the relevant sectors can play a powerful role in addressing AMR. For example, in health, AMR can be addressed by improving prescription practices to increase the rational use of antibiotics and limit unnecessary prescription (e.g., of antibiotics for viral infections). In agriculture, reducing and eliminating the use of antimicrobials as growth promoters and facilitating the uptake of improved husbandry practices have been shown to reduce AMR (European Commission 2022). Actions to address AMR can also be built into the approach across sectors. These AMR-sensitive approaches are based on the recognition that AMR is driven by anthropological and socioeconomic factors (Collignon et al. 2018), that the spread of resistant strains and genes is a dominant factor in the rise of AMR, and that reducing antimicrobial use alone will not be sufficient to address AMR. Improving sanitation, increasing access to clean water, and improving governance and private health sector regulation are examples of AMR-sensitive measures that are necessary to reduce the emergence and spread of AMR.

References


Why Addressing AMR Remains Critical to Global Health Security and Global Development

**Summary.**

In 2019, antimicrobial resistance (AMR) was one of the biggest killers worldwide—yet it remains a neglected threat to global health security. Despite AMR’s substantial global impact to date, and the recognition that, if unchecked, AMR stands to kill more than 10 million people each year by 2050 (Antimicrobial Resistance Collaborators 2022), AMR is often overlooked, and antimicrobials taken for granted.

Addressing AMR is critical to global health security because antibiotics are an essential tool for quickly and effectively managing and preventing disease. The lack of sustainable access to antimicrobials threatens basic and modern medicine and risks undoing public health gains of the last century. Antimicrobials are vital to the resilience of health systems: they are a first line of defense for a host of health conditions, from minor wounds to complex surgeries, and they enable health systems to manage routine care and respond to shocks such as pandemics.

Addressing AMR is a development challenge that will negatively and disproportionately impact low- and middle-income countries (LMICs). By 2050, a high-AMR scenario could wipe away 3.8 percent of global gross domestic product each year and push 28 million people into poverty (World Bank 2017). Antimicrobials are a global public good that are entwined with our ability to meet the Sustainable Development Goals (SDGs). They are vital to our ability to sustain and improve global reductions in child and maternal mortality, to end extreme poverty and promote shared prosperity, to end hunger, to promote healthy lives and well-being, and to achieve sustainable and inclusive economic growth.
Antimicrobial resistance as a threat to global health security and global development

In 2019, antimicrobial resistance was one of the biggest killers worldwide (Antimicrobial Resistance Collaborators 2022); despite this substantial impact on global health security, AMR is often overlooked. Despite its substantial global impact to date, and the recognition that, left unchecked, AMR stands to kill more than 10 million people each year by 2050, AMR is often overlooked, and the power of antimicrobials is taken for granted. Nevertheless, no one is immune from the threat of AMR, and citizens of LMICs stand to be disproportionately and negatively impacted. By 2050, a high-AMR scenario could wipe away 3.8 percent of global gross domestic product each year and push 28 million people into poverty (World Bank 2017).

Addressing AMR remains critical to the future of global health security and global development, as antimicrobials are essential for managing human and animal health systems, ensuring the sustainability of our food systems, and protecting life as we know it today. Antimicrobials have become critical infrastructure within modern society; therefore, AMR has the potential to upend ordinary life (World Bank 2019. Antimicrobials are used every day for a wide range of animal and human health needs. They have become commonplace across modern medicine and are used to treat people with infected bites and wounds, patients undergoing complex surgeries, cancer and heart failure patients, and women delivering babies, as well as children, the elderly, and people with HIV or with weakened immune systems. Antimicrobials are also used to treat sick animals and to control the spread of disease.

The misuse and overuse of antimicrobials has accelerated AMR, which is aggressively threatening the ability of health systems to manage disease quickly and effectively—in terms of both the quality and cost of care. The treatment of tuberculosis (TB) highlights the negative impact of AMR. In 2019, nearly half a million people developed rifampicin-resistant TB, 78 percent of whom were infected with multidrug- or extensive drug-resistant (MDR-TB or XDR-TB) isolates (WHO 2020a). Drug-resistant TB poses a significant economic threat to households, as treatment can cost up to 25 times more than for drug-susceptible strains and take three times longer to cure (Manjelievskaia et al. 2016). Among people with MDR-TB or XDR-TB and their households, 80 percent face catastrophic costs associated with treatment (defined as costs greater than 20 percent of annual household income) (WHO 2020).

Building sustainable systems across human, animal, and environmental health, as well as water and sanitation, can help keep AMR at bay and preserve vital resources for decades to come. The experience of the COVID-19 pandemic has crystallized the importance of sustainable investments to build and develop the systems that keep citizens and economies around the world healthy. The ability of these systems to support their own sectors, as well as work across sectoral boundaries, will be an important enabler of long-term recovery from COVID-19 and of our collective ability to eradicate poverty and boost shared prosperity. The widespread importance of antimicrobials to modern life requires improving the capacity of health and animal systems at the local, regional, and country levels, and improving the ability of systems to connect, work, and collaborate with other systems. For example, a local surveillance network that connects to a national and regional system will be better placed to understand trends and transmission patterns of resistance, support the development of mitigation measures, and preserve the efficacy of essential medicines. This type of investment can optimize the use of antimicrobials as public goods.
The world remains at a critical juncture in translating the experience of COVID-19, which painfully demonstrated the importance of strong systems, into tangible investments that safeguard our collective future with global public goods such as efficacious antimicrobials. COVID-19 drove an additional 97 million people into extreme poverty in 2020 (World Bank 2021). A new and actionable consensus—one that recognizes the importance of preventive action and specific investments to improve human, animal, and environmental health systems—is essential. Without it, critical tools such as antimicrobials will not be safeguarded, and our ability to manage disease will be severely limited.

Interventions to address AMR are among the most cost-effective investments that can be made in the health and agricultural sectors, and the economic case for action has been clearly established. The emergence of drug-resistant pathogens is inevitable, but widespread AMR can be controlled through interventions in health, agriculture, water and sanitation, and environmental sectors, as well as many others, as it is accelerated by human behavior. Health systems perform the core functions of early detection and of prompt and effective control of AMR. In 2012, spending on these systems was identified as having a high expected economic return (57–86 percent a year) (World Bank 2012). In 2019, the Organisation for Economic Co-operation and Development (OECD) conducted an analysis of progress toward tackling the burden of AMR in high-income countries and found that investing €1.5 per capita per year in a comprehensive package of mixed public health interventions would avoid 27,000 deaths per year in the European Union. Moreover, the package of interventions would pay for itself in one year alone and return approximately €1.4 billion in savings (OECD 2019). Across the OECD, interventions to promote the prudent use of antibiotics in hospitals were costed at US$0.3 to US$2.7 per capita per year in many OECD countries (OECD 2018).

Despite this compelling economic case at the global level, many factors have hindered progress on AMR, including the nature of antimicrobials as global public goods, the need for multisectoral solutions with an integrated systems perspective, the perception of complexity, general lack of awareness, and financing gaps. In 2020, the Wellcome Trust noted that action on AMR has entered a “state of paralysis” (Wellcome 2020a, 11); several barriers have inhibited movement from consensus on the importance of AMR to coordinated action and financing for addressing AMR. One challenge relates to communicating the importance of AMR to policy makers, budget holders, and the general public, given the perceived complexity of the topic. As the shared experience with COVID-19 has shown, simple measures—improved hand hygiene and improved infection prevention and control measures in hospital and everyday settings—can have a powerful impact on the spread of disease. Responding to AMR is no different.

The under-recognition of AMR as a global threat may be attributed to various factors, including funding challenges, the long-term nature of the AMR challenge, and the complex nature of AMR and its multifaceted impact on health systems, economies, and societies. Results for the 2019–2020 Tripartite AMR country self-assessment survey (TrACSS 4.0) conducted by the World Health Organization (WHO) among implementers of National Action Plans (NAPs) highlighted the critical issue of funding as the primary challenge to effective AMR action. The survey revealed that a significant gap exists between the recognition of the problem and the availability of financial resources to address it. As of 2020, only 14 percent of NAPs had been costed and funded, indicating a considerable shortfall in financial support for AMR initiatives (WHO 2022). The consequences of inadequate funding extend beyond the immediate challenges of combating AMR. Insufficient financial support limits the capacity to raise awareness, educate health care professionals and the public, and develop innovative solutions to tackle AMR. It perpetuates a cycle of limited resources, hindering the development of new antimicrobial drugs, diagnostic tools, and infection prevention measures that are crucial for effectively managing resistant infections.
Securing funding for such comprehensive initiatives can be challenging, especially when resources are limited, and competing priorities exist. Additionally, unlike immediate health crises or emergencies, the consequences of AMR may not be readily apparent or easily quantifiable. This can lead to a perception that investing in AMR prevention and control measures is less urgent than for other pressing health care issues. Moreover, the lack of awareness about the potential catastrophic consequences of AMR among policy makers and the general public can contribute to a reduced sense of urgency and, consequently, limited funding. Efforts to raise awareness about AMR, its impacts, and the importance of investing in prevention and control strategies are crucial to mobilize financial support.

Another example of under-recognition of AMR is the lack of market incentives for the antimicrobial research and development pipeline. R&D for new antimicrobial drugs has experienced a significant decline since the 1980s (Wellcome Trust 2020b), and the current state of the pipeline can be described as inadequate. This decline can be attributed to various factors. One key factor is the high cost associated with conducting R&D for antimicrobials. Antimicrobials may not be as commercially attractive when compared with drugs that require prolonged usage and can command high prices. This lack of commercial viability diminishes the incentives for pharmaceutical companies to invest in the development of new antimicrobial drugs. Without strong economic incentives, there is limited motivation for pharmaceutical companies to allocate resources to antimicrobial research. As a result, the pipeline for new antimicrobial drugs remains stagnant, with fewer potential treatment options being developed. Given this scenario, it becomes increasingly crucial to preserve the effectiveness of existing antimicrobial drugs by minimizing their misuse and overuse, and ensuring sustainable access plans for the few new drugs that become available. By preventing the emergence and spread of antimicrobial resistance through appropriate and responsible use, the available drugs can be preserved for as long as possible.

Individuals, governments, regional entities, multilateral organizations, and development banks all play a role in a proactive response to AMR. Many steps have already been taken, but an unfinished agenda remains. Step one is designing and developing investments to build the strength and resilience of existing systems across the One Health spectrum. The investment case is familiar and clear. Following the COVID-19 pandemic, there is an important opportunity to rebuild systems so they are resilient to future global health security threats. The current moment is a watershed that offers significant opportunities to build human health systems, animal health systems, and food systems that are more proactive, effective, and resilient.

Given its multisectoral drivers, AMR is also closely aligned with the One Health agenda (CDC 2022). A One Health approach can be defined as:

an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals, plants and ecosystems. It recognizes the health of humans, domestic and wild animals, plants, and the wider environment (including ecosystems) are closely linked and interdependent. The approach mobilizes multiple sectors, disciplines and communities at varying levels of society to work together to foster well-being and tackle threats to health and ecosystems, while addressing the collective need for clean water, energy and air, safe and nutritious food, taking action on climate changes and contributing to sustainable development (OHHLEP 2022).
Addressing AMR can benefit from a One Health approach because the antimicrobials used to treat infectious diseases in humans may be the same as or similar to those used in animals, and resistant bacteria arising in humans, animals, or the environment can spread from one domain to the others (WHO 2021a). The One Health Joint Plan of Action (2022–2026) launched by the Quadripartite organizations includes curbing AMR as one of its six action tracks (FAO et al. 2022).

**A One Health approach can help to maximize the effectiveness and sustainability of interventions and can also be cost-effective.** Where collaboration across sectors is possible, a One Health approach in the design and implementation of programs, policies, legislation, and research can allow all sectors to benefit from collaboration, coordination, communication, and capacity strengthening. It is important to acknowledge that multisectoral action is not always possible; but where sectors can tackle AMR together there is scope to achieve critical human, animal, and environmental health outcomes (WHO 2021b). A multisectoral, One Health approach can help to mitigate AMR’s emergence and spread in all domains, and it also offers benefits in related areas such as food safety and food security, biosecurity and animal welfare, WASH (water, sanitation, and hygiene), pollution reduction, emerging infectious disease prevention, and pandemic preparedness and response.

**References**


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3 The Quadripartite members are the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), the World Organisation for Animal Health (WOAH, founded as OIE), and the World Health Organization (WHO). Programme (UNEP), the World Organisation for Animal Health (WOAH, founded as OIE), and the World Health Organization (WHO).


Wellcome. 2020b. “Why Is It So Hard to Develop New Antibiotics.” Why is it so hard to develop new antibiotics? (wellcome.org)


To facilitate better understanding (and funding) of interventions to address antimicrobial resistance (AMR), this chapter provides decision-makers and implementers with 20 intervention areas that can be supported through World Bank operations. The perceived complexity of AMR, lack of awareness about the steps that can be taken to address the issue, and insufficient financing have been identified as barriers to investing in relevant interventions. This chapter describes intervention areas of varying scope and scale that contribute to broader programming areas, as well as findings from a review of evidence to support task teams and clients. This list is not exhaustive or intended to imply that other interventions are not as valuable, but rather aims to provide a starting point for action.

While AMR is a multisectoral issue, sector-specific entry points are important for mobilizing prompt action. The driving forces behind AMR are shaped by actions in multiple sectors, but entry points for addressing AMR can be sector-specific. Several World Bank Global Practices—Health, Nutrition and Population (HNP), Agriculture and Food (AGF), Environment, Natural Resources and Blue Economy (ENB), and Water—and their relevant sectors can all play an important role, and their respective leadership is critical to ensuring that action is taken.

This chapter provides a review of the evidence for intervention areas and guidance on how to optimize investments within these areas across diverse settings. This chapter presents the current state of knowledge for each intervention to orient practitioners to challenges and opportunities. It provides guidance on the feasibility of interventions and considerations to maximize the potential for positive impact.
Introduction

Addressing the significant threat of AMR requires improved awareness of AMR and the interventions that can be taken to address AMR’s emergence and spread. The need for investments in interventions that protect global public goods and ensure no one is left behind in the fight against AMR was highlighted in the World Health Organization (WHO) Global Action Plan on AMR (WHO 2015), and successive Joint External Evaluations (JEEs) have highlighted financing as a constraint to addressing AMR in low- and middle-income countries (LMICs) (WHO 2018; Gupta et al. 2018). The goal of the Global Action Plan was that by 2017, all member states would have a National Action Plan (NAP) on AMR. Countries are in various stages of developing, budgeting, implementing, and evaluating NAPs; however, overall, operationalizing their NAPs remains a challenging process worldwide.

The challenge of developing and implementing NAPs is symptomatic of a broader political economy challenge facing AMR, but greater clarity about the steps that World Bank financing can support should allow more progress on AMR to be achieved. As noted by the Wellcome Trust (2020), the global activity and discussion surrounding AMR have been beneficial in raising awareness of critical issues that can all too easily be overlooked. But interest in AMR has not translated into broader implementation of initiatives, especially in LMICs, because AMR competes for attention and resources with other development priorities. This chapter addresses this limitation by highlighting interventions that are beneficial for AMR but that also contribute to the strengthening of the systems that are critical to addressing AMR, across human and animal health, water and sanitation, and the environment.

The chapter provides World Bank teams and clients with a list of interventions that can guide the design of operations at the country and regional level. The intervention areas are aimed at preventing the emergence and spread of diseases and AMR. The evidence reviews examine the state of existing evidence to glean insights and guidance for the design of operations, while recognizing that a current lack of evidence does not indicate ineffectiveness. In some cases, the intervention has not been studied for AMR specifically, and thus the expected outcomes, challenges, and enabling factors cannot yet be fully determined. The intervention areas in this chapter are not definitive or exhaustive. Rather, they are intended to provide a starting point to support clients and World Bank teams in discussing, selecting, and shaping interventions. This chapter also provides guidance on how to draw on existing evidence to maximize the effectiveness of interventions.
Entry points for Global Practices and sectors for AMR interventions

In countries of varying income levels, a set of interventions have been used in effective AMR programs across the HNP, AGF, Water, and ENB Global Practices (Table 2). These interventions are not equally effective or feasible in all settings, and prioritization of interventions as part of broader programs is especially important in resource-constrained environments. At the national, subnational, or regional level, intervention prioritization should be risk-based, reflecting estimated levels of risk and scale of impact to target resources. In general, AMR interventions related to surveillance, infection prevention and control (IPC), and animal husbandry have been found to be highly effective and broadly feasible in a variety of settings.

Sector-owned interventions play a critical role in addressing gaps and weaknesses that leave populations vulnerable to the threat and impact of AMR. Multisectoral action, drawing on the principles of One Health, can offer value addition in many cases, and coordination is required to identify how each sector can best contribute; however, multisectoral implementation can be challenging and can often face political challenges. Sector-specific interventions, ideally as part of well-coordinated multisectoral NAPs, can be more feasible in constrained environments and provide an important foundation for advancing toward multisectoral approaches that maximize scarce resources in the longer term. Thus, it remains important for each sector to understand the connections with other sectors so that single-sector interventions are positioned to enable multisectoral approaches and results. For a given intervention area, the relevant sectors may vary widely based on the distribution of mandates in a country, as well as the specific activities; the evidence review thus demonstrates how sectoral involvement could vary. For example, surveillance is examined under the health sector, but could also involve or be led by agriculture and environment; similarly, countering substandard and falsified (SF) antimicrobials could also be an intervention deployed through law enforcement agencies.

Multisectoral coordination and governance remains important; for example, quality monitoring of antimicrobial products, surveillance, and stewardship campaigns could serve, be leveraged by, or be taken up by multiple sectors. In fact, the effective implementation of high-priority interventions within the context of multisectoral NAPs requires a multisectoral governance framework or committee with the necessary leadership, mandate, resources, and accountability. Models like the Regional Disease Surveillance Systems Enhancement (REDISSE) project's human and animal health system strengthening provide proof of concept for addressing sector-specific operational and capacity needs while strengthening multisectoral coordination; this coordination makes sense, for example, when considering common issues (such as procurement, supply chain, and access) that need to be addressed in both human and animal health systems. At the country level, One Health or multisectoral coordination platforms are an increasingly important resource for undertaking problem scoping and information sharing, and for optimizing project design, implementation, and evaluation to promote adequate and appropriate action. Therefore, strengthening collaboration within One Health or similar multisectoral coordination platforms is encouraged to support effective understanding of AMR risks and targeting and implementation of solutions, including the effectiveness of national action planning on AMR and related initiatives such as health security.

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4 Information is presented for relevance to World Bank Global Practices; for this reason, information may be presented by sector, topic, or typical line ministry, depending on context.

### Table 2. Intervention Areas

#### Health

1. Improving infection prevention and control in health care settings
2. Improving prescribing practices through guidelines for health care workers
3. Conducting public awareness campaigns
4. Increasing human health laboratory capacity and access to diagnostics
5. Strengthening surveillance of antimicrobial use (AMU) and AMR in human populations

#### Water and environment

12. Improving infrastructure to provide access to water and sanitation in health care centers
13. Implementing effective treatment and disposal of sewage and wastewater
14. Improving waste management practices in agricultural and aquaculture production/processing
15. Improving safe disposal of unused antimicrobials
16. Monitoring presence of antimicrobial residues and antibiotic-resistant bacteria and genes in water and sanitation systems

#### Agriculture and food

6. Increasing oversight of AMU by veterinarians
7. Monitoring AMU, surveillance of AMR, and increasing oversight in plant/crop production
8. Improving animal husbandry practice and biosecurity
9. Monitoring sales and use of antimicrobials and surveillance of AMR in animals
10. Promoting behavior change campaigns in animal production
11. Increasing veterinary laboratory capacity and access to diagnostics

#### Multisectoral

17. Detecting and deterring substandard and falsified antimicrobials (customs/law enforcement/health/agriculture)
18. Improving human and animal nutrition (health/agriculture)
19. Expanding vaccination coverage in humans and animals (health/agriculture)
20. Using closed water systems in aquaculture (agriculture/environment)

Source: World Bank, please note that Table 2 is a repeat of Table 1
Table 3 summarizes the evidence assessment for each of the intervention areas. Summary points are structured in terms of the state of evidence, feasibility, and key qualifiers or multisectoral considerations.

**Table 3. Evidence Assessment for the Intervention Areas**

### Health sector

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<tr>
<th>INTERVENTION</th>
<th>SYNTHESIS</th>
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| **1** Improving infection prevention and control in health care settings | Certain multidrug-resistant bacteria result in a high incidence and burden of disease from health care–acquired infections and are priorities for IPC in health care settings. IPC measures may encompass a wide set of interventions to help avoid preventable infections. This review examined the effects of IPC measures in human health care settings, including uptake of practices and the occurrence of resistant infections.  

**State of evidence:** There is strong evidence of effectiveness in both high-income countries (HICs) and LMICs, and of cost saving in particular in HICs. More research should be supported in LMICs. Implementation is still defective in many countries, in particular LMICs, and in primary health care settings.  

**Feasibility:** IPC interventions are mostly low in cost and feasible. However, implementation of IPC varies widely and requires sustained resource allocation and compliance for success.  

**Considerations:** Synergistic with water, sanitation, and hygiene (WASH), patient safety, quality improvement, health emergencies interventions. |
| **2** Improving prescribing practices through guidelines for health care workers | Inappropriate prescribing of antimicrobials contributes to unnecessary AMU and potentially the development of AMR. Rational prescribing guidelines are key to counteract overprescribing and provide clinical guidance on prescribing the correct antimicrobial at the correct dose by the correct route for the correct duration. Studies were examined for the effect of prescribing guidelines on provider awareness, adherence to clinical guidelines, and infections.  

**State of evidence:** Evidence is limited in LMICs, but increasing buy-in for this approach indicates that the intervention is promising and has scope to decrease incorrect prescriptions.  

**Feasibility:** Feasibility is challenged by multiple prescribers (not just at point of care), limited access to diagnostics, chronic stockouts of both access and watch antimicrobials especially antibiotics, and poor enforcement of regulations related to over-the-counter antimicrobials. Logistics influence supply, which can affect access and ultimately prescribing practices. |
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<th>Intervention</th>
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<td><strong>Conducting public awareness campaigns</strong></td>
<td><strong>Considerations:</strong> Likely to be complementary to demand-side reduction; requires addressing supply-side gaps to create enabling conditions, and may require implementation flexibility in some settings or work best initially for specific diseases. It is also important that national governments, regional bodies and community prescribers align with and utilise the WHO’s AwRe guidelines, ensuring that the key essential Access antibiotics are accessible and prescribed accordingly. The misuse and overuse of antimicrobials is driven in part by public perception. Targeting patient attitudes and perception of appropriate context for antimicrobial use will help combat further increases in resistance. This review looked at the effects of education and awareness campaigns for the general public on knowledge and prescribing practices. <strong>State of evidence:</strong> The evidence base shows wide variation in programs and mixed findings. Effectiveness has been demonstrated in a number of studies and across the income spectrum, particularly in terms of prescribing for respiratory infections. <strong>Feasibility:</strong> Generally feasible, though requires a baseline understanding of AMU practices and drivers of antimicrobial use, including perceptions, to target campaigns. <strong>Considerations:</strong> Appropriateness of campaigns will vary by baseline data on access to antimicrobials and AMUs.</td>
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<td><strong>Increasing human health laboratory capacity and access to diagnostics</strong></td>
<td>Limited access to laboratory services, including diagnostics, hinders timely diagnosis and targeted treatment. Increasing laboratory capacity and rapid diagnostics to rapidly test patient samples could increase the likelihood of correct diagnosis, identify resistant pathogens, and lower the incidence of antimicrobial misuse. Studies on laboratory enhancement and access to diagnostics were reviewed for effects on prescribing and resistance. <strong>State of evidence:</strong> There is some evidence of effectiveness to inform appropriate prescribing of antimicrobials for select diseases, including in LMICs (for laboratory capacity, apparent benefits are more at the public health system level, whereas point-of-care diagnostics are more patient directed). Except in relation to select pathogens, diagnosis and antimicrobial prescribing generally remain imprecise in HICs and LMICs. For rapid diagnostics, there is an inadequate evidence base to assess effects on resistance-specific outcomes, though research protocols are in progress that will likely make the evidence base more robust.</td>
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<tr>
<td><strong>Feasibility:</strong> Feasibility to inform prescribing relies on access (financial, physical) to routine laboratory consumables and rapid diagnostics, as well as integration into care provider workflows. While needs vary by context, broad screening approaches are not widely accessible at present.</td>
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<td><strong>Considerations:</strong> Training and quality assurance are important enablers for success. Incentives are often not in place to support thorough diagnostic screening. Integration of point-of-care diagnostics should consider links to the broader surveillance system.</td>
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**Strengthening surveillance of antimicrobial use (AMU) and AMR in human populations**

Inadequate surveillance of AMU/antimicrobial consumption and AMR means that clinically important trends can be missed. Enhancing surveillance can enable an understanding of consumption trends, the early detection of resistant strains of public health importance, and the prompt notification and investigation of outbreaks. This review examined the effects of AMU and AMR surveillance programs on public health understanding and action.

**State of evidence:** The link between antimicrobial resistance and use of antimicrobials is well documented. There is evidence of the effectiveness of AMU surveillance for prescribing patterns in both HICs and LMICs. There is strong evidence of the effectiveness of surveillance for AMR detection in all settings, though programs vary in scope and use.

**Feasibility:** Broad feasibility, with data on antimicrobial sales already available, and data on antimicrobial use requiring a targeted approach. Quality and scale of information collection and utility for follow-up actions can depend on medicines legislation, data management infrastructure, and technical capacity (training on methodologies for monitoring antimicrobial consumption and use of data for action). The implementation of the Global Antimicrobial Resistance and Use Surveillance System (GLASS) in hospital settings has been successfully demonstrated in a variety of countries. The intervention area is adaptable to relevant context, but functionality requires information management systems and surveillance inputs (sampling, laboratory testing, etc.).

**Considerations:** This intervention may be considered an anchor to inform selection of other interventions. Optimizing this intervention area requires multisource and multisectoral data coordination.
### Agriculture and Food sector

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| **6** Increasing oversight of antimicrobial use by veterinarians | Weak animal health systems often suffer from poor oversight of antimicrobial use. Regulators help ensure that veterinarians prescribe antimicrobials appropriately and only when necessary. Policies and programs on veterinary prescribing were reviewed for effects on AMU and appropriate prescribing.  

**State of evidence:** Strong evidence in high- and middle-income countries demonstrating effectiveness for reduction in AMU and resistant isolates in food-producing animals; poorly tested in low-income countries.  

**Feasibility:** Feasibility requires practitioner buy-in and awareness, and is likely to be constrained where veterinary services are weak (e.g., relatively limited access in rural compared to urban settings) and where antimicrobials are differentially regulated in feeds and as stock remedies.  

**Considerations:** Synergistic with monitoring and enforcement (otherwise, unlikely to be broadly effective), and may require reform of over-the-counter purchase of veterinary antimicrobials. |
| **7** Monitoring of AMU, surveillance of AMR, and increasing oversight in plant/crop production | Inappropriate use of antimicrobials in plant/crop production can drive the development of AMR. Monitoring programs can improve understanding of usage trends and track the development of resistant strains to guide change in use and regulatory oversight. This review examined the evidence base on monitoring of AMU, surveillance of AMR, and regulatory oversight of AMU in crop production.  

**State of evidence:** Good evidence that AMU and AMR monitoring in crop production can detect meaningful scope and sources of AMR threats, whereas the effect of increased oversight is not clear—primarily because of few reported examples of regulatory changes, particularly in LMICs.  

**Feasibility:** Feasibility varies based on the scope and scale of monitoring, and may be challenged by weak agricultural sector governance (and resulting enforcement) and capacities and by lack of suitable alternatives.  

**Considerations:** May inform oversight needs, and may need to address farm-level awareness and use practices. |
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<tr>
<td>Improving animal husbandry practice and biosecurity</td>
<td>Poor animal welfare and biosecurity conditions contribute to the incidence and prevalence of infections and subsequent antimicrobial use on farms. Improving husbandry practices and biosecurity conditions, including in animal production systems that are rapidly intensifying, could promote overall animal health and reduce the need for antimicrobials. Husbandry and biosecurity enhancements were reviewed for effects on AMU and animal health.</td>
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<td>State of evidence: Strong evidence in LMICs and HICs. Clear outcomes are reducing infections and AMU.</td>
<td>Feasibility: Feasibility demonstrated by tailoring to different productive contexts and settings; may require more intensive or sustained intervention based on status of baseline supporting infrastructure.</td>
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<td>Considerations: May need to address farmer perceptions and comparatively low cost of antimicrobials as well as up-front costs to implement on farms.</td>
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<tr>
<td>Monitoring of sales and use of antimicrobials and surveillance of AMR in animals</td>
<td>The scale and scope of AMU and AMR in animals are generally poorly understood at national and subnational levels. AMU monitoring and AMR surveillance can improve understanding of current practices to guide targeted interventions that limit inappropriate use and detect changes over time. Studies on AMU monitoring and AMR surveillance were reviewed for effects on detection of usage patterns and changes in use practices.</td>
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<td>State of evidence: Strong evidence from HICs and to some extent LMICs that monitoring and surveillance can provide information about usage as well as possible stakeholders, intervention needs, and entry points, but data capture is uneven.</td>
<td>Feasibility: Broad feasibility, though quality and scale of information collection and utility for follow-up actions will likely depend on veterinary legislation/enforcement, laboratory capacity (including availability of bacteriology services), and data management infrastructure and reporting systems.</td>
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<tr>
<td>Considerations: This intervention may be considered an anchor to inform selection of other interventions and evaluate their effectiveness. For public health relevance, this intervention requires a One Health approach to integrate animal data with other information.</td>
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### Promoting behavior change campaigns in animal production

Animal production is a major driver of inappropriate antimicrobial use. Behavior change campaigns aimed at farmers and other animal production stakeholders target an important source of antimicrobial purchasing and administration. Studies on behavior change campaigns in farmers were reviewed for effects on knowledge and use.

- **State of evidence:** Promising reductions in AMU were seen in HICs, but evidence base is lacking in LMICs.
- **Feasibility:** Broad feasibility, though interventions will likely require general awareness around appropriate AMU practices first; may be challenging in settings with weak veterinary services.
- **Considerations:** Advisable in settings with sufficient alternatives to support reduced AMU.

### Increasing veterinary laboratory capacity and access to diagnostics

Limited access to laboratory services, including diagnostics, hinders timely diagnosis and targeted treatment of animals. Increasing laboratory capacity and rapid diagnostics to test animal samples could increase the likelihood of correct diagnosis, identify resistant pathogens, and lower the incidence of antimicrobial misuse. Studies on laboratory enhancement and access to diagnostics were reviewed for effects on prescribing.

- **State of evidence:** Some promising early evidence from HICs on reduction of AMU for select diseases, but not yet for field-level treatment of disease in LMICs; utility for LMICs is likely for early detection as part of broader animal health surveillance.
- **Feasibility:** Feasibility is challenged by access to routine laboratory consumables, limited access/logistical challenges for diagnostics in rural areas where agriculture is often concentrated, and limited availability of field-ready and rapid diagnostics.
- **Considerations:** Complexities around farmer-veterinarian incentive structures may affect uptake of diagnostics.
## Water and environment sector

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| **12 Improving infrastructure to provide access to water and sanitation in health care centers** | Health care settings are a significant source of infections, particularly among patients with weakened immune systems. Increasing water and sanitation infrastructure in health care facilities as part of overall WASH enhancements is a priority for preventing initial infections and their spread—and the development of resistance—within facilities and to the broader community. This review examined the evidence on the effect of upgraded water and sanitation infrastructure in health care facilities on AMU, water quality, hand hygiene, and infection rates.  
  
  **State of evidence:** Although WASH infrastructure in health care settings is a foundation for IPC, the evidence in relation to AMR-specific outcomes is mixed from both HIC and LMIC settings. Most studies to date report on cross-sectional findings or examine multiple interventions.  
  
  **Feasibility:** In addition to up-front infrastructure, interventions require adequate water supply and continuous sanitation systems. Design must take into account points of contamination and monitoring and disinfection measures.  
  
  **Considerations:** Synergistic with monitoring and system maintenance, as well as hand hygiene and other IPC measures. |
| **13 Implementing effective treatment and disposal of sewage and wastewater** | Untreated effluent can result in dissemination of residues or resistance into the environment, including drinking water sources. Advanced treatment technologies may help reduce the spread of antimicrobial residues, drug-resistant microorganisms, and antimicrobial-resistant genes (ARGs). This review examined the effects of advanced waste and wastewater treatment technologies on antimicrobial residues, resistant bacteria, and genes.  
  
  **State of evidence:** Evidence for both conventional and advanced techniques demonstrates variable results for removal or reduction of resistant pathogens and genes.  
  
  **Feasibility:** Many advanced (tertiary) methods appear experimental, with limited field deployment. There are several advanced treatments, which should be assessed separately.  
  
  **Considerations:** Wastewater composition affects removal ability. |
<p>| <strong>14 Improving waste management practices in agricultural and aquaculture production/processing</strong> | Waste products from agriculture and aquaculture production and processing are potential sources of antimicrobial residues, resistant bacteria, and ARGs. Limiting the flows of wastewater, manure, and agricultural runoff containing antimicrobial residues, drug-resistant microorganisms, and ARGs helps limit the spread of resistance. Studies involving anaerobic digestion, composting of manure, and manure lagoons were reviewed for effects on residues and genes. |</p>
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<th>INTERVENTION</th>
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<tr>
<td>Improving safe disposal of unused antimicrobials</td>
<td>Improper disposal can result in dissemination of antimicrobials into the environment via trash, sewage, or other waste, potentially contaminating water systems. Improved antimicrobial disposal practices may help to avoid water contamination. This review focused on the effects of safe medication disposal initiatives on awareness and utilization.</td>
</tr>
<tr>
<td>State of evidence: Some evidence from HICs and LMICs for medicines in general (not just antimicrobials), but most point to limited uptake.</td>
<td></td>
</tr>
<tr>
<td>Feasibility: Feasibility challenges relate to centralized collection, awareness, incentives, and responsibility for destruction, particularly where systems for proper disposal are lacking.</td>
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<tr>
<td>Considerations: Programs vary in scope, frequency, geographic coverage, and longevity; a few long-standing take-back programs in HICs do report high rates of return of unused medicine.</td>
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<tr>
<td>Monitoring presence of antimicrobial residues and antibiotic-resistant bacteria and genes in water and sanitation systems</td>
<td>Contamination of water can result in dissemination of resistant bacteria and genes. Monitoring can generate data on the type of antimicrobials being detected in water and waste sources and on resistance patterns to guide epidemiological understanding and action. This review focused on effects of monitoring antimicrobials (via residues) and antimicrobial resistance in water and sanitation systems on detection and disease investigation.</td>
</tr>
<tr>
<td>State of evidence: Effectiveness demonstrated from a range of settings to detect residues, drug-resistant microorganisms, and antibiotic-resistant genes (ARGs).</td>
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<td>Feasibility: Generally feasible, with standard technologies available in most settings.</td>
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<td>Considerations: Requires a One Health approach to put information from monitoring into context for risk determination and to inform risk management strategies.</td>
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### Multisectoral

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<th>INTERVENTION</th>
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<tr>
<td><strong>17 Detecting and deterring substandard and falsified (SF) antimicrobials</strong></td>
<td>SF antimicrobials include those that are counterfeit, degraded, mislabeled, or expired, and thus may be ineffective (or suboptimally effective) in treatment, prevention, or control of infections. Detection and deterrence mechanisms can play a role in ensuring the quality of antimicrobials to promote effective treatment for both humans and animals. Studies involving detection interventions were reviewed for effects on tracking, product quality, and legal outcomes (e.g., confiscation, prosecution).</td>
</tr>
<tr>
<td><strong>State of evidence</strong>: Evidence base comes from a range of settings, but evidence of effectiveness is mixed in low-income countries, with some promising findings for reduction of substandard and falsified products, including antimicrobials.</td>
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<tr>
<td><strong>Feasibility</strong>: Feasibility varies based on screening methods and quality and on scale of problem.</td>
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<tr>
<td><strong>Considerations</strong>: Likely requires accompanying enforcement and deterrence mechanisms, incentives for reporting, education/awareness, and alternatives to SF antimicrobials for success.</td>
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<tr>
<td><strong>18 Improving human and animal nutrition</strong></td>
<td>Nutrition status can affect susceptibility to infection and the severity and duration of disease in humans and animals, while some infections affect the body’s ability to take up nutrients from food. Good nutrition can play a role in preventing infections and potentially reducing the need for antimicrobials and the subsequent selection pressure for resistance. Studies involving nutrition or food security improvements in humans and animals were reviewed for their effect on AMU or AMR.</td>
</tr>
<tr>
<td><strong>State of evidence</strong>: The evidence base is limited overall and focuses primarily on nutrient or probiotic supplementation. Reported findings are promising overall for effects on AMU.</td>
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<tr>
<td><strong>Feasibility</strong>: Likely to vary based on access. Nutrition interventions can vary widely among humans and in animal species, with specific goals that may or may not align with AMR-related objectives.</td>
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<tr>
<td><strong>Considerations</strong>: In animals, improved nutrition is often used in tandem with other interventions or to replace nonveterinary medical use of antimicrobials (i.e., for any other purpose than to treat, control, or prevent infectious diseases, such as weight gain). Interventions should also consider food safety implications.</td>
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<tr>
<td>INTERVENTION</td>
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| Expanding vaccination coverage in humans and animals | Infections can lead to AMU and the development of resistant pathogens. Vaccination provides individual protection and sometimes indirect effects to curb transmission of disease in humans and animals, reducing incidence of vaccine-preventable diseases, including several associated with high disease burden and antimicrobial use and the potential for development of resistant pathogens. Studies were reviewed for effects of vaccination on AMU and AMR in humans and animal populations.  

**State of evidence:** There is evidence in all settings, with promising (but in some cases mixed) results regarding AMU and some resistant pathogens.  

**Feasibility:** Requires infrastructure and resources for campaigns. Dependent on effectiveness against circulating strain(s), which can vary geographically. Some veterinary vaccines have safety challenges leading to narrow indications for use.  

**Considerations:** Existing vaccines are underutilized. Significance may vary based on AMR priorities and ability to target illnesses and syndromes with high AMU. Future vaccines may increase relevance for AMR outcomes specifically. |
| Using closed water systems in aquaculture | Effluent from aquaculture farms can be a source of environmental contamination, including the dispersion of antibiotic residues and resistant pathogens and genes through surface water. Recirculating water systems limit the flow of influent and effluent to and from the broader environment, playing a role in preventing the introduction and dissemination of contaminants that may be linked to resistance. Studies involving effects of closed aquaculture systems on AMR-related water treatment and water quality outcomes were reviewed.  

**State of evidence:** Studies of this intervention are limited to date in all settings.  

**Feasibility:** Dependent on aquaculture practices as well as infrastructure. Systems may vary widely.  

**Considerations:** May be relevant for biosecurity enhancements, particularly in certain aquaculture production systems or markets. |

*Source: World Bank*
For the interventions listed in Table 2, the evidence base was generally limited in terms of effects related to AMR specifically. Because of the challenges of monitoring AMR or burden of disease from AMR as an endpoint, most studies focus on intermediate indicators or proxies (such as antimicrobial use). The interventions target many primary effects, which may or may not be directly indicative of effects related to AMR (for example, rapid diagnostics and ensuring sustainable access, leading to change in mortality or length of stay in a patient population would be inherently relevant for AMR, unless tracking something like health care–acquired resistant infections). Similarly, interventions were often implemented in concert; therefore, measurement cannot usually isolate the effects specifically from one component. More routine or increased monitoring will help to observe patterns that inform how the direction of AMR is changing.

Selecting appropriate indicators for monitoring and evaluating interventions related to AMR can pose challenges, primarily due to variations in the readiness of different countries to assess AMR and antimicrobial use systems. These variations extend to measuring additional outcomes, such as access to and the quality of medicines, and biosecurity in food production. In this context, WHO’s (2019b) Monitoring and Evaluation of the Global Action Plan on AMR toolkit emerges as a reference standard for guiding the selection of core indicators. The toolkit strikes a crucial balance that allows global comparability while also accounting for unique contextual factors and data availability within countries. It provides a structured framework for countries seeking to align their monitoring and evaluation efforts with global standards, thereby fostering a more comprehensive and standardized approach to monitoring the emergence of resistance.

Overall, the evidence review provides a starting point to guide operations addressing AMR. The evidence reviews in this chapter provide a template that can be replicated for future intervention areas under consideration. They can help support the design of World Bank operations, increase awareness of potential challenges and realistic results to be expected, and guide selection and design of project components addressing AMR that can be applied across different settings and scales.

Bibliography


