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FORESIGHT BRIEF

Antimicrobial Resistance

According to a 2014 worst-case forecast, antimicrobial resistance (AMR) infections could cause ten million deaths each year globally by 2050. Antimicrobial resistance (AMR) occurs when microbes become resistant to antimicrobial drugs, such as antibiotics. These microbes pose serious threats to public health, the economy, and the environment.

AMR's growth is driven primarily by use (including overuse and misuse) of antimicrobial drugs in human healthcare and agriculture. Other factors include climate change and the easy circulation of people and animals around the world.

AMR is increasing, which could reduce the efficacy of antimicrobial drugs that are critical for healthcare and agriculture. As these drugs lose effectiveness against microbes with acquired resistance, the prevention and treatment of infections may become more expensive and difficult.

AMR could bring far-reaching challenges, including reduced trust in healthcare, disruption of food systems, and increased competition for social services. If reduced access to effective antimicrobials worsens health outcomes, dissatisfaction with healthcare could spread. This could also lead some people to alternative and possibly risky sources of antimicrobials.

On the other hand, the disruptions caused by AMR could also create opportunities. Research into new antimicrobial drugs and new ways of coping with microbial infections is accelerating. Ongoing efforts to take a holistic or One Health approach to AMR could inspire new approaches to other complex problems. Worries over AMR in healthcare contexts could lead to improved patient care standards and faster adoption of sustainable agriculture practices.

This brief aims to deepen readers' understanding of AMR and its implications for a range of policy areas, including some that may be unexpected. Anyone who engages with the following areas might find this brief relevant to their work: agriculture, environment, food, governance, health, industry, research and development, reconciliation, rights and social justice, security, and work. Thinking about the changes shaping the future of AMR can help decision-makers understand some of the forces already influencing their policy environment. Considering the potential implications of such changes can also help policymakers identify opportunities to make decisions today that may benefit Canada in the future.

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Antimicrobial Resistance (AMR)

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Introduction

A 2014 worst-case forecast by the United Kingdom's Review on Antimicrobial Resistance suggested that by 2050, AMR infections could cause ten million deaths each year globally.[1] AMR occurs when microbes, such as fungi, bacteria, viruses, and parasites, adapt to resist the effect of antimicrobial drugs. These microbes pose serious threats to public health, the economy, and the environment. The discovery of drugs capable of treating infections caused by these microbes remains one of the great triumphs of modern medical science. Antibiotics are still the best-known antimicrobial drugs, but this category also includes antiviral, antifungal, and antiparasitic drugs.

AMR happens over time, as microbes evolve and gradually acquire genetic resistance to drugs designed to kill them. Certain microbes, sometimes called "superbugs," can resist a broad range of antimicrobials and can cause infections that are especially difficult to treat.

Any use of antimicrobials, no matter how necessary and careful, can increase AMR. However, overuse and misuse of antimicrobials in human healthcare and agriculture are the key factors pushing AMR to problematic levels.[2] Another is how easily AMR microbes move among humans, animals, and their environments. This is due in large part to antimicrobial environmental pollution from human and animal waste; public health challenges linked to food systems, dense populations, or poor hygiene; and global trade and travel networks that transport microbes across borders.

AMR and human healthcare

Antimicrobial drugs remain "critical infrastructure" for human healthcare. Effective and affordable antimicrobials are readily available in many jurisdictions around the world, but this might change in the coming decades.

Even highly developed regions like the European Union already experience shortages of certain antibiotics.[3] In other regions, the price of some common and generic antimicrobials has risen steeply.[4] Considering these trends and the growth of AMR, access to effective and affordable antimicrobials may become less secure in places where they are currently plentiful. The slow pace of antimicrobial discovery in recent years is a complicating factor.[5] Despite the importance of antimicrobials, relatively poor returns on investment have made pharmaceutical companies reluctant to pursue antimicrobial discovery and development.

If AMR causes existing antibiotics to be ineffective and new alternatives do not emerge, routine medical procedures may become very risky. Antibiotics are used to prevent or treat post-operative infections and compensate for suppressed immune responses from treatments like chemotherapy. If AMR increases, more people may die or need radical interventions such as amputations. Health inequities could also worsen, particularly for vulnerable groups such as racialized communities, people living in poverty, children under five, and the elderly. These groups already experience disproportionate levels of negative outcomes from drug-resistant infections, and this could worsen if antimicrobials become less effective and more expensive.[6]

With global rates of AMR on the rise, its negative impacts are already apparent. According to one study, AMR caused 1.27 million deaths in 2019.[7] This means that AMR is already hitting vital systems.[8] Healthcare is seeing increased pressures and rising costs due to longer hospital stays and more expensive treatments for AMR-related infections. Economies are adversely affected by declining productivity due to longer absences and the rising healthcare costs of longer, more severe illness.

AMR and agriculture

AMR threatens agribusiness[9] and food security.[10]

Antimicrobials, including several medically important types, remain critical for agriculture and aquaculture.[11] Antimicrobials are used to prevent or treat outbreaks of disease that could endanger animal health and threaten production. Antimicrobial pesticides, such as fungicides, are also commonly used in crop production.[12]

Untreatable infectious outbreaks in agriculture and aquaculture could lead to catastrophic losses for individual producers. They may also drive up insurance, labour, and facilities costs across the sector. These challenges to producers could have negative knock-on effects for rural economies. Significant disruptions to the agricultural sector and resulting rises in food prices could threaten food security for segments of the population and possibly the nation. AMR could also reduce consumer confidence in the food system if outbreaks of drug-resistant food-borne illnesses become more common.[13]

AMR is constantly evolving as it interacts with a wide range of forces.

Research suggests that AMR and its impacts are worsening, though at different rates around the world depending on antimicrobial availability and stewardship efforts. Severe challenges have already been reported in some low- and middle-income countries.[14] High-income countries in the Global North are not immune to these challenges. Recent data on AMR in the United States notes that deaths from so-called "superbugs" increased by 15% throughout the COVID-19 pandemic.[15] Canada has not seen the same increase in mortality, but the available evidence tells a mixed story. Some types of AMR infections have been trending down, but AMR "continued to increase for most priority organisms" according to the 2022 Canadian Antimicrobial Resistance Surveillance System Report.[16]

There is growing evidence of a link between accelerating climate change and the growth of AMR around the world.[17] Rising temperatures lead some microbes, such as certain fungal pathogens, to evolve in ways that may make them more dangerous to human health, including gaining antimicrobial resistance.[18] Climate change shifts the habitat of insects and animals as well as microbes, giving the latter new populations to infect. Extreme weather events like floods also create ideal conditions for these microbes to spread.[19] And since the typical response to these infections is to prescribe antimicrobials, they are likely to drive the growth of AMR.[20]

High levels of global travel and connection also facilitate the spread of drug-resistant microbes and related illnesses. Although temporary travel for business or tourism[21] is a factor, the movement of populations due to conflict, natural disaster, and climate change causes more concern among experts. Poor healthcare and unsanitary conditions during transit mean a higher chance of infection for migrants.[22] Movements of live animals and plants through international trade networks also spreads resistant microbes.

Significant efforts to mitigate the impacts of AMR are under way, but their success remains uncertain. Understanding[23] of AMR's dangers has grown to the point that key international forums, including the G7 and G20,[24] the OECD,[25] the UN,[26] and the WHO,[27] have made it a key part of global health agendas. Research into understanding and mitigating AMR is underway at universities around the world, including the University of Calgary's One Health AMR Consortium.[28] Some countries have already committed to fight AMR using a "One Health" perspective, which includes humans, animals, and their shared environments.[29] Likewise, new best practices for stewardship of antimicrobials in both human health and agriculture are spreading and have started to yield some positive results.[30] In the human healthcare context, work also continues on alternative treatments, such as vaccines and phage therapy, for common bacterial infections.[31] Similar efforts are underway within agriculture, where improved biosecurity measures, wider vaccination programs, dietary supplements, and alternative therapies for infections are gaining traction.[32]

Policy implications

The implications below emerged through an exploration of plausible AMR futures. They represent policy considerations that might emerge but are not inevitable. Failing to reflect on them could lead to policy failure.

This list is not exhaustive, and policy makers are encouraged to further reflect on the challenges and opportunities listed here. Based on these policy implications, decision makers could ask themselves the following questions:

- How might changes in AMR challenge specific policies or programs?
- How would the assumptions built into today's policies and programs fare in the face of challenges and opportunities created by this future?
- What actions could be taken now to maximize opportunities and mitigate challenges related to AMR in the future?

Despite ongoing efforts to reduce AMR's risks with improved stewardship, new treatments for infection, and holistic approaches to health, these risks are likely to affect a broad range of policy domains. Examples include:

Trust in healthcare: People may avoid medical facilities and routine healthcare out of fear of infection if they believe superbugs are more common in clinical settings. The long-term consequences of delayed diagnosis and treatment could be severe.

Disruption of food systems*:* If alternatives to antimicrobials make it more expensive for producers to ensure animal or plant health, some animal and plant products may become luxury items. In the short term, this could cause significant social dissatisfaction among consumers. If international agricultural producers continue to rely on relatively cheap antimicrobials, Canadian producers might struggle to compete until those drugs become ineffective due to AMR.

Competition for social services: In a future where the negative health impacts of AMR increase, the need for certain benefits and services, such as employment insurance, occupational therapy, and long-term care could increase. This could lead to greater competition for benefits and services, delaying or denying access to some.

Access to antimicrobials*:* A future where effective and affordable antimicrobial drugs are in short supply—due to the continued slow pace of pharmaceutical innovation, the rising costs of effective antimicrobials, or the cost of bringing new drugs to small markets—could create a critical challenge across health and agricultural systems. At some point, access to antimicrobial drugs or alternative treatments might become a concern for both social stability and national security.

Demand for antibiotics*:* Stricter controls over the prescription and use of antibiotics as a way to control AMR might lead some patients to alternative sources, including illegal markets and home production systems that might present challenges for regulators, law enforcement, and customs officials. Subsequent side effects and illnesses could also put further strain on health systems.

Despite these complex challenges, experts continue to explore ways to combat AMR and find opportunities in some of the disruptions it generates. Promising spaces include innovations in antimicrobial discovery, holistic health perspectives, patient care standards, and agricultural practices.

Antimicrobial discovery: New generative AI tools and advances in biotechnology may make it much cheaper to develop new antimicrobial drugs[33] and alternative therapies. This could slow the impacts of AMR on human health, providing time for strategies aimed at mitigating AMR itself to take off.

Holistic health and reconciliation: One Health initiatives that focus on AMR surveillance and stewardship of antimicrobial compounds could create opportunities for meaningful collaboration with Indigenous partners. This could produce AMR strategies that recognize the unique cultures, contexts, needs, and priorities of Indigenous peoples. It could also inspire holistic approaches to other complex challenges facing human and natural systems.

Patient care standards: A well-publicized rise in AMR-related health complications like amputations or premature death, especially among otherwise healthy young people, may shift public satisfaction and expectations with respect to healthcare. This could amplify discontent arising from other likely challenges to healthcare and might eventually inspire calls for new standards of patient care or improved compensation mechanisms when expectations are not met.

More sustainable agriculture: Widespread use of improved infection prevention and control measures in agriculture, as well as treatment alternatives that reduce reliance on antimicrobials, could reduce antimicrobial environmental pollution. Even if such measures increase costs, sustainability benefits might follow. If rising food costs reduce consumer demand, herds and flocks could shrink, which might mean less methane and manure for natural systems to absorb. Elevated costs of traditional meats could also increase interest in alternatives such as insect proteins, which appear highly sustainable.[34]

Conclusion

AMR emerges from the interaction of powerful evolutionary processes and the widespread use of antimicrobials. It worsens with poor public awareness, and systems that facilitate the global movement of microbes and antimicrobials. Despite many ongoing projects to boost public awareness, improve antimicrobial stewardship, and develop new antimicrobial drugs and therapies, AMR is a significant threat. It directly affects human, animal, and environmental health, as well as the stability of food and healthcare systems. Indirectly, it could disturb a range of other policy domains, like trust in institutions, national security, and social services. However, efforts to mitigate AMR may create opportunities for new infection treatments, holistic approaches to human and environmental health, higher patient engagement in healthcare decisions, and more sustainable agriculture.

Learn more

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