Forecasting the Fallout from AMR: Averting the Health and Economic Impacts through One Health Policy and Investment

A policy brief from the EcoAMR series

BY 2050...

- If no action is taken, human health care costs due to antimicrobial resistance (AMR) could rise to **US$ 159 billion** per year globally.
  But investments in drug innovation and health care improvements can reduce these costs by **US$ 97 billion** per year globally, boost the labour force by 23 million workers,[1] the rates of tourism by 1.2% and hospitality by 0.6%, adding **US$ 960 billion** to the annual GDP; and generate a further **US$ 679 billion** per year in health value, as measured by GDP per capita. It would cost US$ 64 billion a year to roll out this policy, achieving a return on investment of 28:1 by 2050.
- If no action is taken, the impacts of AMR on livestock could reduce global GDP by **US$ 40 billion** per year.
  But achieving a global 30% reduction in animal antimicrobial use (AMU) within five years can raise GDP in 2050 by **US$ 14 billion** in comparison to the business-as-usual forecast. Further reduction towards more optimal AMU levels within 20 years can raise GDP in 2050 by **US$ 26 billion**.
- The spread of resistant pathogens from livestock to humans could cost another **US$ 77–384 billion** per year in GDP, depending on the severity of the modelled spillover and its impact on labour productivity.
- Without action, AMR in humans could cause **38.5 million deaths** between 2025 and 2050 – reaching a **60% higher annual toll** than today. People aged 70+ would suffer the most, with a 131% rise in deaths for this age group.
- The human health burden would be heaviest in lower- and middle-income countries (LMICs) in **South Asia** (630,000 annual deaths), **Southeast Asia, East Asia and Oceania** (390,000), and **Sub-Saharan Africa** (320,000).
  But development of new gram-negative antimicrobials can **save more than 10 million lives** between 2025 and 2050 – while combining new antimicrobials with improved health care and vaccination as well as safe water, sanitation and hygiene (WASH) in LMICs can boost this impact to **save 110 million lives** from both AMR and non-AMR infections.

IN 2022 ALONE...

- A total of **1.15 million human deaths** were attributable to bacterial AMR.

We need a One Health response and the evidence to guide it

To effectively respond, governments and international actors must know the potential implications and broader impacts of AMR on economies and lives. That knowledge depends on multi-sectoral One Health evidence that reflects the connections between humans, animals and the environment, and that empowers principles of equity, equilibrium, stewardship and transdisciplinarity.

1 This includes people who would otherwise leave the labour force due to illness or death. Without investment, additional people may leave to avoid heightened AMR risk (e.g. those with compromised immune systems).

The EcoAMR project has produced the most complete modelling-based forecasts to date of the impacts of AMR in humans and animals

Using the latest data from 204 countries and 621 sub-national locations, three studies modelled a range of scenarios to investigate the burden of antimicrobial resistant bacteria on human health, the cost of this burden, and the economics of antimicrobial use and resistance in livestock. While the evidence presented here is restricted to bacterial agents, and therefore under-estimates the complete scope of AMR, it brings One Health approaches to AMR closer than ever, laying the foundations for unified models and solutions that reach across sectors.

SCENARIOS TO AVOID

Scenario modelled	Annual impacts by 2050
Human health business-as-usual scenario	■ Health care costs will rise to US$ 159 billion per year ■ AMR will be responsible for 38.5 million deaths between 2025 and 2050
Animal sector business-as-usual scenario	■ Livestock production loss will be equivalent to the consumption needs of 746 million people per year, with the heaviest impact in LMICs ■ Annual GDP loss will be US$ 40 billion
Human health scenario with accelerated rise in AMR (top 15% of past increases)	■ Health care costs will rise to US$ 325 billion per year ■ Annual GDP will be US$ 1.7 trillion lower than in the human health business-as-usual scenario ■ AMR will be responsible for 45.2 million deaths between 2025 and 2050
Animal sector scenario with accelerated rise in AMR (based on high disease incidence and heavy AMU)	■ Livestock production loss will be equivalent to the consumption needs of 2.1 billion people per year ■ Annual GDP will be US$ 74 billion lower than in the animal sector business-as-usual scenario
Animal sector scenario with moderate spillover effects on human health	■ Annual GDP will be US$ 77 billion lower than in the animal sector business-as-usual scenario
Animal sector scenario with accelerated rise in AMR and serious spillover effects on human health	■ Annual GDP will be US$ 384 billion lower than in the animal sector business-as-usual scenario

BETTER FUTURES

Scenario modelled	Annual impacts by 2050
Regular release of new antimicrobials for humans, targeting gram-negative bacteria	■ Annual GDP gain of US$ 743 billion ■ New antimicrobials will avert 10.2 million deaths between 2025 and 2050
Better human health care and regular release of new antimicrobials	■ Annual GDP gain of US$ 959 billion ■ GDP-based health benefits will be worth US$ 679 billion per year ■ Better health care and new antimicrobials will avert 100 million deaths due to bacterial infections between 2025 and 2050
Better human health care, including access to new antimicrobials, improved vaccination and the elimination of unsafe WASH	■ Annual GDP gain of US$ 990 billion ■ Combined improvements will avert 110 million deaths due to bacterial infections between 2025 and 2050
A global 30% reduction in animal AMU by 2030	■ Annual GDP gain of US$ 14 billion
A more significant reduction in animal AMU by 2045, reaching use levels of 20 mg per kg of biomass, as tracked in the global ANIMUSE database	■ Annual GDP gain of US$ 26 billion

WHY ARE THE BENEFITS OF ACTION SO GREAT?

EcoAMR sought to identify a myriad of health and economic pathways through which AMR will impact humans and animals. These are also the pathways for action.

To model the **human health burden** of AMR under different scenarios, the Institute for Health Metrics and Evaluation (IHME) built on the Global Burden of Disease framework to forecast AMR-associated deaths, AMR-attributable deaths and disability-adjusted life years. In the business-as-usual scenario, IHME found that the growing burden would be driven significantly by population ageing and growth. While AMR deaths among those aged five and younger will continue to decrease, the forecast shows that deaths among those aged 70+ will more than double. Multipronged action will therefore have significant benefits if it can address age-related comorbidities, as well as infection treatment and control. Effective initiatives for this would be new and more accessible antimicrobials, better health care, vaccines and safe WASH.

The Center for Global Development (CGD) built an economic model using IHME's health estimates to understand the **economic consequences** of the health burden. They began by modelling the costs to health systems of rising AMR. For the first time in a global study, this was based on country-specific estimates of health care costs per infection. CGD then looked beyond health care at other ways in which AMR can affect economies, including people being unable or reluctant to go to work, travel or dine out during outbreaks. Together, these factors formed the broadest range of economic shocks ever modelled for AMR. All the estimates were fed into a global macroeconomic model to forecast the wider ripples in the economy.

The **animal sector** team of the World Organisation for Animal Health (WOAH) and RAND Europe used a livestock production disease model to simulate outputs under different scenarios. These results were then passed on to an economy-wide macroeconomic model for the first-ever analysis of the global economic impact of AMR in livestock production. The modelling was paired with insights from two case studies. The first case study, carried out in partnership with Animal Industry Data (AID), evaluated a low-cost AI-based system used for early disease detection on pig farms. Showing an average yearly return on investment of more than 400% per pig, this study demonstrated the type of innovation that can profitably reduce AMU. The second case study surveyed more than 1,400 farmers in Bangladesh. It highlighted a persistent lack of awareness and widespread practices that contribute to AMR, such as antimicrobials in feed and reliance on untrained service providers. Furthermore, farmers expressed significant economic difficulties associated with livestock disease and death, including cut backs on household provisions, school fees, health care and employee layoffs. The livestock production disease model mirrors this: when inappropriate AMU in food production contributes to the emergence and spread of AMR, the modelled effects of AMU on productivity shift from positive to negative. Pathogens can also be potentially transmitted to humans through direct contact, food or wastewater.

Overall, the EcoAMR project has conducted a more comprehensive analysis than any previous study on the damage AMR will cause to people, food production and the global economy. Hence, the results offer a comprehensive demonstration of the promise that investments can achieve for a better future.

RECOMMENDATIONS

EcoAMR forecasts show that failing to confront AMR right now will endanger human life, animal health, economies and food production on a global scale, and will hinder the attainment of the Sustainable Development Goals.

The forecasts also show the enormous gains that can be achieved if interventions to reduce the unnecessary use of antimicrobials in humans and animals are accelerated. Every single area of intervention that was modelled in the study adds significant benefits. The message is simple: take action now to avoid the more catastrophic scenarios.

Make the case

To safeguard economies and lives, governments and international actors should leverage the strong health

and economic modelling case to make high, coordinated and sustained investments in action that will have far-reaching global benefits.

Mobilise investments

The evidence is grounds to significantly amplify investment – public and private, bilateral and multilateral, equitably across sectors, within and beyond the AMR Multi-Partner Trust Fund. In addition, the results must drive a response that is ambitious enough to create the better futures that are modelled here. AMR arises out of deficiencies in our systems, and we must strengthen these across the board: drug and vaccine development and distribution systems, water and sanitation systems, and health systems at large.

Look to LMICs

In all the modelled scenarios, the impact of AMR is felt most acutely in LMICs. It is particularly in these countries that evidence-based alternatives to antimicrobial-only approaches are essential to curbing AMR. These approaches include vaccines, bacteriophages, better WASH and improved farm biosecurity coupled with antimicrobial stewardship. As a matter of priority, sustainable financing must go to the 89% of AMR National Action Plans that still have no funding allocated for their implementation – especially those of LMICs.

Let data flow

Countries need more evidence to prioritise interventions and determine their cost-effectiveness. Furthermore, responsive One Health actions of all kinds require better, newer data on how AMU and AMR affect humans, animals and the environment. There is a dire need for better global and national systems that track AMU and AMR in animals, that are viable for LMIC settings, and that include investments in sentinel and in-field real-time diagnostics.

Aim policies at prevention

Policies should bolster preventive measures. They should sustain efforts in both human and animal vaccination, including the development of new animal vaccines, fulfill the promise of safe WASH, promote good animal husbandry and biosecurity, as well as access to animal health professionals with effective education of farmers and animal health professionals. Conversely, governments should renounce antimicrobials as livestock growth promoters; in fact, EcoAMR's analysis shows 45% higher AMU where such use is allowed. Countries should create toolkits of costed interventions, such as the AI solution reported here, that will achieve global targets for AMU and AMR, as the economic potential is immense.

Pursue R&D across One Health

Incentivising the development of new human and animal antimicrobials and vaccines is essential. So, too, are many other research efforts that can get us through the AMR crisis, from timely, affordable diagnostics and environmental studies to further economic and policy studies. Research priorities have recently been set out by authorities including the Quadripartite Joint Secretariat, UNEP and WHO. New research can build on EcoAMR to further establish the health and economic impacts and the case for investing in AMR using a One Health approach. It can also quantify spillover linkages and effects between AMR in animals, humans and the environment, and ultimately, it can inform the selection of high-impact interventions.

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