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World Innovation Summit for Health
7
النسخة
EDITION

NOVEMBER 2024

TACKLING ANTIMICROBIAL RESISTANCE

HOW TO KEEP ANTIBIOTICS WORKING FOR THE NEXT CENTURY

REPORT OF THE WISH ANTIMICROBIAL RESISTANCE FORUM 2024

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FOREWORD

It has been more than a decade since I (Dame Sally) produced my first World Innovation Summit for Health (WISH) report on the need for a collaborative solution to tackle antimicrobial resistance (AMR). I had made it my top priority as the UK's Chief Medical Officer, but was acutely aware that this was a problem to which the whole world needed to respond.

Much has happened over the last 11 years and AMR is now established as a priority for action among human health system leaders, as well as animal health, environment, food security and economic chiefs. This is a global, multisectoral, intergenerational emergency, which we all have roles in addressing.

However, as our analysis of the recommendations in my first report show, there is still a long way to go to truly find a solution to AMR. COVID-19, and other competing priorities, dissipated some of the collective energy and focus we had globally on tackling AMR, and we need to get that back – and go further. This report, emerging directly after the September 2024 United Nations General Assembly High-Level Meeting on AMR, seeks to provide fresh impetus.

For this report I am joined as co-chair by Lord Ara Darzi.

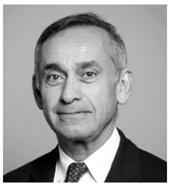
I (Lord Darzi) was instrumental in establishing WISH as a leading forum for health policymaking. I am a cancer surgeon who is also a champion of the power of innovation in healthcare.

I have now made tackling AMR my biggest priority as, if we do not do so, modern medicine will cease to exist as we know it. Surgery, for instance, would be much riskier without effective antibiotics. That is why I am leading the Fleming Initiative to keep antibiotics working for the next 100 years.

We both believe that, for Alexander Fleming's discovery of penicillin to be safeguarded for generations to come, we need a multidisciplinary approach that harnesses science, public engagement, behavioral research, policy and regulation. And, while many of the solutions may be shared globally, they must be implemented in a way that is appropriate to the local context.

Global commitment with local implementation is needed.

Professor Dame Sally Davies
Special Envoy on Antimicrobial Resistance for the UK



Professor Lord Ara Darzi
Director of the Institute of Global Health Innovation and Paul Hamlyn Chair of Surgery at Imperial College London; Executive Chair, WISH

EXECUTIVE SUMMARY

The first WISH report on tackling antimicrobial resistance (AMR) was published more than a decade ago. Section 1 of this report reviews progress on recommended actions in the five areas identified by the 2013 report. A 'traffic light' system – with green representing excellent progress, amber moderate progress and red insufficient progress – has been used, and the results are set out below.

Action area	High-income countries	Low-income countries
Awareness	Amber	Amber-Red
Antibiotic conservation	Amber	Amber-Red
Sanitation, hygiene, infection prevention and control	Amber-Green	Red
Surveillance and monitoring	Amber	Amber-Red
Research and development	Amber-Red	Red

The results suggest there is still much to be done.

Section 2 of the report considers opportunities for action in three areas, illustrated by case studies from around the world.

1. **Global citizen engagement:** The world's population needs to understand the issue and take action to be part of the solution. In particular, efforts must be made with those who regularly prescribe antibiotics in their work.
2. **Translational science:** The last decade has seen exciting developments in point-of-care testing, vaccines in aquaculture and the use of artificial intelligence (AI) in discovering new antibiotics. These advances need to be put into action more universally in tackling AMR.
3. **Policy and regulation:** Incentives for research and development (R&D), regulations, access approaches and national action plans are important tools in supporting the right action.

Section 3 of the report takes stock of what has emerged from the United Nations (UN) General Assembly High-Level Meeting on tackling AMR. It welcomes the Political Declaration, whilst recognizing that action needs to go further and faster. To that end it makes six recommendations.

Recommendation 1

International organizations should put into action the 2024 UN AMR high-level meeting recommendation to establish an independent body to advise on the evidence and inform action. This panel will identify gaps in the current evidence on AMR, assess emerging and future risks of AMR, and inform cost-effective options for mitigating AMR, including global targets.

Recommendation 2

Countries and international bodies should engage their citizens in tackling AMR, with clear plans to do so by 2028.

Recommendation 3

Governments should give more priority to water and sanitation in addressing AMR. This includes increasing investment in water, sanitation and hygiene (WASH) to reduce infections and environmental microbe exposure, and the development of national programs to surveil antibiotic residues, resistance genes and resistant pathogens in the water supply and factory effluent.

Recommendation 4

By 2027, high-income countries should commit to only prescribing antibiotics (with a few defined exceptions) when need is confirmed by a diagnostic test. Low- and middle-income countries should achieve this by 2030.

Recommendation 5

By 2026, all high-income countries should have introduced pull incentives for the development of new antimicrobials, to deliver on global antibiotic priorities.

Recommendation 6

Global health organizations should use the forthcoming centenary of the discovery of penicillin (2028) to accelerate progress on the AMR agenda.

We have four years before the centenary of the discovery of penicillin (2028) to accelerate progress on tackling AMR, so that we can keep antibiotics working for the next 100 years.

SECTION 1. PROGRESS OVER THE LAST DECADE

The first WISH report on antimicrobial resistance (AMR),[1] *Antimicrobial Resistance: In search of a collaborative solution*, was published in 2013. The timeline below sets out the progress made in tackling AMR since that report was launched.

2013

- First WISH report on AMR

2014

- Antibiotic Guardian Campaign is launched in the UK
- The Centers for Disease Control and Prevention establishes antibiotic stewardship guidelines for all US hospitals
- First Ministerial Conference on AMR takes place in the Netherlands

2015

- The UK's National Health Service introduces antimicrobial stewardship guidelines through the National Institute for Health and Care Excellence
- World Health Organization (WHO) publishes a Global Action Plan on AMR
- Introduction of World Antibiotic Awareness Week (changed to World AMR Awareness Week in 2023)

2016

- The O'Neill Review (*The Review on Antimicrobial Resistance*) is published
- United Nations General Assembly (UNGA) adopts a political declaration on AMR, elevating it to a global priority
- Combating Antibiotic-Resistant Bacteria Biopharmaceutical Accelerator (CARB-X) and the Global Antibiotic Research and Development Partnership (GARDP) are launched
- World Organisation for Animal Health (WOAH) releases first report monitoring antimicrobial use in animals globally (ANIMUSE database)

2017

- European Centre for Disease Prevention and Control launches its report on prudent use of antimicrobials in humans
- Global Antimicrobial Resistance and Use Surveillance System (GLASS) is launched
- WHO launches Access, Watch, Reserve (AWaRe) classification of antibiotics
- Formation of the United Nations ad hoc Interagency Coordination Group on Antimicrobial Resistance

2018

- Global AMR Research and Development (R&D) Hub established to collate AMR research data
- Fleming Fund starts support for 28 low- and middle-income countries to tackle AMR

2019

- UN Interagency Coordination Group on Antimicrobial Resistance presents its report to the UN Secretary General
- Quadripartite Joint Secretariat is established, implementing the Inter-agency Coordinating Group on AMR (IACG) recommendations

2020

- Launch of AMR Action Fund to support development of new antibiotics
- Quadripartite Global Leaders Group on AMR launched
- Investor Action on AMR initiative launched
- Sweden launches pull incentive pilot (pull incentives reward development by ensuring revenue)

2021

- Quadripartite AMR Country Self-assessment Survey begins
- First joint G7 Finance and Health Ministers' commitments on pull incentives

2022

- European Union bans routine and sub-therapeutic doses of antibiotics in animals
- UK launches a subscription-based model for antibiotics to incentivize company innovation
- The first comprehensive systematic study is published in *The Lancet* on the global burden of AMR
- The new Antibiotic Manufacturing Standard, the industry standard on antibiotic pollution from manufacturing, is published
- Codex Guidelines on Integrated Monitoring and Surveillance of Foodborne Antimicrobial Resistance

2023

- Japan launches pull incentive pilot
- Quadripartite AMR Multi-Stakeholder Partnership Platform launched
- Fleming Initiative launched

2024

- United Nations Food and Agriculture Organization (UN FAO) launches Reduce the Need for Antimicrobials on Farms for Sustainable Agrifood Systems Transformation (RENOFARM)
- WHO launches Task Force of AMR Survivors
- World Bank publishes its Framework for Action on AMR
- Updated burden of AMR study published by *The Lancet*
- WOAH & the World Bank co-publish a report series on the economic impacts of AMR in humans and food-producing animals

The 2013 report made recommendations for action in five areas: awareness; antibiotic conservation; sanitation, hygiene, infection prevention and control; surveillance and monitoring; and research and development.

This report builds on that work by assessing progress on these priority areas by using a 'traffic light' system:

Light	Description
Green	Excellent progress
Amber-Green	Good progress
Amber	Moderate progress
Amber-Red	Limited progress
Red	Insufficient progress

While the scoring is subjective, (combining multiple data points from different contexts), it has been considered by the report's advisory group and endorsed as a high-level assessment of progress (or lack thereof) in the five priority areas.

The decision was taken to provide one score for high-income countries (HICs) and one for low- and middle-income countries (LMICs). The lower scores for LMICs do not indicate a lack of effort on their part in tackling AMR, but recognize the more challenging starting position for those countries, often owing to more immediate health issues, governance capabilities and lack of resources. It is also a powerful reminder that AMR is a global challenge, and there is little point in HICs making more progress than LMICs.

AWARENESS

High-income countries
Rating: Amber

Formative education and the global media have played a role in raising awareness about AMR, but this is more prominent in HICs. School curriculums now include sections on antimicrobials and AMR, and initiatives such as the 'eBug' program in the UK offer resources on hygiene, microbes and AMR.[2]

AMR campaigns in the media and in journals – and on social media platforms such as X, Instagram and LinkedIn – also raised awareness. The UK Health Security Agency's Antibiotic Guardian Campaign has contributed mainly to healthcare professionals (HCPs), and occasionally the public, making pledges to change behavior toward antimicrobials.[3] Such campaigns have the potential to reach millions of media consumers, however, quantifying their impact on audiences is difficult as many may already be engaged with the issue of AMR.[4–6]

One positive awareness initiative, initially launched by the World Health Organization (WHO), and now coordinately run by the four Quadripartite organizations, is the World AMR Awareness Week (WAAW), running each November since 2015 (formerly World Antibiotics Week until 2023). While WAAW offers an annual global effort to improve awareness and understanding of AMR, trends of internet searches from 2015 to 2020 suggest that WAAW has done little to improve public engagement on AMR.[7] Health organizations must consider how WAAW can have a greater impact.[8]

AMR awareness among prescribers has increased globally and is partly attributable to AMR national action plans, which include periodicals and communiques to prescribers.[9,10] Translation of this awareness into lower antimicrobial prescribing and better antimicrobial stewardship has mainly been seen in HICs.[11]

The NHS found that, while courses are available to healthcare trusts, only 35 percent of organizations actively promoted the course and sessions to staff.

For HCPs in HICs, national health organizations such as the Centers for Disease Control and Prevention (CDC) in the US and the National Health Service (NHS) in the UK have developed antibiotic stewardship guidelines and courses for medical students and practitioners,[12,13] which have contributed to a decrease in antibiotic prescribing.[14] However, even in HICs, not all healthcare organizations deliver programs, and formal assessments are not always available. The NHS found that, while courses are available to healthcare trusts, only 35 percent of organizations actively promoted the course and sessions to staff.[15,16]

Low- and middle-income countries
Rating: Amber-Red

In LMICs, AMR awareness has increased, but not to the same level in HICs. While there has been activity surrounding AMR, and national action plans have been implemented, AMR has greater competition from other public health issues in LMICs, leading to small-scale AMR campaigns that do not target all stakeholders.[17,18]

AMR has greater competition from other public health issues in LMICs, leading to small-scale AMR campaigns that do not target all stakeholders.

Formative education programs such as Superheroes Against Superbugs in India[19] and Students Against Superbugs in Africa[20] provide creative, in-school activities that educate children about microbes, hygiene and AMR, and are similar to programs in HICs.

Translation of national action plans into lower antimicrobial prescribing and higher antimicrobial stewardship is low in LMICs. This is partly due to the lack of prescribing and stewardship education for antimicrobial prescribers and HCPs.[21–23]

Consumption of news and media is similar in HICs and LMICs. Therefore, the reach of media campaigns may not be the limiting factor for AMR education in LMICs.[24] It is more likely that the translation of AMR research into public-friendly campaigns is limited in LMICs, and more work is needed to target awareness to informal healthcare providers, small-scale farmers and others who use antimicrobials inappropriately.[25]

Self-medication, incomplete antibiotic use and unlicensed prescribing require bespoke awareness campaigns.[26] Some efforts are being made – for example, the Red Line campaign in India, where antibiotics have a red line printed on blister packs to differentiate them from other drugs. These make antimicrobials easily identifiable to the public, with the aim of reducing over-the-counter antimicrobial take-up.[27] However, in a 2019 survey, only seven out of 100 Indian HCPs, including doctors, nurses and paramedics, recognized the significance of the red line.[28]

ANTIBIOTIC CONSERVATION

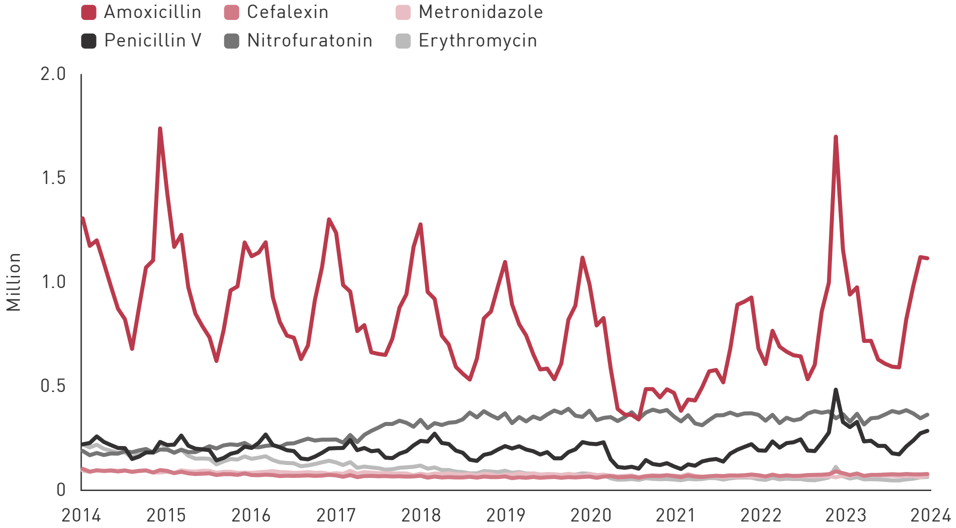
High-income countries
Rating: Amber

Antimicrobial prescriptions have decreased in some HICs such as the UK, Australia, Canada and New Zealand.

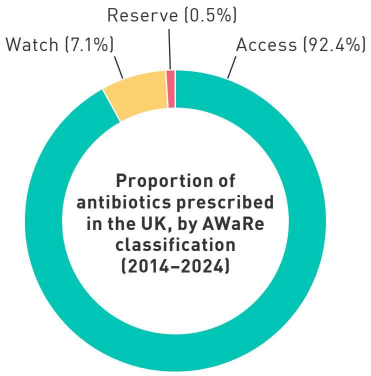
The WHO AWaRe framework classifies antibiotics into three groups: Access; Watch; and Reserve, depending on the antibiotic's impact on AMR. Access antibiotics have unrestricted use; Watch antibiotics are the most susceptible to resistance; and Reserve antibiotics are a 'last resort'. This tool helps monitor consumption and the effects of stewardship policies.[29]

Prescriptions of Access antibiotics have remained constant over the last 10 years in HICs like the UK. Only seasonal variation and COVID-19 impact prescription numbers.

Prescription numbers of WHO Access designated antibiotics in the UK (2014–2024)



The proportion of antibiotics prescribed has adhered to the WHO AWaRe classification, with lower numbers of Watch and Reserve antibiotics prescribed.



HICs like the UK have adhered to WHO AWaRe guidance and prescribing levels of Watch and Reserve antibiotics are low. However, prescribing of antimicrobials in HICs is still high – one-fifth of antibiotic prescriptions in the primary care setting are inappropriate for the type of disease.[30]

Prescribing antibiotics for non-bacterial infections, and the wrong classes of antibiotics for bacterial infection, contribute to this.[31,32] Broad spectrum antibiotics are also consumed at higher levels in HICs, with 3.9 defined daily doses (DDD)/1,000 people compared to 0.8 DDD/1,000 people in LMICs in South Asia.[33]

Economic deprivation and reliance on care affect the amount of antimicrobials consumed in HICs. Older age groups and adults in residential care were prescribed more antimicrobials than younger groups in a 2023 review. Also, rural areas and locations with greater economic deprivation have higher antibiotic use compared to areas with no or lower deprivation. This was attributed to a higher incidence of disease in these places, combined with lower levels of health insurance.[34]

Global use of antimicrobials in animals has been reducing since 2015, according to data reported by more than 150 countries to ANIMUSE, the WOAH global monitoring database. In their 2024 report, a slight increase is reported, suggesting a slowdown in the efforts to reduce antimicrobial use in regions where animal biomass is the highest (i.e., Americas and Asia-Pacific).[35] Recent bans on routine and sub-therapeutic antibiotic dosing of animals by the European Union (EU) are positive legislative changes that might help reduce AMR burden in animal husbandry.[36] However, instead of mandatory regulation of antimicrobial usage[37,38] the UK has taken the novel approach of working with farmers. Consequently, the nation has some of the lowest rates of antimicrobial use in animal farming globally and the lowest rate in Europe.

The United Nations Food and Agriculture Organization (UN FAO) has recently launched Reduce the Need for Antimicrobials on Farms for Sustainable Agrifood Systems Transformation (RENOFARM). This major initiative aims to be a country-focused and -led initiative that reduces the need for antimicrobials throughout the food production chain by promoting alternatives such as vaccines and greater biosecurity, economic and productivity incentives and better health services.[39]

Low- and middle-income countries
Rating: Amber-Red

For LMICs, antimicrobial conservation is a difficult balance between the need for better access to antibiotics, and the potential unconstrained access without effective conservation and innovation, which increases the chances of AMR.[40]

In middle-income countries (MICs) – for example, Brazil, Russia, India and China (BRICs) – food scarcity can lead farmers to use sub-therapeutic doses of antimicrobials and widescale metaphylaxis (treatment using antimicrobials when not showing signs of disease) for healthy animals to promote quicker animal growth. Combined with the unregulated access to antimicrobials, this drives the improper use of antimicrobials. This practice, uncompliant with the international standards from the WOAH,[41] also contravenes countries' national action plans,[42] although these are often not followed through due to low funding, insufficient human resources, lack of AMR education and inadequate data-sharing infrastructure.[43]

The high number of patients and insufficient time to make full diagnoses, lack of standardized treatment guidelines, and patient demand for prescription antimicrobials, are a few reasons why antimicrobials can be overly prescribed in LMIC healthcare settings.[44] Underlying challenges are under-resourced medicines management and inadequate regulation by LMIC governments. Poor prescribing guidelines and absence of rigorous protocols (for example, the National Institute for Health and Care Excellence (NICE) guidelines in the UK) are also to blame.[45,46]

SANITATION, HYGIENE, INFECTION PREVENTION AND CONTROL

High-income countries
Rating: Amber-Green

HICs have relatively resilient infection prevention and control (IPC) activities and sanitation. Formal IPC programs and teams exist in 89 percent of 46 surveyed HIC healthcare settings in 2022.[47] Ninety percent of HICs meet half of WHO's minimum IPC requirements, but only about 10 percent meet the full requirements.[48]

BOX 1. THE IMPACT OF COVID-19 ON AMR

While COVID-19 highlighted the need for good hygiene and infection prevention and control, the pandemic also caused challenges in combatting AMR. For instance, in the US, healthcare facilities saw up to 20 percent more antimicrobial-resistant infections and corresponding deaths, especially in hospitals. This was attributed to a shortage of personal protective equipment, longer hospital stays, more invasive procedures with catheters and ventilators, and inappropriate antibiotic use – with 80 percent of hospitalized patients receiving antibiotics while only 4 percent had true bacterial co-infection.[49–51] As of July 2024, the levels of antimicrobial-resistant pathogens had not yet returned to pre-pandemic levels.

According to studies in the US and Italy, carbapenem-resistant enterobacterales (CREs) and methicillin-resistant *Staphylococcus aureus* (MRSA) co-infections increased significantly, especially in intensive care units.[52] The rise in resistant pathogens was met by a shortage of nursing, medical and public health staff in 71 percent of countries surveyed by the Global Antimicrobial Resistance and Use Surveillance System (GLASS) in 2020. Staff shortages, combined with a significant decrease in funding for AMR work, had the most impact in low- and middle-income countries.[53]

Misinformation during the pandemic also resulted in reduced antimicrobial stewardship, and increased self-administration of antibiotics. News articles, social media and political interference helped spread claims that antibiotics could cure COVID-19. Use of the antibiotic azithromycin increased up to 150 percent in months when there was an amount of misinformation.[54–56]

There is no global IPC tracking system, but WHO publishes a range of monitoring, training and implementation tools for IPC. Protocols vary by country and healthcare provider, and there is no central tracking of norms or infections acquired in healthcare settings due to inadequate hygiene or IPC. National action plans in HICs such as the UK, Japan and the EU have specific provisions on sanitation and IPC to reduce antimicrobial diseases from developing and spreading in healthcare centers.[57,58]

The FAO has a set of food control standards (Codex Standards) which include guidelines on how to deal with AMR by controlling veterinary drugs, animal feed, and food hygiene.[59] However, these are only guidelines and are not always regulated when implemented. In 2020/21, only about 20 percent of all countries reported nationwide implementation of good management and hygiene practices in the food sector, showing that more countries need to abide by the Codex Standards.[60]

In England, Wales and Northern Ireland, the Food Standards Agency (FSA) publishes guidelines on food safety, preparation and avoiding AMR. The FSA also operates a Biosurveillance Network, which is primarily focused on meat production. This program establishes baselines and monitoring data for AMR trends.[61]

Low-and middle-income countries
Rating: Red

LMICs often do not have resilient IPC activities, and some struggle with basic sanitation and hygiene. Of 89 surveyed LMIC healthcare settings, only 58 percent had formal IPC programs and teams, and 1.8 billion people use healthcare facilities that lack basic water and hand washing facilities.[62,63]

IPC interventions in many LMIC healthcare settings are inadequate, and no LMICs achieve all the minimum WHO IPC requirements. Not all IPC and sanitation programs functioned correctly due to lack of full-time IPC professionals, budget, or laboratory support.[64] Added burden is experienced in conflict zones, where AMR increases due to the increase in injuries, limited water and sanitation, damage to laboratory infrastructure, and disruption to healthcare services and public health drives such as vaccination.[65]

Global conflict results in more injuries, destruction of healthcare facilities and limited sanitation and IPC services – allowing drug-resistant infections to spread

1 in 4
people don't have access to healthcare facilities with basic water services

Re-use of equipment like syringes, multiple dose vials, and nasogastric tubes spreads drug-resistant infections in LMICs

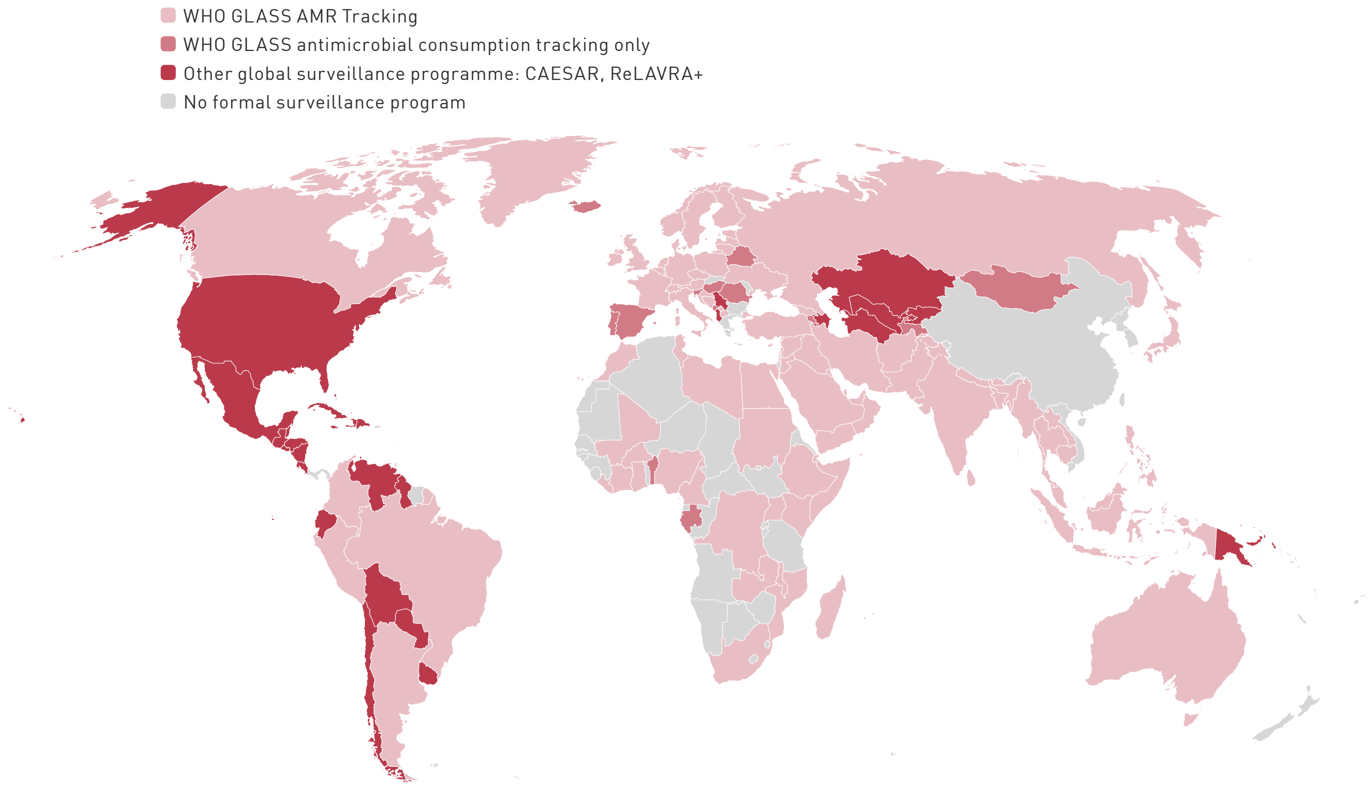
A significant problem in LMIC healthcare settings is the reuse of equipment, which can contribute to the spread of AMR infectious diseases. Oxygen masks, nasal prongs, and nasogastric tubes are some of the most commonly reused in these settings, which can lead to the spread of drug-resistant infections.[66] The reuse of syringes and needles leads to contamination of multiple-dose vials of sterile medication by multidrug-resistant microorganisms, leading to resistant strains spreading in healthcare settings.[67]

The COVID-19 pandemic was responsible for a surge in response in IPC and sanitation, however, there is still a lack of correct personal protective equipment and hygiene practices, including basic sanitation services or safe waste disposal.[68]

Fragmented food control systems in LMICs allow the transmission of AMR. Most countries have informal animal husbandry farms, abattoirs and food vendors, leading to unchecked and unregulated hygiene in the food chain.

In 2023, the British Society for Antimicrobial Chemotherapy report, *Why Clean Water and Hygiene are the Best Medicine Against the Spread of Drug-Resistant Infections*[69] highlighted the importance of clean water and hygiene in preventing AMR. The report campaigned for additional financing for water, sanitation, and hygiene (WASH) facilities in LMICs where such facilities are limited, and advocated for championing WASH and AMR at international forums such as the G7 and G20.

SURVEILLANCE AND MONITORING



High-income countries
Score: Amber

Rapid, frontline surveillance of events that might exacerbate AMR make up part of the first response to preventing the spread of resistant strains. Some HICs use standardized tools, technologies such as pathogen sequencing, and strategies on rapid data sharing and infection prevention. The US National Healthcare Safety Network and European Centre for Disease Prevention and Control have effective monitoring systems, including for antimicrobial use and healthcare-associated infections. These are translated and published in periodicals and notifications for the healthcare community to facilitate appropriate IPC measures.[70]

The World Organisation for Animal Health released its first report on the global use of antimicrobials in animals in 2016, digitalizing the reporting system by launching the digital platform ANIMUSE in 2023 to monitor and report on antimicrobial use in animals globally. The standardized methodology and knowledge provided by ANIMUSE helps to inform national plans and actions in more than 150 countries worldwide.[71,72]

BOX 2. ONE HEALTH

Antimicrobial resistance (AMR) is not only a human problem, as resistant strains of pathogens also spread in animals, birds and fish, leading to animal suffering and losses. Plants and the wider environment are also susceptible to AMR: spilled antimicrobials in soil and waterways create resistant pathogens which infect animals, plants and humans.[73]

The One Health approach to fighting AMR is a joint effort by the World Health Organization, World Organisation for Animal Health, and the United Nations Environment Programme and Food and Agriculture Organization. One Health aims to co-ordinate approaches against AMR across animals, humans, plants and the environment by bringing together public health, animal health and food safety to provide solutions to AMR in all four sectors.[74] One Health works globally to increase awareness of overuse and misuse of antimicrobials, strengthen infection prevention and control, reduce unnecessary use of antimicrobials in agriculture, improve surveillance of drug resistance, promote development of vaccines and preventatives and use of diagnostics, and create incentives and funds to encourage innovation.[75,76]

The Antimicrobial Resistance Multi-Partner Trust Fund also supports transformative and innovative practices that encourage national governments to use One Health approaches to address AMR.[77]

The Global Antimicrobial Resistance and Use Surveillance System (GLASS) is a WHO project that provides a standardized approach to the collection, analysis, interpretation and sharing of AMR data by its members. The data compiled is used by WHO and other international organizations to recommend direction and action. Countries use the data to assess AMR preparedness against specific threats, and to create policies and recommendations.[78]

While most HICs have mature surveillance systems and can provide representative data, not all are part of existing schemes, and many have not contributed to the yearly data sharing. The most notable exclusions include the US, Canada, Australia and a few European nations.[79–81]

Low-and middle-income countries
Score: Amber-Red

Many LMICs have communicable disease surveillance networks and regulations which initiate responses to notifiable diseases.[82] Many have joined the GLASS network – for example, in Africa, Asia and the Middle East. However, scarce financial resources, limited numbers of trained staff, manual data collection and limited laboratory facilities mean that data from these countries is fragmented, and actions to address AMR challenges cannot be taken. Where AMR data is reported to GLASS, it is either partial, or only from some healthcare locations.[83–85]

While there has been significant progress in capacity building for AMR surveillance, good quality representative data, standardized laboratory practices and efficient recording of data remain necessary for the translation of data into policy recommendations and treatment guidelines.[86]

Forming and strengthening regional AMR surveillance networks is also imperative. The Fleming Fund is a UK aid program that supports 25 nations across Africa and Asia to strengthen capacity and capability to tackle AMR. Investing up to £425 million, one of its main focuses is to equip countries to collect, use and share data on AMR.[87]

The CAMO-Net program, which operates in South America, Asia and Africa, aims to create a database of situational data on AMR. CAMO-Net plans to build research collaborations and capacity locally, in a hub-and-spoke model, with national hubs leading efforts and filtering information from smaller national sites.[88,89]

RESEARCH AND DEVELOPMENT (R&D)

High-income countries (HICs)
Rating: Amber-Red

The lack of new antibiotic research over the past 15 years is mainly due to economic pressures. And, even when significant field funding has been introduced in the last five years, the 12 approved antimicrobials in the research and development (R&D) pipeline are not sufficient to challenge the rise in AMR.[90,91]

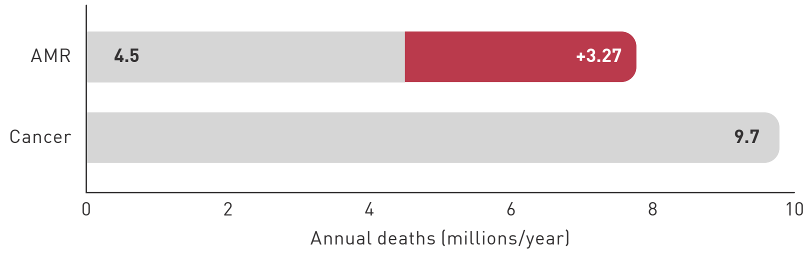
Currently, with about 225 antibacterials in clinical development,[92] compared to more than 1,500 in immuno-oncology, the continuing lack of investment in AMR research is apparent. The R&D pipeline is also unable to meet the present demand for products targeting gram-negative bacteria (which have a tendency to rapidly acquire antibiotic resistance), so there are inadequate antimicrobials to stay ahead of AMR. Most antimicrobials in development are refinements of current therapeutics, and novel treatments are further behind.[93,94]

Up to $1.19 billion is needed in direct R&D funding for antibiotics, yet average sales are just $24 million to $75 million per year. The unattractive economic return seems to be a major limiting factor for AMR research.[95] Currently only about 3,000 researchers focus on AMR globally. The lack of investment combined with diverted government funding is causing a 'brain drain' in AMR research, as experts leave the field. Research papers on antimicrobials have declined too, with only 216 published in 2022 compared to a peak of 586 in 1995.[96]

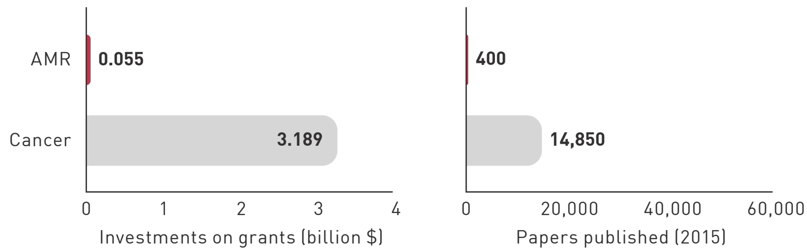
Currently only about 3,000 researchers focus on AMR globally. Research papers on antimicrobials have declined too, with only 216 published in 2022.

However, in recent years, research pipelines and accelerators have boosted funding for work on AMR. For example, Combating Antibiotic-Resistant Bacteria Biopharmaceutical Accelerator (CARB-X) has invested in a wide range of new antibiotics, vaccines, preventatives and rapid diagnostics.[97] The AMR Action Fund also makes similar equity investments in mid-size biotechnology companies that are developing antimicrobials against WHO and CDC priority pathogens.[98] Supplementing these 'push incentives' are novel 'pull incentives', discussed in Section 2.

Deaths associated with AMR are estimated to increase to 8.22 million by 2050.



Investment* in AMR research is very low compared to research into other major diseases. Scientific publications on AMR are also lower than other major diseases, indicating a lack of scientific preparedness for 2050.



Source: Robles Aguilar et al. (2024)[99]
*: This investment on grants data is only from the UN World RePORT data

In animals, where the development of new antimicrobials is not an urgent need, priority must be given to preventative measures, including vaccination. However, R&D in animals is severely underfunded, with barely 7.2 % invested in animal health AMR R&D as a percentage of total AMR R&D spend from public and philanthropic sources. The situation becomes more worrisome when looking into R&D investments for vaccines development in animals, which equates to only six cents out of every ten US dollars spent.[100]

Platforms such as the Global AMR R&D Hub collate AMR research data to prioritize the development of therapeutics, vaccines, operational capacity and other strategies that have the highest potential societal impact. They also aim to help avoid research duplication and overlaps. The Hub has collated about 15,000 projects across those disciplines, accounted for $12.85 billion in funding, and represented 3,121 research organizations in 92 countries since 2017. This allows the AMR landscape to be thoroughly mapped before further funding and research takes place, which maximizes the output of AMR research.[101]

Low- and middle-income countries
Rating: Red

LMICs face the same problems as HICs in terms of R&D. Combined with even lower financial investment, lack of researchers and sub-optimal research conditions, those challenges further reduce AMR research output from those countries. However, many LMICs contribute to the global research effort against AMR, with the highest investors being India, South Africa, Brazil, Argentina, Chile, Indonesia and Egypt.[102]

The Global Antibiotic Research and Development Partnership (GARDP) is an accelerator that works to preserve the power of antibiotics by developing new treatments, improving global access and creating partnerships to revive antibiotic development.[103] GARDP recognizes the lack of antimicrobials targeting gram-negative bacteria which cause sepsis, and the partnership aims to provide new treatments. GARDP also recognizes the 'brain drain' in AMR research, and since 2018 has worked to retain knowledge in the field by connecting and supporting the AMR research community.[104]

The battle against AMR relies on novel therapeutics against resistant microbes, but also on diagnosing diseases to increase antimicrobial stewardship. Development of the COVID-19 rapid lateral flow tests shows that there is capacity to develop rapid, point-of-care diagnostics that can ascertain disease types and mitigate unnecessary antimicrobial prescription.[105] Point-of-care diagnostics have been trialed in Sub-Saharan Africa to shorten the region's 'diagnostic gap', however, the data has not yet shown a reduction in untargeted antibiotic prescription.[106]

OVERALL ASSESSMENT

> **"Are we anywhere near where we need to be? Absolutely not."**
>
> **Mia Mottley, PM of Barbados, and Chair of the Global Leaders Group on AMR, speaking at UN Press Conference, 26th September 2024[107]**

Some progress has been made since 2013, but not enough. Our overall assessment has too many 'ambers' and 'reds'.

Action area	High-income countries	Low-income countries
Awareness	Amber	Amber-Red
Antibiotic conservation	Amber	Amber-Red
Sanitation, hygiene, infection prevention and control	Amber-Green	Red
Surveillance and monitoring	Amber	Amber-Red
Research and development	Amber-Red	Red

Undoubtedly (and justifiably), the immediate health challenge of COVID-19 disrupted efforts to tackle the silent and future pandemic of AMR. Yet, even without the COVID-19 pandemic, it is difficult to see that adequate progress would have been made. Section 2 therefore outlines priority areas for action to deal with AMR.

SECTION 2. OPPORTUNITIES FOR ACTION

GLOBAL CITIZEN ENGAGEMENT

Antimicrobial resistance (AMR) is not onyl a technical problem to be addressed by science; it is a societal issue where individual and systemic behaviors play a significant part. The increase in AMR is directly influenced by the choices people make. A global movement is needed where people alter their behavior – for example, in the way that recycling has become normalized as a way of making better use of the earth's scarce resources.[108]

Some attempts have been made, including a Wellcome Trust-funded collaboration between Mahidol University (Thailand) and the University of Oxford (UK), which has developed an antibiotic footprint calculator.[109] An evaluation of the calculator found a generally favorable response.[110] Yet the antibiotic footprint is not embedded in public discourse in the same way that the carbon footprint is.

Promoting understanding

Carbon emissions are the clear cause of global warming. By contrast, the causes of AMR are complex and not immediately understood by the public. A 2015 multicountry survey by the World Health Organization (WHO) found that 76 percent of respondents believe that antibiotic resistance happens when the body becomes resistant to antibiotics.[111]

The survey also found that 57 percent of respondents feel that there is not much they can do to stop antibiotic resistance, when it is precisely our individual actions that can make a difference.

CASE STUDY 1. MICROPIA (NETHERLANDS)

Micropia in Amsterdam is the world's only museum dedicated to microbes. The museum's aim is to address the general public's lack of understanding about microbes.

Micropia's novel, interactive space brings complex science to life in an easily understandable way. The museum has won multiple awards for its design and content.

Micropia has 110,000 visitors a year and has proved successful in involving school parties and the local community. It has a reach well beyond those who visit its physical galleries, with additional online resources for virtual visitors.

Micropia is part of the ARTIS Amsterdam Royal Zoo. It could provide a model for public exhibitions on antimicrobial resistance.

Promoting greater understanding of the science behind AMR can help people understand how they can be better antibiotic stewards. A good case study of public engagement with microbes is the Micropia museum in Amsterdam (Case study 1).

Wellcome Trust has documented the fragmented information about AMR in communications aimed at the general public. Wellcome has set out recommendations of universal themes to be used across all countries when engaging the public.[112] One main approach is to humanize the issue, recognizing that numbers and statistics generally do not resonate as strongly with the public as human stories. The patient advocacy group, The AMR Narrative,[113] and WHO's 2024 campaign 'AMR is invisible. I am not'[114] show how powerful the voice of AMR survivors can be.

Public involvement

To see positive action on AMR, it is crucial to directly involve the public to increase the relevance, trust and take-up of solutions.[115] For instance, understanding the approach that owners take to antibiotics for their pets can ensure that they are encouraged to make choices that conserve antibiotics appropriately. Such involvement is the main principle behind the Fleming Initiative (Case study 2).

CASE STUDY 2. FLEMING INITIATIVE (GLOBAL)

The Fleming Initiative is a partnership between Imperial College London and Imperial College Healthcare NHS Trust, developed at St Mary's Hospital, where Alexander Fleming discovered penicillin in 1928. Ahead of the centenary of Fleming's discovery in 2028, the initiative aims to open the first Fleming Centre on the site. The center will be a multidisciplinary space bringing together researchers, behavioral scientists, clinicians, policymakers and the public to develop AMR solutions. The center will include a public exhibition and events space where visitors can discover and contribute to the past, present and future of AMR research.

This is a global initiative and there will also be Fleming Centres in regions around the world. All centers will be accessible to the public and involve them in the co-design of effective approaches to tackling AMR.

There will also be outreach beyond the physical Fleming Centres. Social media offers new possibilities for spreading AMR awareness. The Content, Health and AMR Innovation Network (CHAIN) is a partnership between the Fleming Initiative and YouTube Health, where verified clinician content creators commit to spreading awareness about AMR and the actions people can take to their existing global audience of millions.


They can't do it without you
every11seconds.com
FLEMING INITIATIVE
IMPERIAL
TACO BELL
TIMES SQUARE
AT&T
TOURO
ONE WAY

During the week of the UN General Assembly Meeting in New York, The Fleming Initiative highlighted the issue of AMR through a Billboard in Times Square (see photograph above).

Public involvement may be one means of improving surveillance, particularly in LMICs. For instance, a citizen science approach was used in Vietnam to study the prevalence of six pathogenic fungi (Case study 3).

CASE STUDY 3. CITIZEN SCIENCE TO EXPLORE FUNGAL DIVERSITY (VIETNAM)[116]

Surveillance programs can be difficult to implement in LMICs due to capacity and resource constraints. A study in Vietnam circumvented this by recruiting 90 students from secondary schools. They were provided with training videos on how to take air and soil samples, which were processed at the Hanoi Medical University Laboratory. The results provided insights on six fungi that cause disease in humans. The students also received feedback on which fungi were found in their samples, to maintain their interest in being involved in citizen science.

Involving professionals

Professionals are often the gatekeepers for the use of antibiotics. Clinicians prescribe antibiotics to patients, and veterinarians do the same for animals, and so they can have a disproportionate impact on antibiotic conservation.

Sometimes busy doctors may be pressured to prescribe antibiotics by demanding patients.[117] However, through the application of behavioral science, clinicians can be encouraged and supported to conserve antibiotics (Case study 4).

CASE STUDY 4. CHIEF MEDICAL OFFICERS' LETTERS ABOUT DOCTORS' PRESCRIBING RATES (ENGLAND AND AUSTRALIA)

In 2014 a study was conducted in the UK by the Behavioural Insights Team to see if behavioral science could impact on antibiotic use. A cohort was identified of general practitioners (GPs) who were in the top 20 percent of antibiotic prescribers (compared to their local areas). Practices were randomized into a control and an intervention group. Letters highlighting their relatively high prescribing rates were sent from Sally Davies, the then UK Chief Medical Officer, to 3,227 GPs in the intervention group. The behavioral insight revealed that humans generally want to conform to social norms and not be an outlier.

The experiment worked. Between October 2014 and March 2015 prescribing rates in the intervention group fell versus the control group, representing an estimated 73,406 fewer antibiotic items dispensed.[118] A similar approach was adopted in a 2017 trial in Australia and also showed positive results.[119]

TRANSLATIONAL SCIENCE

Significant scientific developments over the last decade offer new possibilities for dealing with AMR.

Diagnostics

Antibiotics have been used for decades without clear knowledge that they are the right treatment. If antibiotics are to be used most appropriately, then affordable, reliable and fast point-of-care diagnostics are required. The 2023 World Health Assembly adopted a resolution that recognizes the critical role that diagnostics play in tackling AMR.[120]

The challenge has often been lack of incentives. Also, the cost of generic antibiotics is low, and so it is often more expensive to conduct a diagnostic test to see if antibiotics are justified. The Longitude Prize was established in part to address this (Case study 5).

CASE STUDY 5. LONGITUDE PRIZE (GLOBAL)

The original Longitude Prize was introduced in the 18th century to encourage innovators to establish an accurate way to measure longitude to help ships navigate. The new Longitude Prize (with £8 million available to the winner) was established in 2014, and the UK public chose its focus on tackling AMR. Specifically, it was decided to be awarded for an affordable point-of-care diagnostic test that could return a result within 30 minutes, and be used anywhere in the world.

On 12 June 2024, the prize was awarded to Sysmex Astrego for the PA-100 AST System, which can diagnose urinary tract infections (UTIs).[121] Using a urine sample, this diagnostic can confirm if a bacterial infection is present within 15 minutes, and identify the most appropriate antibiotic for treatment within 45 minutes. Rapid and accurate diagnosis of UTIs is hugely significant as they are the most common bacterial infection treated by the NHS in England, with over half of women becoming infected with a UTI in their lifetime.

Vaccines

Vaccines can dramatically reduce the need for antibiotic use, as the aquaculture case study from Norway shows (Case study 6).

While vaccinations are making a significant difference to the use of antibiotics in animals, there is great potential to use vaccines to reduce antibiotic use in humans. For instance, a study found that, if 77 percent of children under two years old in 18 LMICs had the rotavirus vaccine, this could avert 13.6 million (31 percent) episodes of antibiotic-treated diarrhea annually.[122]

CASE STUDY 6. VACCINES IN SALMON FARMING (NORWAY)

Norway is the leading producer of farmed Atlantic salmon worldwide, with more than 1.5 million tons raised in 2022.[123, 124] Serious bacterial infections caused significant losses in the early years of the industry, and large amounts of antibiotics were used. In 1987 almost 50 tons of active antibacterial substances were used in production of less than 100,000 tons of farmed salmon. Several antibiotic classes were found to be ineffective against resistant bacteria.

Today, antibiotic use has been mostly replaced by vaccination. All salmon farmed in Norway are now vaccinated against at least five bacterial pathogens. Only 425kg of antibiotics were used in Norwegian aquaculture (all fish species) in 2022.[125] Antimicrobial resistance is now very rarely identified among fish pathogenic bacteria in Norway.

Artificial intelligence (AI)

Arguably the most transformative scientific developments of the last decade have occurred in generative AI. This offers the potential to rapidly analyze large multimodal data sets to provide a much more comprehensive understanding. For instance, AI could be used to answer questions such as which patients will suffer resistant infections, predict resistance transmission, and support clinical decision-making to optimize antimicrobial use.

AI also has the power to speed up diagnostic testing for AMR. For example, deep-learning algorithms have been trained to detect morphological changes that are associated with antibiotic susceptibility, including at the single-cell level, giving results within 30 minutes.[126]

CASE STUDY 7. USING AI TO DEVELOP THERAPEUTICS (US)[127]

Developing new antibiotics through traditional research is time-consuming and costly. As an alternative, researchers at Massachusetts Institute of Technology developed a machine-learning algorithm that can screen one million chemical compounds in a few days for properties that might make them effective antibiotics.

Using this approach, the researchers identified a molecule originally investigated as a possible diabetes drug. This compound, which they labelled 'Halicin', was then tested successfully on bacterial strains in a laboratory setting, and has also proved effective in testing on mice. The researchers are hoping to do further research on Halicin's potential as a human antibiotic, in partnership with the private or voluntary sector.

Such an approach can be developed further. For instance, the AI model could be trained to identify molecules that will only target certain bacteria, while not harming beneficial bacteria in a patient's digestive tract.

AI could also be a powerful tool for increasing the use of diagnostics in resource-limited settings. For example, a smartphone app using AI-powered image processing can more consistently interpret antibiogram data compared to existing hospital-based and manual measurement systems. This can lead to diagnostics being used in more remote settings with fewer lab capabilities, and eventually moving diagnostics into the hands of the patient.

AI can also help in the discovery of new therapeutics (Case study 7).

Environmental

Antibiotic residues can build up in marine environments as water becomes contaminated by antibiotic products. This is bad for microbes in the soil and water. It can also increase AMR by exposing harmful microbes to diluted concentrations of antibiotics, which then develop resistance.

Some work has been done to reduce this discharge. In particular, the AMR Industry Alliance established unified targets for discharge from antibiotic manufacturing using the predicted no-effect concentration (PNEC) – the amount of a substance that marks the limit of adverse effects occurring.[128] The British Standards Institution (BSI) has been applying this in the UK, and some factories in other countries have adopted it. Building on the BSI's work, the PNEC should be applied globally. Less work has been done on reducing effluent from other major sources such as agriculture, and hospital and medical facilities.

POLICY AND REGULATION

To realize the potential of scientific developments and citizen engagement, the right policies and regulations must be in place.

Incentives

The standard approach to paying for drugs by volume doesn't work for new antibiotics. We want to keep new antibiotics in reserve, to use when existing antibiotics are no longer effective. But, why would pharmaceutical companies want to develop a drug that health systems will not initially buy? This is why a different approach is needed.

CASE STUDY 8. SUBSCRIPTION PAYMENT MODEL FOR NEW ANTIBIOTICS (UK)

To provide funding certainty not linked to sales volumes, in 2022, the UK introduced a pilot funding the development of two new antibiotics by Pfizer and Shionogi. The two companies were paid up to £10 million per year, guaranteed for 10 years (with a three-year break clause).

After a successful pilot, the subscription model is being rolled out further, and more antibiotics will join the scheme from March 2025. It is arguably too early to identify if the approach is incentivizing new drugs, and robust evaluation is needed.[129] However, it does demonstrate creative thinking to encourage the life science sector to develop new antibiotics.

The UK has implemented a subscription model (Case study 8) as have Japan and Sweden. The US (through the PASTEUR Act), Canada, Australia and Switzerland are considering their own versions of the scheme. The EU is also exploring options for pull incentives, including awarding a transferable 'exclusivity voucher' that a company can use on a different drug or sell to another company.

Regulation

Regulation can play an important role in antibiotic conservation by restricting indiscriminate use of antibiotics (Case study 9).

CASE STUDY 9. REGULATION ON USE OF ANTIBIOTICS FOR LIVESTOCK (EUROPEAN UNION)

The use of antibiotics to promote growth in livestock has been banned since 2006. From 1 January 2022, the routine prophylactic use of antibiotics in livestock has also been banned in the EU, and preventative use was restricted to exceptional treatments of individual animals. Antibiotics can also no longer be applied to compensate for poor hygiene and animal husbandry practices.

The regulation has significance beyond the EU, as imported meat must conform. It can also act as a model for other countries.

Access

In 2015, 5.7 million people passed away from lack of access to antibiotics.[130] Also, even while allowing for progress, it is likely that deaths will increase from the 1.27 million caused by drug-resistant infections in 2019. Access to the right antibiotic at the right time is crucial for patient outcomes, and is also a vital element of controlling the growth of AMR.[131]

CASE STUDY 10. THE SECURE PROJECT (GLOBAL)[132]

The SECURE project aims to work across the antibiotic value chain to improve access to antibiotics globally. By collaborating with participating countries, the project gathers market intelligence and understanding of public health needs. This data is used to shape an optimized country-level antibiotic portfolio. Depending on the specific drug, access is enhanced by pooling procurement between multiple countries to increase market size, improving affordability through subsidies. This creates attractive markets with revenue or volume guarantees, and prevents stockpiling and shortages.

Opportunities to improve access to antibiotics include improved demand forecasting, strengthened and harmonized regulatory systems, standardized formularies, and use of economic tools such as joint procurement, revenue or volume guarantees, stockpiling and co-payment schemes. The SECURE project, set-up by Global Antibiotic Research and Development Partnership (GARDP) and the World Health Organization (WHO), aims to use many of these tools (Case study 10).

National action plans

WHO has produced a suite of resources to help countries develop and implement national action plans for tackling AMR.[133] Most countries now have a national action plan. However, these plans are often not properly resourced, and many lack specific commitments on important issues such as environmental contamination.

A review of existing national action plans proposed the inclusion of a clear Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis, and highlighted the stakeholders who had contributed.[134] There could be potential for peer review of national action plans in WHO regions to share best practice and encourage healthy competition.

SECTION 3. NEXT STEPS

REFLECTIONS ON THE UN GENERAL ASSEMBLY HIGH-LEVEL MEETING ON ANTIMICROBIAL RESISTANCE (AMR)

On 26th September 2024, world leaders gathered in New York to endorse a Political Declaration on AMR.[135]

The Declaration has much to commend it. It speaks powerfully of the need for coordinated international action. It recognizes this needs to be done jointly in the sectors of human health, animal health, food and the environment, giving clear responsibility to the Quadripartite of the World Health Organisation, the Food and Agriculture Organization of the United Nations, the World Organisation for Animal Health and the United Nations Environment Programme.

Inevitably a declaration that is acceptable to all, will not go as far as those working on AMR would like. For instance, significant questions remain in terms of funding. The Political Declaration calls for the raising of $100 million catalytic funding to support 60% of countries having funded AMR national action plans by 2030. $100 million is not very much when spread across the needs of LMICs. And an ambition to have 60% of countries with funded plans is insufficient as that means the action plans of two fifths of countries would still be unfunded.

Furthermore, important questions regarding agreed targets in agri-health, or means of preventing a 'brain-drain' across R&D still persist. And, as the EU Patient's Forum and the AMR Narrative point out, there is a lack of detail on resourcing and implementation of greater patient and civil society involvement.[136]

Nonetheless, the Declaration presents an opportunity to expand discussions across the various complexities of the AMR ecosystem. Our recommendations therefore build on the Declaration's content and offer complementary additions and ways to achieve its goal of immediate action on an urgent global health threat.

RECOMMENDATIONS

RECOMMENDATION 1

International organizations should put into action the 2024 UN AMR high-level meeting recommendation to establish an independent body to advise on the evidence and inform action. This panel will identify gaps in the current evidence on AMR, assess emerging and future risks of AMR, and inform cost-effective options for mitigating AMR, including global targets.

The Political Declaration has invited the quadripartite organisations to establish an independent panel for action against antimicrobial resistance in 2025. This is excellent news and hopefully such a panel can have a similar impact to the Intergovernmental Panel on Climate Change (IPCC).

One of the panel's first tasks should be to consider metrics. The Political Declaration adopts the metric of a 10% reduction in deaths associated with AMR by 2030. This draws on the 10/20/30 targets proposed by Mendelson et al., (10 percent reduction in mortality from AMR; a 20 percent reduction in inappropriate human antibiotic use; and a 30 percent reduction in inappropriate animal antibiotic use by 2030 from a 2019 baseline).[137] The Political Declaration does not adopt the 20% or 30% reductions, focusing instead on increasing usage of access antibiotics (as a positive framing of reducing inappropriate usage) and talking about "meaningfully reducing" in animal use.

The metrics contained in the Political Declaration focus on 2030. This provides an element of urgency, but risks obscuring bigger, bolder goals that are easier to communicate to the public. For instance, the call for '10 million lives saved by 2040' contained within the 1/10/100 goals proposed by the Bellagio Group for Accelerating AMR Action, led by the Global Strategy Lab, is a powerful message.[138]

Setting metrics is not an easy task. They need to have relevance across human, animal and environmental health. They need to be timely, which can be a challenge for mortality metrics due to time lag and delays in case reporting. Ideally, the metrics can apply at both a global and a national level. The independent panel should therefore thoroughly consider the evidence and, by 2026, propose one or more compelling metrics that will guide work on tackling AMR.

RECOMMENDATION 2

Countries and international bodies should engage their citizens in tackling AMR, with clear plans to do so by 2028.

Citizen engagement was a topic discussed at UNGA side events (see Box 3) and the Political Declaration calls for involvement of "civil society and affected communities" in the solution to AMR.[139] This goal should be achieved in an evidence-based way, drawing on work such as Wellcome Trust's Reframing Resistance study, including public stories by survivors.[140] Meaningful citizen engagement – both awareness raising and active involvement in research and policy work – should be part of all AMR national action plans. This will strengthen the quality, relevance and public trust in what AMR national action plans propose.

BOX 3. CITIZEN ENGAGEMENT DISCUSSED IN NEW YORK

The requirement to move beyond public awareness of AMR into engagement, action and behaviour change was highlighted at an UNGA side event hosted by the Fleming Initiative, in partnership with CAMO-Net, Wellcome and Imperial College London. The event showcased a range of exemplary public engagement and educational initiatives from across the globe, including Brazil, Uganda and South Africa. It highlighted the growing need to develop innovative engagement programmes in an equitable fashion across the world, enabling the public to join in the fight against AMR. The discussions also demonstrated the need to have a clear focus on embedding AMR education into school curricula ensuring advocacy for antimicrobial stewardship is championed by children and young people.

RECOMMENDATION 3

Governments should give more priority to water and sanitation in addressing AMR. This includes increasing investment in water, sanitation and hygiene (WASH) to reduce infections and environmental microbe exposure, and the development of national programs to surveil antibiotic residues, resistance genes and resistant pathogens in the water supply and factory effluent.

Recommending increased spending on sanitation is not novel or innovative. But it is the right thing to do. If the spread of infection can be reduced in the first place, then antibiotics can be conserved and used less frequently. Modeling analysis suggests that universal access to high-quality water, sanitation and hygiene services would prevent about 250,000 AMR-related deaths in low- and middle-income countries (LMICs).[141] The Political Declaration rightly calls for 100% of countries to have basic water, sanitation, hygiene and waste services in all health care facilities by 2030.[142] More resources from high-income countries (HICs) should be provided to LMICs to support this, including through the Global Sanitation Fund.

Governments should also improve surveillance of the water supply. There are already standards of water testing relating to manufacturing waste and pharmaceutical effluent from the production of antibiotics.[143] However, there is evidence that water sources can act as a sink and source for antimicrobial residues and resistance genes.[144] More widespread water testing can yield information on the persistence of residues, emerging resistant strains and epidemiological data on spread. This would be similar to programs developed by global health authorities to track COVID-19 strains.[145]

It is recommended that AMR national action plans should expand testing of urban wastewater. Greater funding and resource should be invested in surveillance networks that include other bodies of water where environmental contamination may persist. In keeping with existing surveillance initiatives, this data should be widely accessible to researchers and policymakers to help fill knowledge gaps. Progress should be assessed by 2028 to see if international work is needed to supplement national efforts.

RECOMMENDATION 4

By 2027, high-income countries should commit to only prescribing antibiotics (with a few defined exceptions) when need is confirmed by a diagnostic test. Low- and middle-income countries should achieve this by 2030.

Diagnostics are now available for many bacterial illnesses, such as urinary tract infections. It is suggested that, with a few exceptions (see Box 4), health systems should commit to prescribing antibiotics only when indicated by a diagnostic test. HICs should do this by 2027. This will require a significant expansion in the use of diagnostics, particularly in primary care and in some contexts improving laboratory capacity and staffing capabilities. In some cases, it will also require a change of mindset and a movement away from traditional approaches such as the use of blood cultures.[146]

This will take longer to achieve in LMICs. It is recommended that an AMR Diagnostic Support Fund be established by 2026 to support use of diagnostics in LMICs.

BOX 4. DIAGNOSTIC EXCEPTIONS

In some cases – for example, suspected sepsis – there may be a need to prescribe antibiotics before a diagnostic is carried out to avoid rapid deterioration of a patient. The list of such exceptions should be agreed nationally.

As molecular diagnostics, and point-of-need testing advances (including in the use of microfluidics and artificial intelligence) the speed of testing should reduce the list of conditions that are exceptions.

RECOMMENDATION 5

By 2026, all high-income countries should have introduced pull incentives for the development of new antimicrobials to deliver on global antibiotic priorities.

Using the momentum from the Political Declaration, which calls for the encouragement of "innovative incentives and financing mechanisms for multisectoral health research and development to address antimicrobial resistance",[147] HICs should ensure that they have the required policies and funding to create a sufficiently sized pull incentive (equivalent to the UK subscription model scaled up to the G7 and EU) by no later than the end of 2026.

The independent panel for assessing progress on AMR should set targets for the antibiotic pipeline to meet global health need (for example, drugs showing potential to treat the World Health Organization's priority pathogens and overcome resistance patterns) with a headline figure for the number of new drugs that need to be developed and made available.

RECOMMENDATION 6

Global health organizations should use the forthcoming centenary of the discovery of penicillin (2028) to accelerate progress on the AMR agenda.

Progress needs to accelerate in addressing AMR. On 28 September 2028, it will be 100 years since Fleming discovered that the penicillium fungus growing in his petri dishes inhibited bacteria growth. Fleming himself predicted the rise of AMR in his Nobel prize acceptance speech.[148] We will start a countdown to the centenary at WISH 2024. The centenary should be used to drive momentum on tackling AMR, to ensure that at the next United Nations General Assembly High-Level Meeting on AMR in 2029, the world is on track for another century of effective antibiotics.

ABBREVIATIONS

AMR	antimicrobial resistance
AWaRe	Access, Watch, Reserve
BRICs	Brazil, Russia, India and China
CARB-X	Combating Antibiotic-Resistant Bacteria Biopharmaceutical Accelerator
CDC	Centers for Disease Control and Prevention
CHAIN	Content, Health and AMR Innovation Network
CRE	carbapenem-resistant enterobacterale
EU	European Union
FSA	Food Standards Agency
GARDP	Global Antibiotic Research and Development Partnership
GLASS	Global Antimicrobial Resistance and Use Surveillance System
HCPs	healthcare professionals
HICs	high-income countries
IPC	infection prevention and control
IPPC	Intergovernmental Panel on Climate Change
LMICs	low- and middle-income countries
MICs	middle-income countries
MRSA	methicillin-resistant *Staphylococcus aureus*
NICE	National Institute for Health and Care Excellence
PNEC	predicted no-effect concentration
R&D	research and development
RENOFARM	Reduce the Need for Antimicrobials on Farms for Sustainable Agrifood Systems Transformation
UN FAO	United Nations Food and Agriculture Organization
UTI	urinary tract infection
WAAW	World AMR Awareness Week
WASH	water, sanitation and hygiene
WHO	World Health Organization

ACKNOWLEDGMENTS

The Forum Advisory Group for this paper was co-chaired by **Professor Lord Ara Darzi**, Co-Director of the Institute of Global Health Innovation, Imperial College London, and **Professor Dame Sally Davies**, UK Special Envoy on Antimicrobial Resistance.

This paper was written by Professors Darzi and Davies in collaboration with **Peter Howitt** and **Anant Pratap Singh**, both Imperial College London.

Sincere thanks are extended to the members of the WISH 2024 Forum on Antimicrobial Resistance Advisory Group, who contributed their unique insights to this paper:

- **Dr Raheelah Ahmad**, Associate Professor, Health Systems, City St George's University of London
- **James Anderson**, Executive Director (Global Health), International Federation of Pharmaceutical Manufacturers and Associations
- **Dr Roberto Bertollini**, Public Health Advisor, Qatar Ministry of Public Health
- **Professor Jim Collins**, Termeer Professor of Medical Engineering & Science and Professor of Biological Engineering at Massachusetts Institute of Technology
- **Professor Nelesh Govender**, University of the Witwatersrand, South Africa
- **Jose-Carlos Gutierrez-Ramos**, Chief Science Officer, Danaher Corporation
- **Professor Alison Holmes**, Professor of Infectious Diseases, Imperial College London
- **Dr Ramanan Laxminarayan**, President, One Health Trust
- **Dr Ali Omrani**, Senior Consultant in Infectious Disease, Communicable Disease Center, Doha, Qatar
- **Professor Leslie Pal**, Founding Dean of the College of Public Policy, Hamad Bin Khalifa University
- **Professor Karin Thursky**, Director National Centre for Antimicrobial Stewardship, Australia
- **Dr Javier Yugueros Marcos**, Head of Antimicrobial Resistance and Veterinary Products Department, World Organisation for Animal Health

The chairperson and authors would also like to extend their sincere thanks to the following individuals:

- **Dr Julia Bishop**, AMR Policy Accelerator, Canada
- **Professor Duncan Colquhon**, Norwegian Veterinary Institute
- **Connie Longmate**, UK Department of Health and Social Care
- **David McKinney**, Alliance for Reducing Microbial Resistance
- **Dr Ghada Zoubiane**, International Centre for Antimicrobial Resistance Solutions

Thank you to the wonderful Fleming Initiative team for their input and review, especially **Dr Amish Acharya**, **Dr Kate Grailey**, and **Dr Emily Scott-Dearing**.

Finally, we would like to thank **Sultana Afdhal**, **Slim Slama**, **Didi Thompson**, and **Maha El Akoum** from the WISH team for their support and editorial guidance in preparing this report.

Any errors or omissions remain the responsibility of the authors.

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WISH RESEARCH PARTNERS

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State of Qatar • دولة قطر

WISH gratefully acknowledges the support of the Ministry of Public Health

ISBN 978-1-913991-37-1

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