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Embracing a One Health Framework to Fight Antimicrobial Resistance





Key findings

- Misuse of antibiotics remains a key driver of antimicrobial resistance (AMR), the ability of microorganisms to resist antibiotics. Over the last two decades, the total consumption of antibiotics in humans increased modestly in OECD and EU/EEA and substantially across non-OECD G20 countries. Consumption of last-resort antibiotics has increased faster than total consumption. Consumption of antimicrobials in animals halved between 2000 and 2019 in OECD and there could be an extra 10% decline by 2035. But by 2035, the sale of veterinary antimicrobials in G20 can be nearly double that of the sales in OECD, after adjusting for livestock population size.
- Without effective action, resistance to third line antibiotics could be 2.1 times higher in 2035 compared to 2005 – making it substantially more difficult to treat infections such as pneumonia and bloodstream infections. For certain countries and for certain antibiotic-bacterium pairs including some that are acquired in hospital settings, up to 90% of infections will be resistant.
- Organisms resistant to antimicrobials are responsible for around 79 000 deaths each year. The total annual cost of AMR across 34 OECD and EU/EEA countries is around USD 58 per capita, adjusting for purchasing power parity (PPP). About one-third of these costs (almost USD PPP 26 per capita) are due to increased health expenditure and the rest due to reduction in workforce productivity (almost USD PPP 33 per capita). Healthcare acquired resistant infections account for 60% of all the deaths while representing about one-third of all resistant infections.
- Most OECD, EU/EEA and G20 countries developed national action plans to tackle AMR but only a fraction of them incorporated financial provisions to implement their plans. Bolstering nationwide implementation of best practices in human and animal health, agri-food systems and the environment and improving surveillance systems are top priorities for action.
- Programmes to promote prudent use of antibiotics and to enhance hand and environmental hygiene in healthcare settings prevent the highest number of deaths due to resistant infections. Beyond human health, enhanced food handling practices and improving biosecurity in farms promise reductions in resistant infections. OECD analysis shows that all of these interventions are cost-effective.
- A multi-disciplinary policy approach, known as One Health, is affordable. Across 34 OECD and EU/EEA countries, investing around USD 4 per capita each year in a mixed package that can be implemented in human health and food sectors could avert more than 17 000 deaths, save more than USD PPP 9.4 billion in health expenditure (USD PPP 8.3 per capita) and yield around USD PPP 13.8 billion (USD PPP 12 per capita) in economic gains through increased participation in the workforce and productivity.
- Benefits of implementing policy packages offset implementation costs. The benefit-to-cost ratio is around 5 for the mixed package, around 4.7 for a hospital-based package and 2.5 for a package comprising community-based actions.

Heavy reliance on antimicrobials in human health and mixed progress in animal health are underpinning the AMR pandemic

The consumption of antibiotics in humans has been increasing for the last 20 years. In OECD and EU/EEA, the sales of all classes of antibiotics increased slightly by nearly 2% between 2000 and 2019, reaching 21.8 defined daily doses¹ per 1 000 inhabitants per day. In this period, the consumption of last-resort antibiotics has increased faster than total consumption. For example, consumption of polymyxins grew by 67% between 2011 and 2020 in EU/EEA countries. Non-OECD G20 countries, which historically had lower levels of antimicrobial consumption, have converged upwards towards the OECD and EU/EEA levels. Antibiotic consumption in human health is forecasted to remain relatively flat in OECD between 2015 and 2035 whereas EU/EEA and G20 countries could see modest declines in the total consumption (3.3% and 6.2% respectively).

Between 2000 and 2019, the average sales of all classes of antimicrobials used in meat production has declined globally and halved in OECD from 181 to 91 mg of antimicrobial per kilogram of food animal. Most of this decline took place since 2014. OECD projections suggest that if current trends continue, antimicrobial consumption in animals could decrease by 10% in the OECD between 2020 and 2035. However, the majority of sales of veterinary antimicrobials occurs outside of OECD, with sales in G20 projected to double the OECD average by 2035 after adjusting for livestock population size.

Too soon to tell: The COVID-19 pandemic and AMR

Emerging data suggests that many OECD countries relied less on antibiotics in human health during the first year of the COVID-19 pandemic. In 2020, the most recent year for which data on antibiotic consumption is available, a majority of EU/EEA countries reported decreases in antibiotic consumption for both the community and the hospital sector. Similar to EU/EEA countries, Australia also saw substantial decreases in antibiotic prescriptions in 2020. In the United States, the overall antibiotic use was lower in August 2021 compared to 2019, though the use of some antibiotics such as azithromycin and ceftriaxone increased. Mobility restrictions and higher use of masks, as well as reduction in the number of hospitalisations for elective surgery have been cited among the reasons underpinning the reduction in prescriptions.

The impact of the reduction in use of antibiotics in humans on AMR rates is still unclear. The AMR surveillance systems of many OECD and EU/EEA countries were severely affected during the initial phases of the pandemic. In addition, the COVID-19 pandemic undermined the implementation of policies to tackle AMR in many OECD countries. For example, out of 26 OECD countries participating in a recent OECD survey, 11 reported interruptions in AMR mass media campaigns and educational programmes for antibiotic prescribers and 9 countries reported disruptions in the monitoring of antibiotic prescribing behaviours in healthcare facilities.

It is too soon to project whether changes in antibiotic consumption and AMR levels will continue in the longer term and if so, what will be their impact. Robust surveillance systems will continue to be vital to monitor the situation and to assess the consequences and inform public health decisions.

¹ Defined daily dose is a standard measure for drugs, calculated as the assumed average maintenance dose per day for a drug used for its main indication in adults.

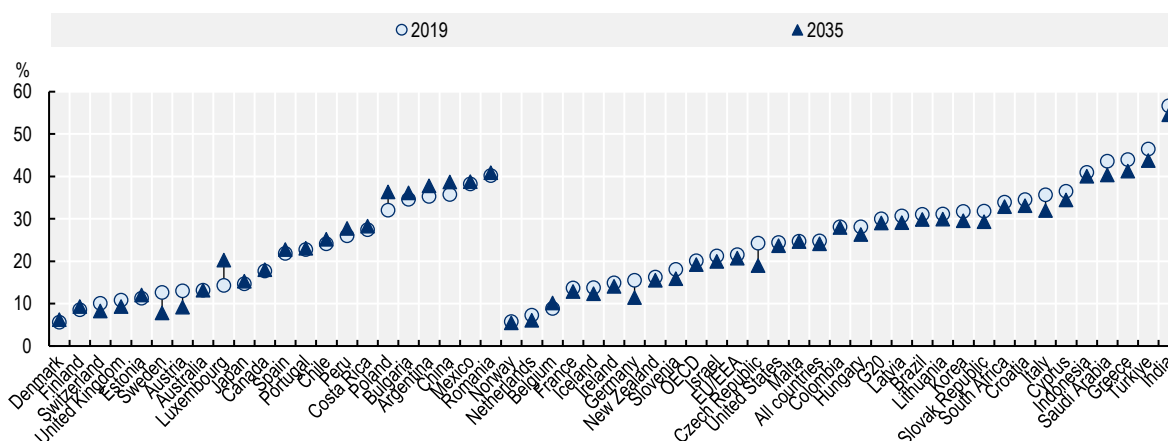
The AMR pandemic is already here

Resistance proportions for 12 antibiotic-bacterium combinations² increased, on average, by 2 percentage points since 2009 and stood at 20% in 2019 (3 percentage point rise in EU/EEA to 22%). This means that today, around one in every five bacterial infections in OECD and EU/EEA are caused by organisms resistant to antimicrobials. In this period, the average largest increase in resistance proportions was for fluoroquinolone-resistant *Acinetobacter baumannii* (*A. baumannii*, 15 and 19 percentage point increase in OECD and EU/EEA respectively), a bacterium causing, in particular, hospital-acquired infections. In 2019, AMR rates for fluoroquinolone-resistant *A. baumannii* averaged at 59% in OECD and 67% in EU/EEA respectively, making it more difficult to treat illnesses such as bloodstream infections, urinary tract infections and pneumonia.

The OECD projections demonstrate that resistance proportions for the 12 antibiotic-bacterium combinations will remain mostly flat by 2035 but 18 out of 51 OECD, EU/EEA and G20 countries will experience a rise in AMR rates by 2035 compared to 2019 (Figure 1). Without decisive policy action, some alarming trends are likely to exacerbate:

- Resistance to third-line antimicrobials – the last resort drugs against difficult-to-treat infections – could reach 2.1 times higher by 2035 in OECD compared to 2005. This means that it will become more difficult and costly to treat illnesses such as pneumonia and bloodstream infections.
- There is cause for concern for some countries such as Greece, India and Türkiye, where resistance proportions were above 44% in 2019 and will remain at high levels by 2035.
- In countries with the highest resistance proportions, almost 90% of infections can be resistant to antibiotics such as fluoroquinolone-resistant and carbapenem-resistant *A. baumannii*.

Figure 1. By 2035, AMR rates will be higher in 35% of OECD, EU/EEA and G20 countries compared to 2019



Note: For countries on the left of this graph, resistance proportions are projected to be higher in 2035 compared to 2019. For countries on the right, rates are projected to be lower in 2035. Otherwise, countries are sorted left to right based on ascending resistance proportions in 2019. Averages for different country groups are unweighted.

Source: Figure 2.6. in OECD (2023), *Embracing a One Health Approach to Fight Antimicrobial Resistance*, available at: oe.cd/amr-onehealth.

² Twelve priority antibiotic-bacterium combinations included in the analysis are vancomycin-resistant *Enterococcus faecalis* (*E. faecalis*), vancomycin-resistant *E. faecium*, third-generation cephalosporin-resistant *E. coli*, carbapenem-resistant *K. pneumoniae*, third-generation cephalosporin-resistant *K. pneumoniae*, carbapenem-resistant *Pseudomonas aeruginosa* (*P. aeruginosa*), meticillin-resistant *S. aureus*, penicillin-resistant *Streptococcus pneumoniae* (*S. pneumoniae*), fluoroquinolone-resistant *A. baumannii*, carbapenem-resistant *A. baumannii*, fluoroquinolone-resistant *E. coli* and carbapenem-resistant *E. coli*.

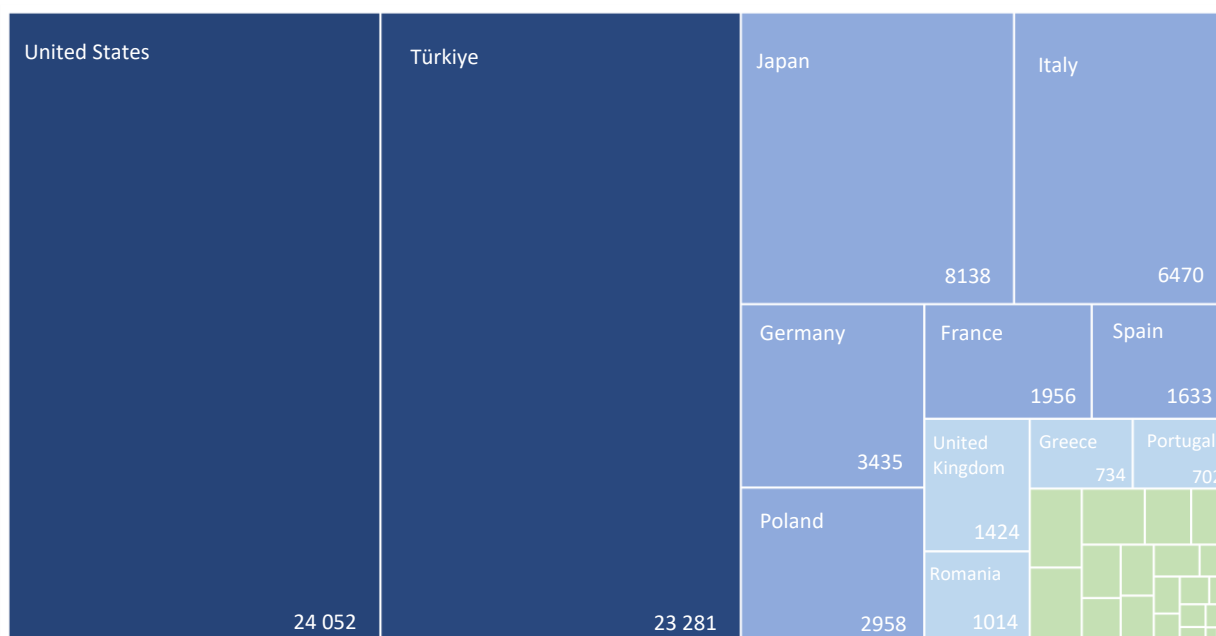
Thousands of people continue to lose their lives due to resistant infections

Every year, nearly 4.3 million infections caused by organisms resistant to antimicrobial treatment occur in 34 OECD and EU/EEA countries, causing the death of around 79 000 people (Figure 2). This corresponds to 2.4 times that of deaths due to influenza, tuberculosis and HIV/AIDS combined in 2020 in these countries. Two out of 3 people who lose their lives due to resistant infections are above the age of 65.

Three out of four AMR-related deaths are caused by only three antibiotic-bacterium pairs: *Escherichia coli*, *Klebsiella pneumoniae* and *Staphylococcus aureus*. Infections caused by these bacteria can occur both in healthcare and in the community. This means that efforts to tackle AMR should adopt a comprehensive approach that goes beyond healthcare settings.

Healthcare-acquired resistant infections pose a particularly high threat to population health. They cause more than 60% of all deaths related to AMR despite accounting for a little over one-third of all resistant infections.

Figure 2. Across OECD and EU/EEA, 79 000 people lose their lives every year due to AMR



Note: Figure 2 presents results using the Elimination scenario, which assumes the elimination of all the resistant infections. The countries shown in green are the following in descending order: Switzerland (420), Belgium (415), the Czech Republic (361), Hungary (264), the Slovak Republic (230), Sweden (213), the Netherlands (190), Austria (172), Ireland (160), Bulgaria (149), Denmark (104), Croatia (98), Finland (85), Lithuania (83), Norway (62), Slovenia (60), Cyprus (49), Malta (32), Latvia (29), Estonia (21), Luxembourg (19) and Iceland (8). These cross-country differences are driven both by the differences in the prevalence of infections and the variation in the strength of AMR surveillance, detection and reporting capacity.

Source: Based on Figure 3.2. in OECD (2023), *Embracing a One Health Approach to Fight Antimicrobial Resistance*, available at: oe.cd/amr-onehealth.

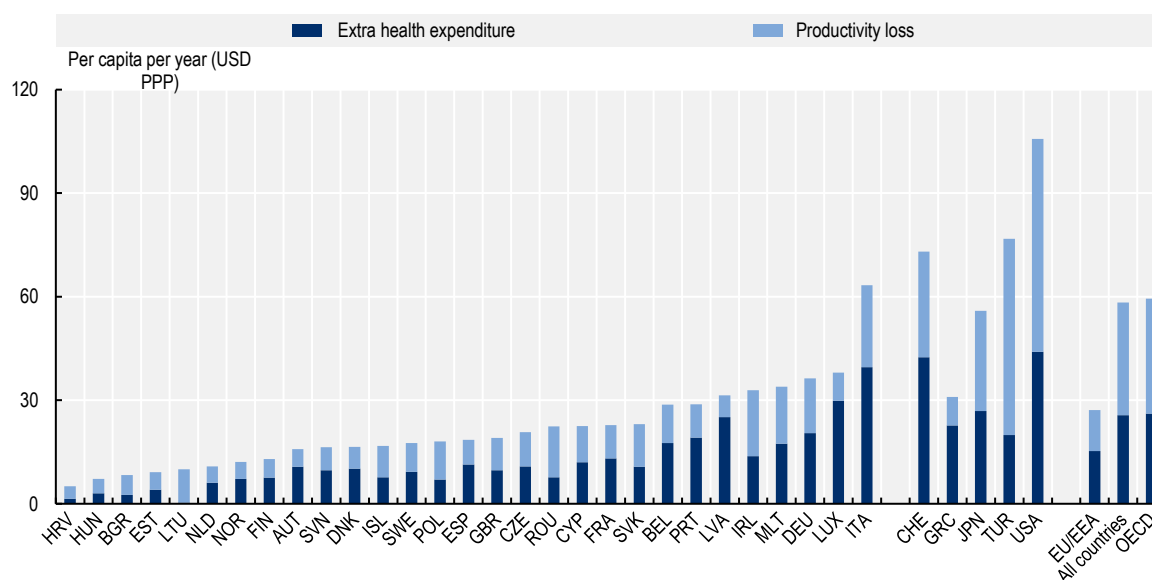
Cost of inaction is unacceptably high

The AMR pandemic is an additional burden on hospital resources. Every year, patients from the 34 OECD and EU/EEA included in the analysis spend around 32.5 million extra days in hospitals for the consequences of resistant infections. This is equivalent to using the entire acute bed capacity in a country such as Spain in 2020 for nearly a whole year.

The cost of AMR to 34 OECD and EU/EEA health systems is around USD 28.9 billion each year up to 2050 adjusting for purchasing power parity (PPP) (Figure 3). This corresponds to almost USD PPP 26 per capita. In the longer term, the cost of AMR to the health systems in OECD and EU/EEA exceeds the equivalent costs from COVID-19. Across the 17 OECD and EU/EEA countries for which data is available, the annual total health expenditure due to AMR is equivalent to about 19% of health expenditure due to COVID-19 in 2020 (evaluated in nearly USD PPP 64 per capita (OECD, 2023^[1])³. In other words, nearly every five years, the cost of AMR to these health systems reaches the same level as the cost of COVID-19 in 2020.

In addition, every year, the losses due to AMR in labour market participation and productivity amounts to USD PPP 36.9 billion for 34 OECD and EU/EEA economies, corresponding to about USD PPP 32.7 per capita. This is roughly one-fifth of the gross domestic product in Portugal in 2020.

Figure 3. AMR costs around USD PPP 58 per capita per year to OECD and EU/EEA countries through extra health spending and reduced productivity at work



Note: Figure 3 shows results using the Elimination scenario, which assumes the elimination of all the resistant infections. Productivity loss refers to reduction in participation in the labour market and reduced productivity at work. Results are presented based on the sources of input data, with data for countries in the group on the left that are all from the same source and calculated with a comparable methodology. Results for Greece are presented on the right-hand side of the panel because data for *S. pneumoniae* are not available. Results are not directly comparable for countries on the left- and right-hand sides of the panel due to the methodological differences in data collection and data extraction practices. Source: Based on Figures 3.9. and 3.11. in OECD (2023), *Embracing a One Health Approach to Fight Antimicrobial Resistance*, available at: oe.cd/amr-onehealth.

³ Source: OECD (2023), Health and Expenditure Database, available at stats.oecd.org.

Financial provisions are needed to support the implementation of One Health policy needed

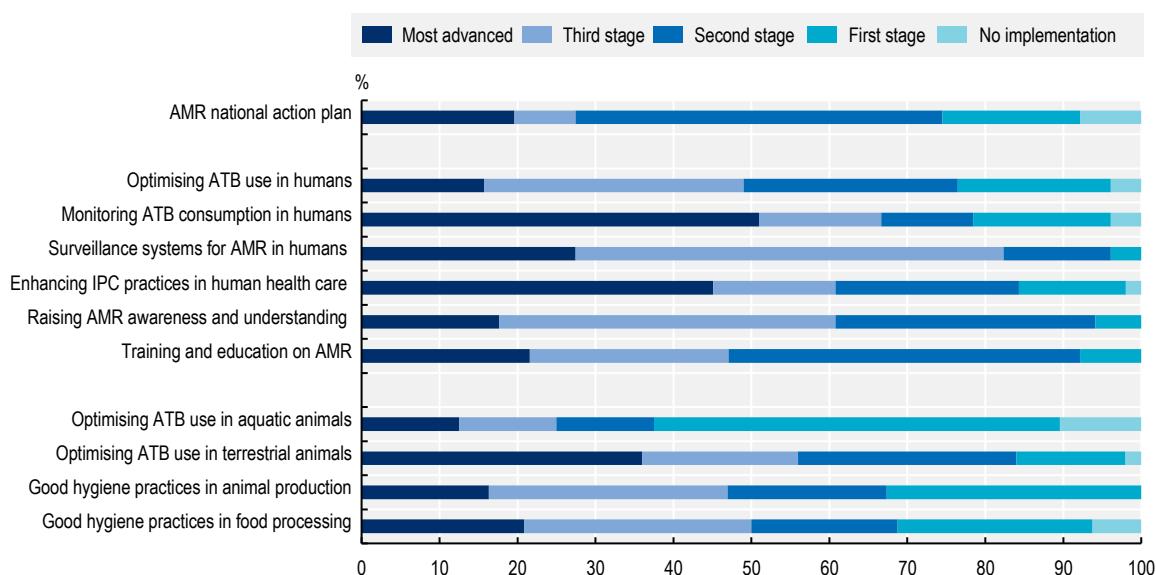
Six years after the publication of the Global Action Plan on AMR, 47 out of 51 OECD, EU/EEA and G20 countries developed their national action plans to tackle AMR (AMR-NAP) (Figure 4). However, only 10 of these countries incorporated financial provisions for the implementation of their AMR-NAPs into national action plans and budgets.

The animal sector has been actively participating in the development and implementation of nearly all action plans developed by OECD, EU/EEA and G20 countries. In recent years, other sectors such as food safety and production, plant health and the environment have increasingly played an important role in shaping the AMR agenda but there is room for more active engagement.

The policy analysis has also identified the following policy priorities for action:

- Bolstering nationwide implementation of programmes for infection prevention and control and for optimal use of antimicrobials in line with international standards and best practices across human and animal health, as well as agri-food systems.
- Investing in more robust surveillance systems, particularly in specific areas in human health (e.g. long-term care) and animal health.
- Ensuring greater compliance with regulatory frameworks, especially to promote prudent use of antimicrobials in animals.
- Increasing investments in research and development for new antibiotics, vaccines and diagnostics.

Figure 4. Nearly all OECD, EU/EEA and G20 countries developed their national action plans but gaps remain in the financing and implementation of policies on the ground



Note: The data presented in the graph is based on 51 countries included in the OECD analysis. No implementation: No AMR-NAP. First stage: AMR-NAP developed. Second stage: AMR-NAP approved by the government and is being implemented. Third stage: AMR-NAP has a costed and budgeted operational plan and has monitoring mechanism in place. Most advanced: Financial provisions for the AMR-NAP are included in national plans and budgets. AMR: Antimicrobial resistance; ATB: Antimicrobial; IPC: Infection prevention and control.

Source: Figure 1.4. in OECD (2023), *Embracing a One Health Approach to Fight Antimicrobial Resistance*, available at: oe.cd/amr-onehealth.

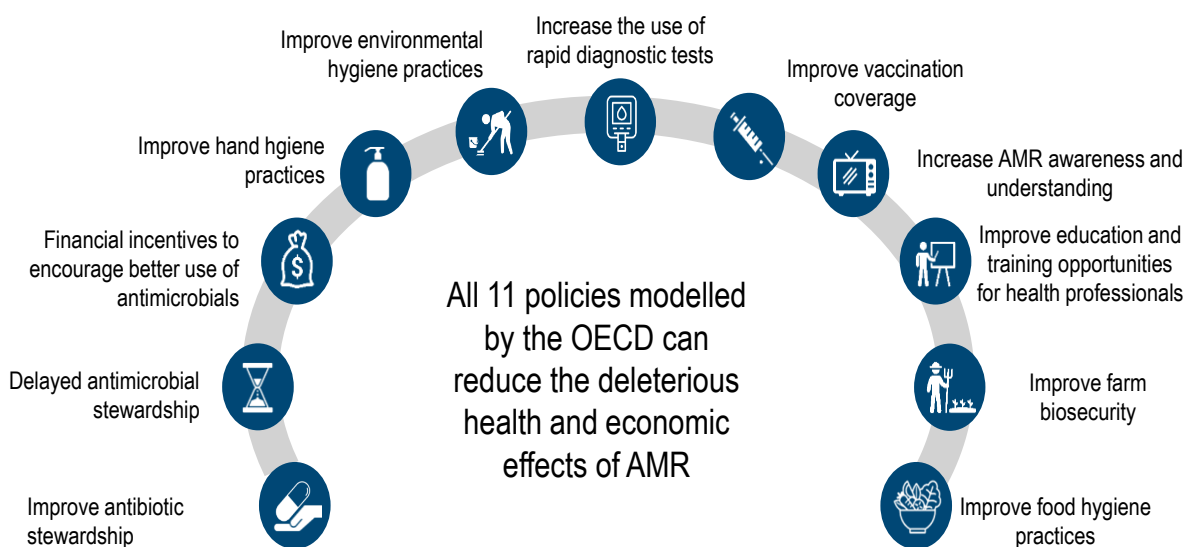
One Health policy action can effectively prevent AMR, saving lives and money

OECD analysis demonstrates that AMR can be prevented by effective policy action aligned with the One Health approach. Eleven policies have been carefully modelled, with results showing they can substantially improve population health while reducing deleterious impacts on the economy (Figure 5):

- Hospital-based interventions prevent the highest number of AMR-related deaths. Scaling up stewardship programmes that can help optimise the use of antimicrobials in human health can prevent more than 10 000 deaths due to resistant infections every year, whereas enhancing environmental hygiene and improving hand hygiene can avoid more than 4 800 and 4 500 AMR-related deaths respectively.
- Community-based interventions such as delayed antimicrobial prescription and scaling up the use of point-of-care rapid diagnostic tests are also highly effective. Delayed prescribing can prevent more than 279 000 resistant infections and avoid 7 800 deaths every year. Rapid diagnostic testing can avert more than 263 000 resistant infections and prevent more than 7 500 deaths.
- Beyond human health, enhanced food handling practices and improving biosecurity in farms also promise significant protective effects, albeit of smaller magnitude.

One Health policy action is affordable. The average annual per capita cost of implementing the interventions varies between USD PPP 0.2 and 2.6, with 7 out of the 11 modelled interventions costing less than USD PPP 1 per capita per year. This corresponds to only a fraction of the healthcare budgets in OECD countries, averaging at USD PPP 4 274 per capita in 2020. For most interventions in human health and food safety, benefits generated in healthcare savings and gains in workforce productivity exceed implementation costs, with the return-on-investment ratio ranging from 2.3 for antimicrobial stewardship programmes to 24.6 for improving hand hygiene. The benefits of enhancing farm biosecurity entirely offset implementation costs.

Figure 5. Fighting AMR requires One Health action



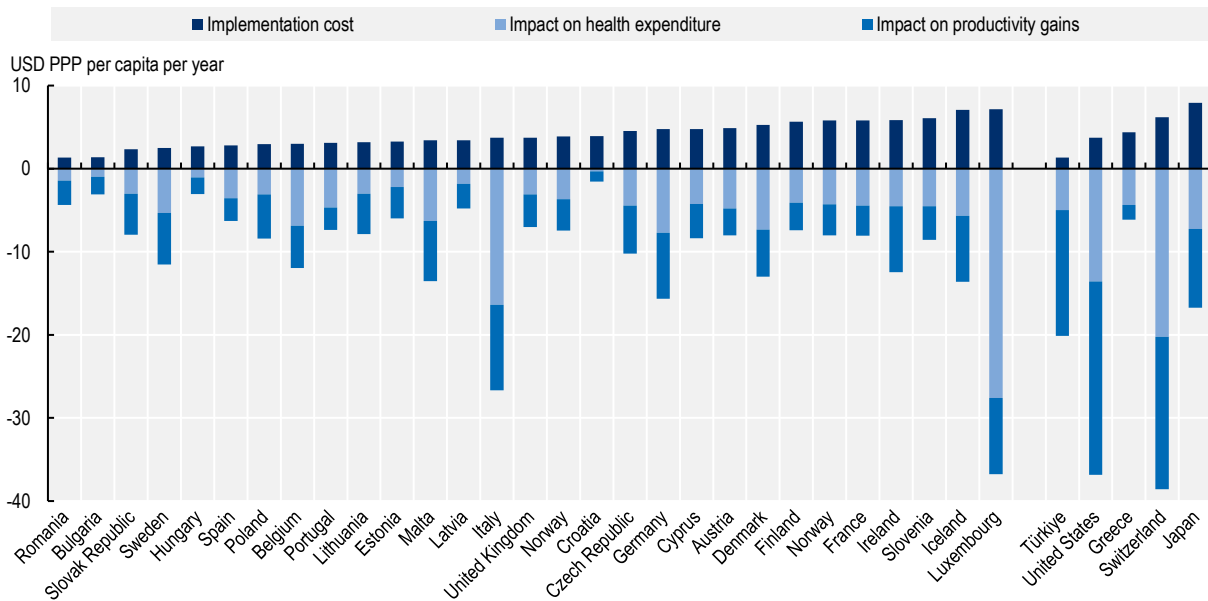
The OECD analysis considered three policy packages:

- A hospital-based package includes improving hand hygiene, enhancing environmental hygiene, and scaling up antimicrobial stewardship.
- A community-based package includes delayed antimicrobial prescriptions, introducing financial incentives to optimise antimicrobial use, scaling up the use of RDTs, scaling up mass media campaigns and scaling up prescriber training.
- A mixed package includes improving hand hygiene, scaling up antimicrobial stewardship programmes, delayed antimicrobial prescription, increasing mass media campaigns and enhancing food handling practices.

All three intervention packages reduce the health burden of AMR while producing savings in health expenditure and generating gains in workforce productivity. For instance, investing in the mixed package could avert more than 1.6 million infections each year, prevent more than 17 000 deaths, save more than USD PPP 9.4 billion annually in health expenditure and yield around USD PPP 13.8 billion in gains made through increased participation in the workforce and productivity across the 34 countries included in the analysis (Figure 6).

Benefits of implementing policy packages more than make up for their implementation costs. The annual average cost of implementing the mixed package is around 5 times lower than the reduction in health expenditure and productivity gains combined. This benefit-to-cost ratio is around 4.7 for a package focusing on hospital-based actions and 2.5 for a package comprising community-based actions.

Figure 6. Health and economic benefits of implementing a mixed-intervention package are five times more than implementation costs



Note: Impact on health expenditure based on the Elimination Scenario, which assumes the elimination of all the resistant infections. Results are presented based on the sources of input data, with data for countries in the group on the left that are all from the same source and calculated with a comparable methodology. Results for Greece are presented on the right-hand side of the panel because data for *S. pneumoniae* are not available. Results are not directly comparable for countries on the left- and right-hand sides of the panel due to the methodological differences in data collection and data extraction practices.

Source: Based on Figure 6.12 in OECD (2023), *Embracing a One Health Approach to Fight Antimicrobial Resistance*, available at: oe.cd/amr-onehealth.

References

- OECD (2023), *Embracing a One Health Framework to Fight Antimicrobial Resistance*, OECD Health Policy Studies, OECD Publishing, Paris, <https://doi.org/10.1787/ce44c755-en>. [2]
- OECD (2023), *Health and Expenditure Database*, <https://doi.org/doi:10.1787/8643de7e-en> (accessed on 25 July 2023). [1]

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Embracing a One Health Framework to Fight Antimicrobial Resistance

Antimicrobial resistance (AMR) – the ability of microbes to resist antimicrobials – remains an alarming global health threat. This is despite the efforts made by OECD and EU/EEA countries to curtail it. Unless additional effective interventions are scaled up quickly, AMR rates are forecasted to increase in the next three decades across OECD and EU/EEA countries, with costs exceeding the healthcare expenditure on the COVID-19 pandemic.

This policy brief provides an overview of the key findings presented in the new OECD report titled “Embracing One Health to Fight Antimicrobial Resistance”. Using microsimulation and machine-learning techniques, this report analyses critical policy levers to inform the next generation of AMR initiatives. It shows that tackling the detrimental health and economic impact of AMR requires embracing a One Health framework – a collaborative, trans-disciplinary and multi-sectoral approach that promotes close co-operation and collaboration across human health, animal health, agrifood systems and the environment. This report identifies 11 One Health “best buys” that, if implemented systematically, would improve population health, reduce health expenditure and generate positive returns for the economy.



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