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Canada

# Canadian Antimicrobial Resistance Surveillance System (CARSS):

## 2023 Executive Summary and Link to the Pan-Canadian Action Plan on Antimicrobial Resistance

**TO PROMOTE AND PROTECT THE HEALTH OF CANADIANS THROUGH LEADERSHIP, PARTNERSHIP, INNOVATION AND ACTION IN PUBLIC HEALTH.**

— Public Health Agency of Canada

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# Introduction to antimicrobial resistance

Antimicrobials, particularly antibiotics, are an essential component of modern medicine that are routinely used to treat, prevent, and control infections. Antimicrobial resistance (AMR) occurs when bacteria, viruses, fungi and parasites evolve over time to withstand the effects of antimicrobials used to cure or prevent infections[1]. Antimicrobial-resistant infections are increasingly difficult to treat, and are often associated with increased disease severity, medical complications and sometimes even death. While AMR is a natural phenomenon, using antimicrobials in humans and animals can accelerate this process. This is why it's important to only use them when necessary. AMR is a complex problem, requiring a One Health solution. It can spread between people and animals, either through direct contact or through the food chain and the environment[2].

*Of organisms considered for AMR surveillance, the Public Health Agency of Canada estimates that one priority infection is identified for every 220 patients admitted to sentinel acute-care hospitals*

## The impact of AMR on Canada

Resistant infections have a significant impact on human health, and in some cases, these infections are becoming more frequent. The Council of Canadian Academies considers it likely that the proportion of human infections resistant to first-line antimicrobials could increase from 26% in 2018 to 40% by 2050. In this scenario, the number of deaths in Canada attributable to AMR would increase to 13,700 per year[3]. Of organisms considered for AMR surveillance, the Public Health Agency of Canada (PHAC) estimates that 1 priority infection is identified for every 220 patients admitted to sentinel acute-care hospitals. This includes methicillin-resistant *Staphylococcus aureus* (MRSA) blood stream infections (BSIs), vancomycin-resistant *Enterococcus* (VRE) BSIs, *Clostridioides difficile* (CDI), and carbapenemase-producing Enterobacteriales (CPE).

Left unchecked, global economic costs could surpass $100 trillion by 2050, with Canada seeing a decrease in gross domestic product upwards of $20 billion[3]. Healthcare costs are an important contribution to this amount. For example, Canadian evidence suggests that an antimicrobial-resistant infection caused by MRSA costs over $8,000 more than a susceptible infection. This estimate does not consider mortality or additional economic impact[3]. If AMR reduces animal farming productivity and animal product exports by 10%, the industry could lose another $190 billion over 30 years[3].

# Key surveillance findings (2017 to 2021)

As reported in previous CARSS publications, some 5-year AMR indicators in humans continue to worsen. The rate of healthcare-associated (HA) VRE BSI increased by 33%. For patients diagnosed with this AMR infection, approximately 1 in 3 died within 30 days (all-cause mortality). Following a decrease until 2019, HA-CDI increased between 2019 and 2020. CPE infection rates have remained low. However, an increase was observed from 2017 to 2018 (0.03 to 0.06 infections per 10,000 patient days). The incidence of community-associated (CA) MRSA BSI detected in patients admitted to hospital increased by nearly 70%. The rate of HA-MRSA BSI remained stable. While overall resistance remained stable in tuberculosis (TB), PHAC was notified of a case of extensively drug-resistant (XDR) TB in 2021.

Indicators of antimicrobial use by humans also continue to worsen. The quantity of antimicrobials dispensed in the community sector has increased to near pre-pandemic levels. The dispensing of reserve-class antibiotics, as defined by the World Health Organization, increased by 14%. In participating Canadian healthcare facilities, nearly one-fifth of prescriptions were considered inappropriate or suboptimal.

Indicators of antimicrobial use in animals remains stable. The quantity of antimicrobials sold for use in animals did not change between 2020 and 2021. However, reported AMU on sentinel volunteer farms increased for broiler chickens and grower-finisher pigs.

As PHAC continues to integrate national data on AMR and AMU beyond the year 2021, the effects of the COVID-19 pandemic on these indicators will be assessed.

| Key trends of antimicrobial resistance | 2017–2021 trend summary |
|---|---|
| Methicillin-resistant *Staphylococcus aureus* bloodstream infections (Healthcare-associated) | Trending up |
| Methicillin-resistant *Staphylococcus aureus* bloodstream infections (Community-associated) | Trending up |
| Vancomycin-resistant *Enterococcus* | Trending up |
| Carbapenemase-producing Enterobacterales infection | Trending up |
| *Clostridioides difficile* infections | Trending down |
| Drug-resistant *Neisseria gonorrhoeae* infections | Trending up |
| Drug-resistant *Mycobacterium tuberculosis* infections | Stable |
| Multidrug-resistant vaccine-preventable invasive *Streptococcal pneumoniae* diseases | Trending down |
| Multidrug-resistant invasive Group A *Streptococcal* infections | Trending down |
| Typhoidal and non-typhoidal *Salmonella enterica* infections | Trending up |

# Strengthening national surveillance of AMR through the Pan-Canadian Action Plan on AMR

Public health surveillance forms the basis of Canada's ability to mitigate the effects of AMR. The Canadian Antimicrobial Resistance Surveillance System (CARSS), launched in 2015, works to raise the national profile of AMR in Canada. It also serves as a national focal point for AMR surveillance activities, showcasing AMR evidence and antimicrobial use (AMU) trends generated by PHAC and its partners. CARSS aims to provide relevant, accessible, timely, accurate and comprehensive information to stakeholders, researchers, healthcare practitioners, policymakers and the public. This information guides public health research, policies and action on AMR and the reduction of inappropriate AMU. Inappropriate AMU is an important driver of AMR.

In June 2023, the federal, provincial and territorial ministers of health and agriculture released the *Pan-Canadian Action Plan on Antimicrobial Resistance* (PCAP)[4]. The PCAP is a 5-year (2023 to 2027) blueprint to coordinate an accelerated pan-Canadian response to address AMR. It has 10 dedicated shared priority actions across 5 pillars:

- Research and Innovation
- Surveillance
- Stewardship
- Infection Prevention and Control (IPC)
- Leadership

The surveillance pillar includes 2 outcomes, each with specific actions.

# PAN-CANADIAN ACTION PLAN SURVEILLANCE PILLAR

## Desired outcome 1:

Canada has robust, integrated One Health AMR/AMU surveillance infrastructure with data that are accessible, reliable, timely, nationally representative and capable of detecting emerging threats

## Action:

Expand sources, coverage and integration of AMR and AMU surveillance data, including the use of modern laboratory technologies and standardized reporting, to help monitor AMR/AMU across One Health sectors. It has specific focus on:

- improving data from the environment
- transmission pathways between sectors
- population groups disproportionately impacted by AMR and inappropriate AMU

## Desired outcome 2:

Canada has a comprehensive understanding of AMR and AMU trends at national, regional and local levels to support evidence-based decision-making and to monitor the impacts of interventions

## Action:

Work with partners to:

- establish baselines and targets for national, provincial and territorial levels of AMR and appropriate AMU in human health
- establish baselines, goals and measures of progress for increasing appropriate AMU and reducing AMR in the agriculture and agri-food sectors

Improving Canada's ability to monitor AMR and AMU through PCAP coordination will build on an existing robust foundation rooted in many surveillance collaborations that already exist. These include partners across federal, provincial and territorial jurisdictions and industry sectors. The results of these collaborations are closely linked to other pillars. These include research and innovation, stewardship, and IPC. Evidence and data support and inform actions, reveal trends and gaps, and help measure the effect of interventions.

## Opportunities to advance PCAP surveillance actions

Canada, alongside many other countries, has adopted a One Health approach to detect, understand, and act against AMR. PCAP helps coordinate One Health surveillance actions to limit the emergence and spread of AMR in humans, animals, plants and crops, and their shared environment.

### Expanding sources, coverage and integration of AMR and AMU surveillance data in humans

Participation in national AMR laboratory surveillance for human health has formally expanded to include British Columbia, Saskatchewan, Ontario, Prince Edward Island and the Northwest Territories. Plans are well underway to enroll all remaining provinces and territories. The sharing of de-identified laboratory data is an excellent opportunity for public health partners to accelerate the implementation of PCAP. These data are often routinely available and have the potential to be fully comprehensive for all AMR diagnoses in Canada. Additionally, these data will support the advancement of other PCAP actions, such as antimicrobial stewardship and the development of antimicrobial-resistant infection baselines in humans.

### Improving the use of modern laboratory technologies to help monitor AMR and AMU across One Health sectors

PHAC is making progress on the use of modernized laboratory technologies through investments in the routine use of whole genome sequencing for all *Neisseria gonorrhoeae* isolates submitted to national surveillance programs. This results in novel data that can help prevent spread through enhanced outbreak and treatment failure investigations. National surveillance of *Neisseria gonorrhoeae*

has identified isolates with multi-drug and extensive drug resistance to the antimicrobials currently recommended for use as treatment. This supports cross-pillar stewardship action on the review of treatment guidelines.

The use of modernized laboratory technologies is also helping PHAC monitor how AMR may be spreading between animals and humans through the food chain. For example, preliminary evidence using newly acquired genetic data is showing that some resistant isolates of *Salmonella* in humans are highly similar to those in animals or food.

## Improving access to data on environmental exposures

PHAC is working with partners to better understand the relationship between the environment and sources of AMR, including pathways of transmission between humans and animals. These important activities can include the testing of environmental samples (such as freshwater) for genetic markers linked to AMR and concentrations of antimicrobial residues and degradation products.

## Exploring methods for developing national performance indicators and targets

PHAC is actively engaging with international partners to learn how they're identifying national baselines, performance indicators and targets for infection incidence rates and the consumption of antimicrobials by humans and animals.

These efforts represent important first steps. PHAC remains committed to work with partners to identify additional activities and work towards implementation for improved One Health AMR/AMU surveillance in Canada.

# The way forward: using evidence to identify and overcome data gaps

Specific AMR threat events continue to be detected in Canada. Between June 2022 and October 2023, PHAC assessed 5 AMR-related events that met specific threat assessment criteria. In the healthcare sector, an investigation into AMR fungal infections (*Candida auris*) was conducted. This organism is an emerging multi-drug resistant pathogen with the potential for rapid and extensive spread in hospitals. *Candida auris* is associated with severe illness and death in hospitalized patients, with mortality rates up to 60%. In the community sector, the emergence of XDR *Shigella* was identified. This particularly affected the two-spirit, gay, bisexual and other men who have sex with men (2SGBMSM) community, and was associated with sexual transmission. A case of ceftriaxone-resistant gonorrhea that was not associated with travel outside of Canada was identified. This is noteworthy, as these cases are most commonly associated with international travel. Finally, antimicrobial-resistant infections caused by *Salmonella* led to the identification of 2 different serotype clusters. One of these *Salmonella* clusters was identified as XDR, and nearly half of those affected were children.

To help prepare national surveillance efforts for emerging AMR signals, PHAC is developing a Canadian risk ranking of all pathogens associated with AMR. It will be informed by such considerations as overall burden to human health and residual risk of disease. This prioritization exercise will build on the previous prioritization conducted in 2015[5]. It will help identify national AMR surveillance gaps and focus the implementation of PCAP surveillance objectives.

National surveillance of antimicrobial consumption has shown that use in humans continues to increase in the community sector. Preliminary results from 2023 indicate that these trends have nearly eclipsed quantities reported pre-pandemic. To help understand the reasons for this increase, and the impact this may have on rates of AMR, PHAC is developing surveillance in key areas known to be at higher risk for the overuse of antibiotics. These include long-term care and primary care settings.

The quantity of antimicrobials sold for use in animals has remained stable since 2019, and AMU on sentinel farms in some sectors appears to be decreasing since 2017. However, between 2020 and 2021, reported AMU on sentinel volunteer farms increased for broiler chickens and grower-finisher pigs.

Monitoring the quantity of antimicrobials consumed by humans and animals is an important component of AMR surveillance. However, only limited data exist about why these antimicrobials are being used, or in some cases, if their use is appropriate. To overcome these limitations, PHAC is developing national surveys on the use of appropriate antibiotics in hospital inpatients. It's also drawing information from sentinel volunteer farms for the major food animal species. These data will be important to inform targeted antimicrobial stewardship programs. These programs are designed to reduce inappropriate prescribing and antimicrobial consumption.

Evidence from remote, northern and isolated regions remains a challenge, given the difficulty of data collection and barriers to accessing healthcare. To help overcome this limitation, PHAC is investigating the feasibility of using wastewater surveillance for AMR and the detection of antibiotic residues.

## AMR and AMU amongst equity deserving populations

PHAC recognizes that AMR disproportionately impacts certain key human populations and socio-demographics in Canada. Enhanced surveillance and tailored approaches are necessary to ensure programs and initiatives are equitable and mitigate disproportionate impacts of AMR.

Residents of long-term care facilities (LTCF) are at higher risk for antimicrobial-resistant infections. International evidence from the Organisation for Economic Co-operation and Development indicates that as many as 75% of antimicrobial prescriptions in LTCFs could be considered inappropriate[6]. This is due to multiple factors linked to patients, health care providers and health care systems. PHAC is working to improve AMR surveillance in Canadian LTCFs to help generate Canadian data to enhance our understanding of this complex issue.

The emergence and transmission of AMR in the community is linked to important health inequities. While approximately 10% of all TB cases are drug-resistant in Canada, those born outside of Canada are overrepresented. In 2021, this group accounted for three-quarters of TB cases and almost 90% of resistant cases[7]. Multidrug-resistant (MDR) TB remains rare in Canada, but almost exclusively affects people born outside of Canada[8].

The 2SGBMSM community is disproportionately affected by antimicrobial-resistant *Mycoplasma genitalium*, a common sexually transmitted bacterial infection first identified in 1981[9-11]. In Canada and in many international contexts, this community also bears a disproportionate burden of drug-resistant and MDR gonorrhea and of XDR shigellosis[12-13].

People who inject drugs have a high and disproportionate burden of serious antimicrobial-resistant infections. This includes invasive group A *streptococcus* (iGAS) infections and MRSA BSIs[14-17]. BSIs can lead to endocarditis (an infection of the heart). Numerous regions in Canada have reported increasing rates of endocarditis among people who inject drugs[18-21]. Some Canadian evidence suggests that 1 in 5 of these cases is caused by MRSA[22].

Data are lacking on the full and distinct burdens of AMR among Inuit, First Nations and Métis. However, existing data demonstrates that Indigenous people face an increased risk for some infections known to be associated with AMR, including invasive pneumococcal disease (IPD) and of iGAS[17,23–25]. For example, people in Arctic communities in Canada are more than 3 times as likely to contract iGAS compared to those in non-Arctic communities[25]. In some First Nations communities, the incidence of iGAS infections is estimated to be 10 times the national level. These communities report higher levels of resistance to erythromycin and clindamycin than in non-Indigenous communities[17].

While this list is not exhaustive, PHAC continues to explore AMR and AMU considerations affecting key populations, equity groups and settings. PHAC remains committed to enhancing data availability on these populations, which will help to inform timely and effective public health interventions, programs, guidelines, and policies.

## Improving access to national data on AMR and AMU

To help improve the availability and timeliness of national data on AMR and the use of antimicrobials in Canada, PHAC has launched an online dashboard. This dashboard will describe the most recent surveillance findings on AMR and AMU data collected by PHAC and its partners. It will also enable stakeholders to access relevant data in an accessible manner. The dashboard will be routinely updated as new information becomes available, including data on AMR health inequities and emerging AMR threats.

While these data are necessary to support all pillars of PCAP, results cannot be achieved without involvement from partners across One Health sectors, guided through coordinated actions.

We encourage all partners across One Health sectors to engage at the federal, provincial, territorial, and regional levels to better identify AMR trends, and improve the appropriate use of antimicrobials in Canada.

# Abbreviations

| | |
|---|---|
| **AMR** | Antimicrobial resistance |
| **AMU** | Antimicrobial use |
| **BSI** | Bloodstream infection |
| **CA** | Community-associated |
| **CARSS** | Canadian Antimicrobial Resistance Surveillance System |
| **CPE** | carbapenemase-producing Enterobacterales |
| **CDI** | *Clostridioides difficile* |
| **iGAS** | Invasive Group A *streptococcus* |
| **IPC** | Infection prevention and control |
| **IPD** | Invasive Pneumococcal Disease |
| **LTCF** | Long-term care facilities |
| **MDR** | Multi-drug resistant |
| **MRSA** | Methicillin-resistant *Staphylococcus aureus* |
| **PCAP** | Pan-Canadian Action Plan on Antimicrobial Resistance |
| **PHAC** | Public Health Agency of Canada |
| **TB** | Tuberculosis |
| **2SGBMSM** | Two-spirit, gay, bisexual and other men who have sex with men |
| **VRE** | Vancomycin-resistant Enterococcus |
| **XDR** | Extensively drug-resistant |

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# Dedication

We dedicate this report in memory of our colleague, mentor and friend, Dr. Michael (Mike) R. Mulvey. This “Super-Bug Fighter” was passionate and committed to the battle against AMR. He was a founder and pillar of several AMR surveillance programs that contribute to CARSS reporting. Dr. Mulvey’s contributions (knowledge, experience, and resourcefulness) were instrumental to these programs. His legacy will echo in the Public Health Agency of Canada for countless years to come.

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