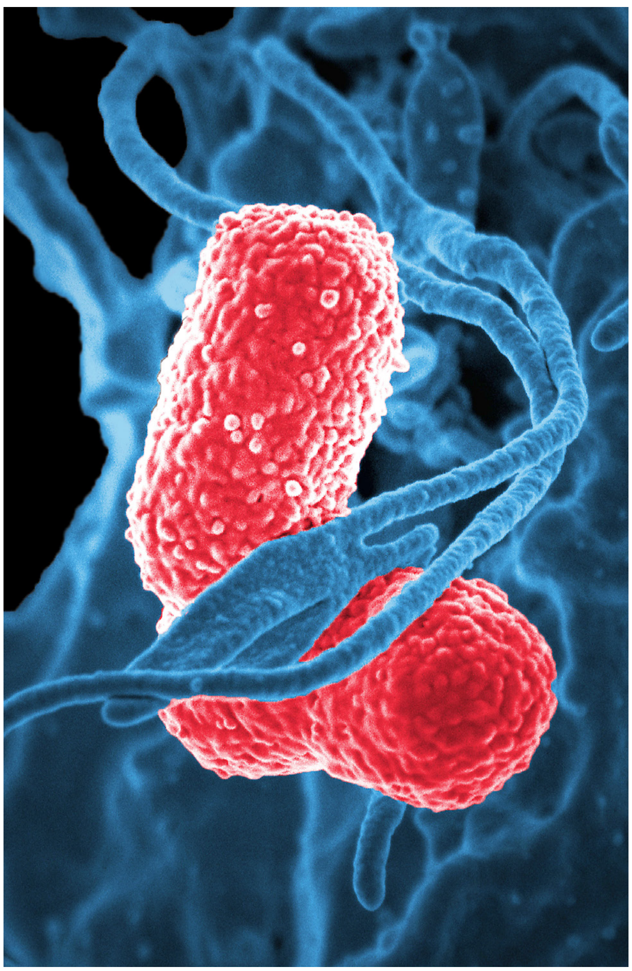
November 3, 2016 • Volume 42-11

CCDR

CANADA COMMUNICABLE DISEASE REPORT

ANTIMICROBIAL RESISTANCE (AMR)



Editorial

Surveillance

Reports

Guest Editors: Jacqueline Arthur and Kanchana Amaratunga

Public Health Agency of Canada
Agence de la santé publique du Canada

Canada

CCDR
CANADA COMMUNICABLE DISEASE REPORT

The *Canada Communicable Disease Report* (CCDR) is a bilingual, peer-reviewed, open-access, online scientific journal published by the Public Health Agency of Canada (PHAC). It provides timely, authoritative and practical information on infectious diseases to clinicians, public health professionals, and policy-makers to inform policy, program development and practice.

Contact Us

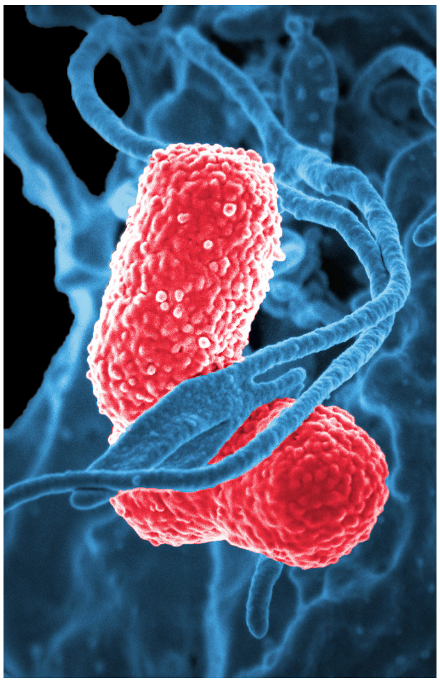
ccdr-rmtc@phac-aspc.gc.ca
613.301.9930

Photo Credit

The image is a digitally-colorized scanning electron micrograph of the multi-drug resistant *Klebsiella pneumoniae* bacteria. Public Health Image Library (PHIL), Centers for Disease Control and Prevention. http://phil.cdc.gov/phil/

ISSN 1481-8531 Pub.150005

CCDR
CANADA COMMUNICABLE DISEASE REPORT



ANTIMICROBIAL RESISTANCE (AMR)

INSIDE THIS ISSUE

EDITORIAL

How is an international public health threat advanced in Canada? The case of antimicrobial resistance

Tsegaye L[1], Huston P[2], Milliken R[2], Hanniman K[2], Nesbeth C[2], Noad L[2]*

Affiliations

[1] Schulich School of Family Medicine and Dentistry, University of Western Ontario, London, ON

[2] Infectious Disease Prevention and Control Branch, Public Health Agency of Canada, Ottawa ON

***Correspondence:** lindsay.noad@phac-aspc.gc.ca

Abstract

On September 21, 2016, the United Nations General Assembly held a high-level meeting on antimicrobial resistance (AMR). Participating political leaders committed to coordinate action across the human and animal health, agriculture and environmental sectors and to work at national, regional and international levels with the public sector, private sector, civil society and all other relevant actors, including the public.

The objective of this article is to outline how the Public Health Agency of Canada (PHAC) has been working to address AMR in Canada. PHAC has used a One Health approach and has been working at the federal level with other government departments and nationally with the provinces, territories, professional organizations and other key players to address AMR. To date, the federal response has focused on surveillance, stewardship and innovation across multiple sectors, including human health, animal health, regulatory actions and research. PHAC is currently working with the provinces and territories as well as key experts in the field to develop a pan-Canadian AMR Framework and subsequent action plan that will outline best practices and approaches to AMR across human and animal health. The Framework will build on previous work done by PHAC and the federal/provincial/territorial Pan-Canadian Public Health Network Council and recognizes the research expertise in Canada, the need to ensure actions are based on evidence, and to combat AMR through infection prevention and control.

The three articles in this issue are examples of the foundational work that has been done federally by PHAC, in developing the Canadian AMR Surveillance System (CARSS), and nationally, through task groups of the Public Health Network Council, in identifying where to strengthen human surveillance of AMR and best practices for stewardship in the human health care system. While we remain in an early stage of national, coordinated AMR action, momentum is building to ensure Canada can respond to this global health threat with a One Health approach involving multiple sectors at local, national and international levels that are all well-aligned with the World Health Organization Global Action Plan.

Suggested citation: Tsegaye L, Huston P, Milliken R, Hanniman K, Nesbeth C, Noad L. How is an international public health threat advanced in Canada? The case of antimicrobial resistance. Can Comm Dis Rep. 2016;42(11):223-6.

Introduction

Antimicrobial resistance (AMR) has been identified as a fundamental threat to global health security as well as a threat to meeting and maintaining international development goals (1,2). The World Health Organization's (WHO) 2014 report on the global surveillance of AMR highlighted the risk of entering a post antibiotic era where common infections could become life threatening due to the progressive loss of effective treatments (3). It has been estimated that by 2050, annual deaths due to AMR could reach 10 million worldwide, overtaking deaths due to diabetes and cancer combined (4). What makes the situation especially difficult is that AMR is not just a human health threat, it is a complex issue that has animal, agricultural, environmental and economic implications.

In September 2016, a high-level meeting was held on AMR at the United Nations General Assembly (UNGA). This was only the fourth time that UNGA had discussed a health issue, which demonstrates both the international commitment and the grave threat posed by AMR. Heads of state committed to take a broad, coordinated approach to address AMR by developing national plans. They pledged to strengthen regulation of antimicrobials, improve knowledge and awareness and promote best practices—as well as to foster innovative approaches using alternatives to antimicrobials and new technologies for diagnosis and vaccines. "Antimicrobial resistance poses a fundamental threat to human health, development and security. The commitments made today must now be translated into swift, effective, lifesaving actions across the human, animal and environmental health sectors. We are running out of time," said Dr. Margaret Chan, Director-General of WHO (5).

So how is a complex global public health threat addressed nationally? In Canada, we have taken a One Health approach to AMR that recognizes that the health of humans is connected to the health of animals and the environment (6). The objective of this article is to provide an update on how the Public Health Agency of Canada (PHAC) has been working at the international, federal and national (federal/provincial/territorial) levels to build the foundation for a coordinated, multi-sector or multi-sectoral response in Canada that is well-aligned with international efforts. This editorial will highlight some of the work that has been done in the health sector and describe a new multi-sectoral approach that is now underway.

International coordination

As the Government of Canada's focal point for international work on AMR, PHAC has been actively engaged in a number of international policy and expert forums on all aspects of AMR. These forums have included the WHO, the Food and Agricultural Organization (FAO), the World Organization for Animal Health (OIE), the G7, the G20 and the Global Health Security Agenda (GHSA) who have all identified AMR as a key area of concern requiring coordinated action and capacity-building. Canada is actively supporting these efforts. One of Canada's key commitments to date has been the endorsement of the WHO Global Action Plan (GAP) on AMR (7), which includes the development of a multi-sectoral national action plan. At the September 2016 United Nations General Assembly high-level meeting on AMR, Canada reaffirmed its commitment to develop a national action plan on AMR and pledged support for the political declaration on AMR (8). This declaration identified support for activities focused on stewardship, surveillance, regulation, research and innovation, and capacity-building at the regional, national and global levels. PHAC is committed to sharing intelligence and outcomes of international meetings and ensuring that Canadian initiatives and activities align with the WHO Global Action Plan.

Federal action

The Federal Framework and Action Plan

Given the complex nature of AMR, responsibility for action crosses the mandates of a number of federal departments and agencies. A coordinated federal approach is essential to effectively launch a pan-Canadian approach to AMR and international AMR initiatives. PHAC led the development of *Antimicrobial Resistance and Use in Canada: A Federal Framework for Action* (9). The federal Framework set out three pillars to guide federal actions:

1. Establish and strengthen surveillance systems.
2. Strengthen the promotion of the appropriate use of antimicrobials (stewardship).
3. Promote innovation.

The Framework was followed by the *Federal Action Plan on Antimicrobial Resistance and Use in Canada*, which identified concrete actions to be undertaken by the Government of Canada to achieve the Framework objectives (10). Federal departments undertaking work under the Action Plan include Health (Public Health Agency of Canada, Health Canada, the Canadian Institutes of Health Research and the Canadian Food Inspection Agency); Agriculture and Agri-food Canada; the National Research Council Canada; and Innovation, Science and Economic Development Canada. Discussions continue across federal departments regarding how to further advance Canada's response to AMR and have expanded to include Environment and Climate Change Canada, as well as Global Affairs Canada (**Figure 1**).

Figure 1: Federal departments taking action on AMR through the Federal Action Plan

The Government of Canada has been working on its commitments in the Federal Action Plan. Here are a few examples of how it has been working on each of the pillars with a special focus on the work of the Agency.

The Canadian AMR Surveillance System (CARSS)

The Canadian Antimicrobial Resistance Surveillance System (CARSS) was launched in 2014 to strengthen surveillance coordination. CARSS is based at PHAC and supported by Health Canada, the CFIA and AAFC. CARSS integrates data about antimicrobial use (AMU) and AMR from nine surveillance systems.

This issue of the *Canada Communicable Disease Report* includes a summary of the second CARSS report (11). The report identifies AMU and AMR trends in both food production animals (e.g. chickens, cows, pigs) and humans, and tracks priority organisms for surveillance. The report highlights that while AMR rates for some organisms have stayed the same or declined, methicillin-resistant *Staphylococcus aureus* (MRSA) rates are higher than in the early-mid 2000s. Of particular concern are the rising rates of drug-resistant *Neisseria gonorrhoeae* in the community. Athough antibiotic use in Canadian hospitals has remained relatively stable, there is a trend towards increased use of parenteral (intravenous) antibiotics in the community. Additionally, antimicrobials important to human medicine were distributed for use in food production animals. In 2014 approximately 82% of antibiotics in Canada were for use in food production animals; only 18% were for human use (11).

Stewardship, research and innovation

The Government of Canada is addressing AMR in the other two pillars as well: stewardship and research and innovation. With respect to stewardship, there has been work in the animal health area to moderate antibiotic use, including strengthening regulations and policy for veterinary medicines and medicated feeds. Health Canada has proposed amendments to the *Food and Drug Regulations* to help address the issue of AMR in the veterinary drugs context, work that is complimentary to policy initiatives also currently underway, including the removal of growth promotion claims of medically-important antimicrobials and their change of status from over-the-counter to prescription. PHAC has supported and promoted a number of local stewardship initiatives (12) and, as described below, has worked with provinces and territories to identify best practices in antimicrobial stewardship.

Surveillance findings have informed stewardship, research and innovation. Programs have covered a wide range of activities, including the development of novel antimicrobials, alternatives to antibiotics, transmission dynamics and diagnostics. In addition to its investigator-initiated research funding, CIHR has supported a number of AMR-related programs since its inception in 2000 (13), and current targetted funding is focused on point-of-care diagnostics for priority pathogens (14) and various topics (e.g, transmission dynamics, development of new drugs) through the European Union Joint Programming Initiative on Antimicrobial Resistance (JPIAMR), an international collaboration of 22 member states (15). Along with PHAC and the NRC, CIHR also co-led a federal working group of 13 organizations focused on identifying priorities for vaccine research, innovation and development, which has the potential to lead to a decreased rate of new antimicrobial resistant infections. The Genomics Research and Development Initiative is another example of innovation and federal multi-disciplinary collaboration. This multi-year program enables federal science departments and agencies to address important biological issues, including how AMR develops and spreads.

National health initiatives

Efforts are underway in human health and animal health sectors. As an example, in the human health sector, PHAC has been working at a national level with the Public Health Network (PHN) Council. The PHN Council is composed of senior health officials from all the provinces and territories plus the Chief Public Health Officer of Canada (16). The Council accomplishes its developmental work through steering committees and task groups.

To identify some of the key human health issues in AMR, the PHN Council's Communicable and Infectious Disease Steering Committee (CIDSC) set up two time limited task groups that included experts and other key stakeholders from across the country: the AMU Surveillance Task Group and the AMR Stewardship Task Group. Each task group developed a report for CIDSC to present to the PHN Council.

Strengthening AMR surveillance

The CIDSC AMR Surveillance Task Group was asked to identify the data requirements for first priority organisms for AMR surveillance in Canada, to determine whether they are being met or not, to assess the feasibility of meeting unmet data requirements and to make recommendations regarding surveillance gaps (17). For just over half of the high priority data requirements, the Task Group found the existing surveillance systems met the required needs. It found that a number of data requirements were not being met and the feasibility of gathering this data was variable. The Task Group recommended that the top priority site of infection for AMR surveillance was the bloodstream due to the high associated morbidity and mortality of bloodstream infections. Another recommendation was to collect susceptibility data on *N. gonorrhoeae* in the community given the rise in resistance and current gaps.

Best practices in antimicrobial stewardship

The CIDSC Stewardship Task Group conducted a scan of best practices in stewardship and developed recommendations to promote stewardship (18). Recommendations include the promotion of stewardship across jurisdictions by instituting a national infrastructure; advancing best practices for education and awareness; developing evidence-based audit and feedback tools; collecting, sharing and mobilizing evidence about prescribing professionals to implement specific targeted interventions; and changing healthcare practitioners' practice regulations.

Next steps

Developing a pan-Canadian framework

In order to deliver a multi-sectoral national plan, as per Canada's international commitments, PHAC has been working with the human and animal health and agriculture governance systems, and has initiated the creation of a new federal/provincial/territorial AMR Governance Structure, reflective of an integrated One Health approach needed for coordinated, comprehensive multi-sectoral actions for a pan-Canadian approach.

This new governance structure is composed of federal/provincial/territorial government officials representing public health, healthcare, animal health and the agri-food sector from all levels of government as well as key stakeholders from academia and industry. The structure is being used to facilitate the development of the pan-Canadian Framework on AMR.

Conclusion

How is an international public health threat addressed in Canada? The case of AMR goes beyond human health and requires a One Health approach with multi-sector action at local, regional, national and international levels. The WHO Global Action Plan on AMR and the recent commitment by Heads of State worldwide to address the root causes of AMR will enable a high level of collaboration and coordination. Although a lot of foundational work has been completed in Canada, there is still much to be done. As Canada moves forward with its pan-Canadian Framework and action plan, ongoing engagement with domestic and international partners across all sectors will be key to ensuring alignment and protecting the health and welfare of not just Canadians, but the global community.

Acknowledgements

Many thanks to all the front line clinicians, veterinarians, health care administrators, academics, government officials, regulators, researchers, politicians and more who have been fighting the battle against AMR on multiple fronts.

Conflict of interest

None. Dr. Patricia Huston is the Editor-in-Chief of the *Canada Communicable Disease Report* and recused herself from taking editorial decisions on this manuscript. Editorial decisions were made by the two the Guest Editors, Jacqueline Arthur and Dr. Kanchana Amaratunga.

References

1. United Nations [Internet]. The millennium development goals report 2015. New York, NY: United Nations; 2015. Available from: http://www.undp.org/content/dam/undp/library/MDG/english/UNDP_MDG_Report_2015.pdf.
2. United Nations [Internet]. Transforming our world. The 2030 agenda for sustainable development. New York, NY: United Nations; 2015. Available from: https://sustainabledevelopment.un.org/content/documents/21252030%20Agenda%20for%20Sustainable%20Development%20web.pdf.
3. World Health Organization (WHO) [Internet]. Antimicrobial resistance: Global report on surveillance, 2014. Geneva: WHO; 2014. Available from: http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf?ua=1.
4. O'Neill J [Internet]. The review on antimicrobial resistance. London, UK: Her Majesty's Government; 2016. Available from: https://amr-review.org/.
5. Press release: High-level meeting on antimicrobial resistance [Internet]. Sep 21 2016. Available from: http://www.un.org/pga/71/2016/09/21/press-release-hl-meeting-on-antimicrobial-resistance/.
6. Public Health Agency of Canada [Internet]. One health. Ottawa, ON: PHAC; 2013. [updated 2013 Mar 28; cited 2016 Oct 11]. Available from: http://www.phac-aspc.gc.ca/owoh-umus/index-eng.php.
7. World Health Organization (WHO) [Internet]. International health regulations. Geneva: WHO; 2005. Available from: www.who.int/ihr/publications/9789241596664/en.
8. United Nations General Assembly [Internet]. Draft political declaration of the high-level meeting of the General Assembly on antimicrobial resistance. New York, NY: United Nations; 2016. Available from: http://www.un.org/pga/71/wp-content/uploads/sites/40/2016/09/DGACM_GAEAD_ESCAB-AMR-Draft-Political-Declaration-1616108E.pdf.
9. Public Health Agency of Canada [Internet]. Antimicrobial resistance and use in Canada: A federal framework for action. Ottawa: Government of Canada; 2014. Available from: http://healthycanadians.gc.ca/alt/pdf/drugs-products-medicaments-produits/buying-using-achat-utilisation/antibiotic-resistance-antibiotique/antimicrobial-framework-cadre-antimicrobiens-eng.pdf.
10. Public Health Agency of Canada [Internet]. Federal action plan on antimicrobial resistance and use in Canada: Building on the federal framework for action. Ottawa: PHAC; 2015. Available from: http://healthycanadians.gc.ca/alt/pdf/publications/drugs-products-medicaments-produits/antibiotic-resistance-antibiotique/action-plan-daction-eng.pdf.
11. Public Health Agency of Canada [Internet]. Canadian Antimicrobial Resistance Surveillance System report 2016. Ottawa, ON: PHAC; 2016. Available from: http://healthycanadians.gc.ca/publications/drugs-products-medicaments-produits/antibiotic-resistance-antibiotique/alt/pub-eng.pdf.
12. Taylor G. The importance of stewardship. Can Comm Dis Rep. 2015;41(S-4):3-5. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/15vol41/dr-rm41s-4/editorial-eng.php/.
13. Canadian Institutes of Health Research [Internet]. About CIHR's antimicrobial resistance initiatives. Ottawa, ON: Government of Canada; 2015. [updated 2015 Apr 13; cited 2016 Oct 11]. Available from: http://www.cihr-irsc.gc.ca/e/40485.html.
14. ResearchNet [Internet]. Funding opportunity details: Antimicrobial resistance. [updated 2016 Aug 16; cited 2016 Oct 11]. Available from: https://www.researchnet-recherchenet.ca/rnr16/vwOpprtntyDtls.do?prog=2441&view=currentOpps&type=EXACT&resultCount=25&sort=program&all=1&masterList=true.
15. Joint Programming Initiative on Antimicrobial Resistance (JPIAMR) [Internet]. Home page. Stockholm, Sweden: JPIAMR; 2015. [updated 2015; cited 2016 Oct 11]. Available from: http://www.jpiamr.eu/
16. Pan-Canadian Public Health Network (PHN) [Internet]. Overview. Ottawa, ON: PHN; 2016. [updated 2016 Mar 21; cited 2016 Oct 11]. Available from: http://www.phn-rsp.ca/index-eng.php.
17. Amaratunga K, Tarasuk J, Tsegaye L, Archibald CP and the 2015 Communicable and Infectious Disease Steering Committee (CIDSC) AMR Surveillance Task Group. Advancing surveillance of antimicrobial resistance: Summary of the 2015 CIDSC Report. Can Comm Dis Rep. 2016;42(11):232-7. Available from: http://webqa.phac-aspc.gc.ca/publicat/ccdr-rmtc/16vol42/dr-rm42-11/ar-03-eng.php.
18. Khan F, Arthur J, Maidment L, Blue D on behalf of the 2015 CIDSC Task Group on AMU Stewardship. Advancing antimicrobial stewardship in Canada: Summary of the CIDSC Report. Can Comm Dis Rep. 2016;42(11):238-41. Available from: http://webqa.phac-aspc.gc.ca/publicat/ccdr-rmtc/16vol42/dr-rm42-11/ar-04-eng.php.

Antimicrobial use and antimicrobial resistance trends in Canada: 2014

Ebrahim M[1], Gravel D[1]*, Thabet C[1], Abdesselam K[1], Paramalingam S[1], Hyson C[1]

Affiliation

[1] Centre for Communicable Diseases and Infection Control, Public Health Agency of Canada, Ottawa, ON

***Correspondence:** denise.graveltropper@phac-aspc.gc.ca

Abstract

Background: There is a global concern that the emergence of antimicrobial resistance (AMR) threatens our ability to treat infectious diseases. The Canadian Antimicrobial Resistance Surveillance System (CARSS) was created in response to the Government of Canada's commitment to address AMR. CARSS integrates information from nine different national surveillance systems for tracking antimicrobial use (AMU) and AMR in both humans and animals to inform AMU/AMR research and policy.

Objective: To provide highlights of CARSS data on antimicrobial use in humans and animals, AMR trends in human infections in both hospital and community settings and AMR bacteria found in food production animals.

Methods: Information on AMU in humans and animals is purchased and additional information on AMU in animals is collected through the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS). AMR data in humans focuses on first priority organisms. Data on priority organisms for hospital-based AMR is collected through Canadian Nosocomial Infection Surveillance Program (CNISP), Canadian Tuberculosis Laboratory Surveillance System (CTBLSS), Canadian Tuberculosis Reporting System (CTBRS) and CIPARS. Data on community-based AMR is collected through CTBLSS, CTBRS, CIPARS, the Antimicrobial-resistant *Neisseria gonorrhoeae* Surveillance System (ARNGSS) and the National Surveillance of Invasive Streptococcal Disease (NSISD). AMR data on animals is collected through CIPARS.

Results: In terms of antibiotic usage in 2014, approximately 82% of antimicrobials were directed to food production animals, 18% to humans and less than one percent to companion animals (e.g., pets) and crops. Over the past five years, 73% of antimicrobials distributed to food production animals belonged to the same classes as those used in human medicine. Antibiotic usage in humans has remained relatively stable. Trends in 2014 for AMR in hospitals include declining rates of hospital-acquired *Clostridium difficile* to 3.4 cases per 1,000 patient admissions, methicillin-resistant *Staphylococcus aureus* (MRSA) infections to 2.89 cases per 10,000 patient days and vancomycin-resistant Enterococci (VRE) to 0.45 cases per 10,000 patient days. Resistance to a number of antimicrobials used to treat *Streptococcus pneumoniae* has decreased since the introduction of pneumococcal vaccine in 2010. In contrast, trends in 2014 for AMR in the community included increasing rates of community-acquired *N. gonorrhoeae* - 52.4% of isolates were resistant to at least one antibiotic. Trends for carbapenem-resistant Enterobacteriaceae (CRE) were stable at 0.22 cases per 10,000 patient days. Also, between 2004 and 2014, nine percent of tuberculosis (TB) culture positive cases were resistant to at least one first line anti-tuberculosis drug and this has remained relatively stable over that time. Trends in 2014 for AMR in food production animals showed decreasing resistance of *Escherichia coli* and *Salmonella* species to third-generation cephalosporins (ceftriaxone) in poultry associated with a decrease in cephalosporin use on chicken farms but resistance to ciprofloxacin in *Campylobacter* species in chicken and cattle has been increasing.

Conclusion: Overall, antibiotic use in humans has not declined despite concerns about overuse. Although resistance rates of *C. difficile*, VRE, MRSA and AMR *S. pneumoniae* have been gradually decreasing, and drug-resistant tuberculosis and CRE have remained stable, community-associated drug-resistant *N. gonorrhoeae* has been increasing. Although efforts to decrease antibiotic use in animals have been met with some success, AMR continues to occur in fairly high levels in food production animals.

Suggested citation: Ebrahim M, Gravel D, Thabet C, Abdesselam K, Paramalingam S, Hyson C. Antimicrobial use and antimicrobial resistance trends in Canada: 2014. Can Comm Dis Rep. 2016;42(11):227-31.

Introduction

The extent of antimicrobial use (AMU) and antimicrobial resistance (AMR) are global concerns due to increased resistance levels detected in some pathogenic microbes and the selective pressure resulting from antimicrobial use in both animals and humans (1). The damaging effects of AMR are already manifesting themselves across the world with antimicrobial resistant infections currently claiming at least 50,000 lives each year across Europe and the US alone, with many hundreds of thousands more dying in other areas of the world (2). In order to monitor AMU/AMR in Canada, the Canadian Antimicrobial Resistance Surveillance System (CARSS) was created. Through collaboration with internal and external stakeholders, CARSS integrates several sources of AMU/AMR surveillance information to provide a unified national picture of AMU and AMR in humans and animals in Canada. Data on both humans and animals is included because inappropriate antimicrobial use in food production animals is a public health concern as it contributes to the emergence of resistant bacteria in animals that can be transmitted to humans through the food supply (3). The first CARSS Report, issued in March 2015, provided information on AMU/AMR in Canada until 2013 (4).

The objective of this summary is to highlight the key findings of the CARSS second report summarizing surveillance data up to 2014. The full report is available online (5).

Methods

Information is collected in four key areas: AMU in humans, AMU in animals, AMR in humans in health care and community settings and AMR in food production animals.

Antimicrobial usage in humans and animals

CARSS purchases human AMU data from IMS Health Canada Inc., a global company that collects information on hospital antibiotic purchases and prescriptions dispensed by retail pharmacies in the community as well as antimicrobials prescribed by physicians. CARSS obtains animal AMU data from the Canadian Animal Health Institute (CAHI) which collects data on over 90% of all sales of licensed animal pharmaceutical products in Canada. The Public Health Agency of Canada (PHAC) collects additional AMU information from sentinel farms through the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS). CIPARS monitors trends in AMU and AMR in selected bacterial organisms from human, animal and food sources across Canada (6).

AMR in humans

Health care settings

CARSS collects data concerning AMR in priority organisms transmitted in health care settings through a number of different surveillance systems. The Canadian Nosocomial Infection Surveillance Program (CNISP) tracks *C. difficile*, carbapenemase producing organisms (CPO) and carbapenem-resistant Enterobacteriaceae (CRE), methicillin-resistant *S. aureus* (MRSA) and vancomycin-resistant Enterococci (VRE) (7). Human *Salmonella* isolates in hospitals are captured through CIPARS (8). Data on hospital tuberculosis (TB) cases are provided through the Canadian Tuberculosis Laboratory Surveillance System (CTBLSS) and the Canadian Tuberculosis Reporting System (CTBRS) (9).

Community settings

AMR is monitored for the following priority organisms primarily transmitted in community settings: *Streptococcus pneumoniae*, Group A Streptococcus, *Neisseria gonorrhoeae* and *Mycobacterium tuberculosis.* Provincial public health laboratories submit isolates to the National Microbiology Laboratory (NML) for serotyping for *Streptococcus* and *Neisseria gonorrhoeae.* AMR data concerning *Mycobacterium tuberculosis* is forwarded to PHAC through the CTBLSS and CTBRS (9).

AMR in food production animals

CIPARS includes susceptibility testing for the following priority bacteria transmitted to humans through food production animals: generic *Escherichia coli, Campylobacter* and *Salmonella* species (8). *E. coli* samples are collected at three different spots along the food chain (farms, slaughter houses and retail stores) for chicken and swine and from slaughter houses or retail stores for cattle. *Campylobacter* samples are collected across the food chain for chicken and are collected only from slaughter houses for swine and cattle; *Salmonella* species samples are collected at farms and slaughter houses for chickens (5).

A summary of all the data collected by CARSS on AMR on priority organisms for both humans and animals is summarized in **Table 1**.

Table 1: Sources of antimicrobial resistance data provided to CARSS in humans and animals

Data collected	Surveillance system	Pathogens	Provides information for:
Hospital AMR	CNISP	• Methicillin-resistant *Staphylococcus aureus* • *Clostridium difficile* • Vancomycin-resistant enterococci • Carbapenem-resistant Enterobacteriaceae (CRE) and Carbapenemase producing organisms (CPO): - CP *Acinetobacter* species (CPA) - CP Enterobacteriaceae (CPE)	• Health care- and community-associated infections in acute-care hospitals
	CTBLSS & CTBRS	• *Mycobacterium tuberculosis*	• Drug resistance patterns
	CIPARS	• *Salmonella*	• Hospital cases
Community AMR	CTBLSS & CTBRS	• *Mycobacterium tuberculosis*	• Drug resistance patterns
	ARNGSS	• *Neisseria gonorrhoeae*	• Antimicrobial susceptibility
	CIPARS	• *Salmonella*	• Community cases
	NSISD	• *Streptococcus pneumoniae* • *Streptococcus pyogenes* • *Streptococcus agalactiae*	• Antimicrobial susceptibilities
Production animal AMR	CIPARS	• *Escherichia coli* • *Campylobacter* • *Salmonella* species	• Resistance in foodborne bacteria in chicken, swine and cattle

Abbreviations: AMR, antimicrobial resistance; ARNGSS, Antimicrobial-resistant *Neisseria gonorrhoeae* Surveillance System; CIPARS, Canadian Integrated Program for Antimicrobial Resistance Surveillance; CNISP, Canadian Nosocomial Infection Surveillance Program; CTBLSS, Canadian Tuberculosis Laboratory Surveillance System; CTBRS, Canadian Tuberculosis Reporting System; NSISD, The National Surveillance of Invasive Streptococcal Disease

Analysis

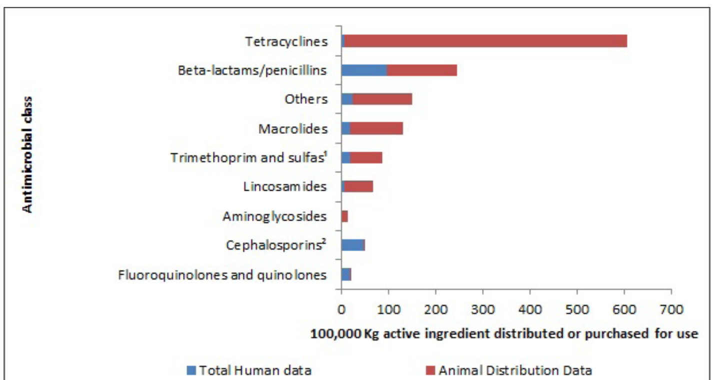
Due to the nature of the method used to collect the data from the established surveillance systems, statistical analysis is descriptive. Numerous years of data facilitated the establishment of benchmarks and the analysis of trends over time.

Results

Antimicrobial use

Approximately 1.4 million kilograms (kg) of medically important antimicrobials were distributed and/or sold in 2014. Approximately 82% were used in food production animals, 18% for humans and less than one percent for both companion animals and crops. In humans, the predominant classes of antimicrobials sold were β–lactams, cephalosporins and fluoroquinolones. In animals, the predominant classes were tetracyclines, β–lactams and “other” antimicrobials **(Figure 1)**.

Figure 1: Kilograms of antimicrobials distributed and/or sold for use in animals and humans by antimicrobial class, 2014



[1] Including all sulfas

[2] 1st generation, 2nd generation, others

Over the past five years (2010 to 2014) 73% of antimicrobials distributed to food production animals belonged to the same classes as those used in human medicine, with 1.5 million kg of antimicrobial active ingredients distributed for use in animals in 2014. This is a 5.0% increase from 2013.

Usage in humans

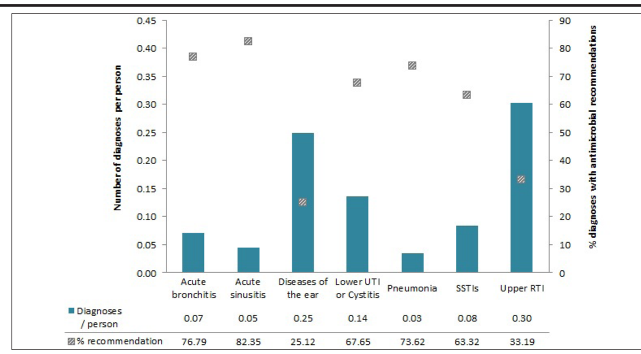
AMU in humans has remained relatively stable in Canada over the last 13 years. In 2014, compared to 2013, there was little change in the total number of antimicrobials dispensed by community pharmacies whereas hospital purchases decreased by 4.0%. Antimicrobials dispensed by community pharmacies accounted for 93% of all antimicrobial use. Between 2010 and 2014, prescribing rates for antimicrobials declined among children (0–14 years) by 8.0%, and among adults (15–59 years) by 3.0%, but decreases were not observed among seniors (60+ years).

In 2014, 38,340 kg of antimicrobials were purchased by hospitals across Canada at a cost of $104 million. Ciprofloxacin was the antimicrobial most commonly purchased in 2014, followed by amoxicillin, azithromycin, ceftriaxone and doxycycline. Purchases of ceftriaxone and doxycycline have had the highest increase from 2002 to 2014.

The majority of antimicrobials used in the Canadian outpatient population in 2014 were drugs for oral administration. Compared to 2013, parenteral (intravenous) antimicrobials dispensed at higher levels in 2014 included daptomycin, ticarcillin and clavulanic acid, fosfomycin, imipenem and cilastatin, ceftazidime, ceftriaxone and colistin. A steady increase has been noted over the last five years in dispensing of parenteral antimicrobials.

In 2014, antimicrobials were the recommended treatment in eight percent of all diagnoses. The majority of recommendations were for the treatment of respiratory infections including upper respiratory tract infections, bronchitis and acute sinusitis **(Figure 2).** This a concerning trend because antibiotics are not recommended as a first line of treatment in acute bronchitis or acute sinusitis (10,11). Generally, the percentage of diagnoses for which an antimicrobial was recommended remained stable.

Figure 2: Number of specific diagnoses per person and the percentage of those diagnoses with recommendations for an antimicrobial in Canada, 2014

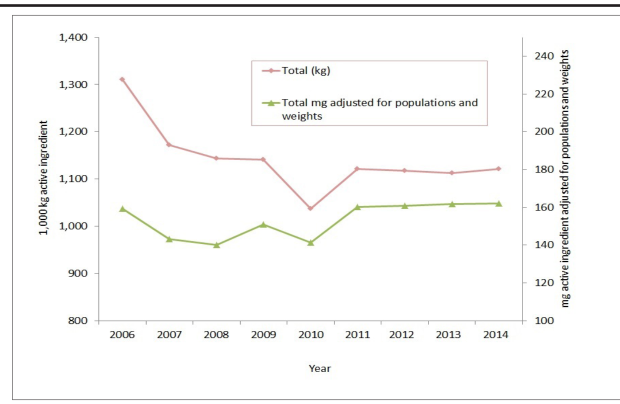


Usage in food production animals

Fluoroquinolones are classified as of “very high importance to human medicine” by Health Canada’s Veterinary Drugs Directorate. Since 2010 there has been a 40% increase in the quantity of fluoroquinolones distributed for use in animals, likely due in part to the approval of a new indication for fluoroquinolone use. Between 2013 and 2014, the quantity increased by 14%. Third-generation cephalosporins are also highly important to human medicine because they are a last line of defence. CAHI data show a 60% decline in the quantity of cephalosporins distributed for use in animals from 2011 to 2014.

As shown in **Figure 3**, after adjusting for animal population numbers and weight (green line), the overall quantity of antimicrobials distributed has remained relatively stable over time with a 3.0% increase since 2006 and a 1.0% increase since 2013. Over the past five years (2010-2014), this amount has increased by 16%.

Figure 3: Medically-important antimicrobials distributed for use in animals over time; measured as kilograms active ingredient and milligrams active ingredient, adjusted for populations and weights, 2006 to 2014



AMR in humans

Health care settings

In health care settings AMR trends are tracked for first priority organisms (those identified as of highest concern) (**Table 2**).

Table 2: Trends in antimicrobial resistance for organisms identified as priority organisms primarily transmitted in health care settings

Priority organism[1]	AMR trends
Healthcare acquired *Clostridium difficile* (HA-CDI)	The overall HA-CDI infection rates peaked in 2008 at 5.8 HA-CDI infections per 1,000 patient admissions then declined slowly to approximately 3.4 HA-CDI infections per 1,000 admissions in 2014.
Carbapenem-resistant Enterobacteriaceae (CRE)	CRE rates remained relatively stable from 2010 to 2014. In 2014, rates were of 0.22 per 10,000 patient days compared to 0.19 per 10,000 patient days in 2010.
Enterococcus species	VRE infection rates increased sharply from 0.1 cases per 10,000 patient days in 2007 to 0.61 cases per 10,000 patient days in 2012 before decreasing to 0.45 cases per 10,000 patient days in 2014.
Methicillin resistant *Staphylococcus aureus* (MRSA)	MRSA infections have decreased approximately 25% since 2008 with infection rates decreasing from 2.92 per 1,000 patient admissions in 2008 to 2.12 per 1,000 patient admissions in 2016.

[1] As developed and accepted by the CIDSC AMR Surveillance Task Group, December 2014 (unpublished report)

Community settings

Trends in AMR for first priority organisms in community settings are outlined in the 2016 CARSS Report (**Table 3**).

Table 3: Trends in antimicrobial resistance for organisms identified as of priority organisms primarily transmitted in community settings

Priority organism[1]	Antimicrobial resistance trends
Neisseria gonorrhoeae	In 2014, a total of 1,995 *N. gonorrhoeae* samples (52.4%) were found to be resistant to one or more antibiotic, representing an increase in AMR since 2009, especially to azithromycin, ciprofloxacin, erythromycin, penicillin and tetracycline.
Streptococcus pyogenes & *S. pneumoniae*	Resistance to a number of antimicrobials used to treat *S. pneumoniae* has decreased since 2010 following the introduction of a pneumococcal vaccine. For example, resistance to penicillin declined from 12% in 2011 to 9% in 2014. In 2014, all samples of *streptococcus pyogenes* were sensitive to first line antimicrobials while resistance to second line drugs were unchanged or declined since 2010.
Mycobacterium tuberculosis	Between 2004 and 2014, 9% of culture positive cases were found to be resistant to at least one first line anti-tuberculosis drugs. Isoniazid resistance was the most common pattern of resistance reported. Also, for the same time period, 8% of the culture positive cases were monoresistant, 0.5% were polyresistant and 1% were multi-drug resistant tuberculosis (MDR-TB). Also, the proportion of cases with MDR-TB remained relatively stable ranging between 1% and 2%.
Salmonella species	82% of typhoidal isolates were resistant to nalidixic acid. Ciprofloxacin resistance increased from 2003 to 2014 from 0% to 14%, with 16% being multiclass-resistant. Over time, resistance in non-typhoidal isolates has decreased since 2004 with the exception of nalidixic acid which has almost doubled between 2013 (5%) and 2014 (9%).

[1] As developed and accepted by the CIDSC AMR Surveillance Task Group, December 2014 (unpublished report)

AMR in food production animals

PHAC monitors AMR in select bacterial organisms in a number of food production animals across Canada. The 2014 data regarding AMR in food production animals is presented in **Table 4**.

Table 4: Trends in antimicrobial resistance for organisms transmitted through food production animals

Priority organism[1]	Antimicrobial resistance trends
Escherichia coli	In 2014, 96% of chicken, 55% of swine and 56% of cattle samples were positive for generic *E. coli*. Following a ban of preventive use of antimicrobials in 2014, resistance to third-generation cephalosporins in *E. coli* from chicken samples across the food chain decreased. In 2014 only 21% of isolates were resistant to third-generation cephalosporins compared to 28% in 2013.
Campylobacter species	Chicken: 44% of isolates were resistant to tetracycline. Resistance to ciprofloxacin increased from 4% to 11% between 2004 and 2014. Swine: High resistance rates to tetracycline (78%), azithromycin (53%), telithromycin (43%) were noted in 2014; resistance rates to ciprofloxacin were stable at 11%. Cattle: Resistance is mainly to tetracycline, with 54% of isolates resistant in 2014. Resistance to ciprofloxacin has increased between 2008 and 2014 from 2% to 7%.
Salmonella species	In chicken, resistance to *Salmonella* spp. for ceftriaxone decreased from 24% in 2013 to 17% in 2014 and no resistance was found to ciprofloxacin. In swine resistance to *Salmonella* spp. for ceftriaxone has remained stable and low at 4%.

[1] As developed and accepted by the CIDSC AMR Surveillance Task Group, December 2014 (unpublished report)

Discussion

The CARSS 2016 Report identified that in 2014, more than 80% of all antimicrobials distributed in Canada were directed to food production animals. Antimicrobial use in humans and animals has remained relatively stable over the past few years. Healthcare-associated *C. difficile* infection, VRE and MRSA, have decreased, whereas, CRE remained relatively stable. In the community, resistant *S. pneumoniae* has gradually decreased; drug-resistant *N. gonorrhoea* has increased, while drug-resistant TB has remained stable. In food production animals, resistance to third-generation cephalosporins in generic *E. coli* and *Salmonella* species has decreased in chicken, while resistance to ciprofloxacin in *Campylobacter* species and has increased in chicken and cattle.

With the implementation of CARSS, PHAC has improved the coordination of surveillance for AMU/AMR to assist stakeholders with the integrated data they need to inform further progress in reducing the threat of AMR and preserving the efficacy of today's antimicrobials.

Despite the advances in our surveillance capacity, gaps still exist. There is a need for more data on a number of priority pathogens (e.g., *E. coli*, *Neisseria gonorrhoea* and *Shigella*) and there is limited data on AMR in smaller, non-academic hospitals, including those in rural and northern health care settings and First Nations communities. Overall, there is limited data on AMR in the community, outpatient clinics, long-term care facilities and physicians' and dentists' offices. Data on AMU in animals is also limited. For example, data concerning the amounts of over-the-counter antimicrobials sold without veterinary prescription or the amounts imported as active pharmaceutical ingredients for compounding by veterinarians and/or used in food production animals is limited. Even with all the data we do have, we still do not completely understand the link between AMU and the emerging patterns of AMR in Canada.

PHAC is committed to addressing these surveillance gaps by working with provincial and territorial partners and other stakeholders to expand surveillance activities to collect quality data regarding health professional prescribing practices, infection rates and resistance patterns for key priority organisms, particularly in community settings. PHAC is also working with the World Health Organization to develop common indicators for AMR resistant pathogens.

Acknowledgements

The authors thank all members of The Canadian Nosocomial Infection Surveillance Program, The Canadian Integrated Program for Antimicrobial Resistance Surveillance, The Canadian Tuberculosis Laboratory Surveillance System, The Canadian Tuberculosis Reporting System, The Antimicrobial resistant *Neisseria gonorrhoeae* Surveillance System, The National Surveillance of Invasive Streptococcal Disease, The Canadian HIV Strain and Drug Resistance Surveillance System and The National Microbiology Laboratory. The authors would also like to acknowledge with thanks the Canadian Antimicrobial Resistance Surveillance System (CARSS) team for the creation of materials and Figures used in this summary.

Conflict of interest

None.

Funding

This work was supported by the Public Health Agency of Canada.

References

1. World Health Organization [Internet]. Antimicrobial resistance: Global report on surveillance 2014. Geneva: WHO; June 2014. Available from: http://apps.who.int/iris/bitstream/10665/112642/1/9789241564748_eng.pdf?ua=1.
2. O'Neill J [Internet]. Antimicrobial resistance: Tackling a crisis for the health and wealth of nations. London, UK: Review on Antimicrobial Resistance; December 2014. Available from: https://amr-review.org/sites/default/files/AMR%20Review%20Paper%20-%20Tackling%20a%20crisis%20for%20the%20health%20and%20wealth%20of%20nations_1.pdf.
3. Centers for Disease Control and Prevention [Internet]. National Antimicrobial Resistance Monitoring System for Enteric Bacteria (NARMS). Antibiotic use in food production animals. Atlanta, GA: CDC; 2014. [updated 2016 Mar 29; cited 2016 Oct 05]. Available from: https://www.cdc.gov/narms/animals.html.
4. Public Health Agency of Canada [Internet]. Canadian Antimicrobial Resistance Surveillance System: Report 2015. Ottawa, ON: PHAC; March 2015. Available from: http://healthycanadians.gc.ca/alt/pdf/publications/drugs-products-medicaments-produits/antibiotic-resistance-antibiotique/antimicrobial-surveillance-antimicrobioresistance-eng.pdf?_ga=1.101498113.1672826305.1472829660.
5. Public Health Agency of Canada [Internet]. Canadian Antimicrobial Resistance Surveillance System – Report 2016. Ottawa, ON: PHAC; March 2015. Available from: http://healthycanadians.gc.ca/publications/drugs-products-medicaments-produits/antibiotic-resistance-antibiotique/alt/pub-eng.pdf.
6. Government of Canada [Internet]. Human antimicrobial use report - 2014. Guelph ON: Public Health Agency of Canada; November 2015. [updated 2015 Nov 17; cited 2016 Oct 05]. Available from: http://healthycanadians.gc.ca/publications/drugs-products-medicaments-produits/human-antimicrobial-use-2014-utilisation-antimicrobiens-humains/index-eng.php.
7. Public Health Agency of Canada [Internet]. Antimicrobial resistant organisms (ARO) surveillance: Summary report for data from January 1, 2009 to December 13, 2014. Ottawa, ON: PHAC; August 2015. [updated 2016 Sept 29; cited 2016 Oct 05]. Available from: http://healthycanadians.gc.ca/publications/drugs-products-medicaments-produits/antimicrobial-summary-sommaire-antimicrobien/index-eng.php.
8. Public Health Agency of Canada [Internet]. CIPARS 2013 Annual report: Chapter 1. Design and methods. Ottawa, ON: PHAC; 2014. Available from: http://www.phac-aspc.gc.ca/cipars-picra/2013/annu-report-rapport-eng.php.
9. Public Health Agency of Canada [Internet]. Tuberculosis in Canada 2014 report. Ottawa, ON: PHAC; June 2016. Available from: http://healthycanadians.gc.ca/publications/diseases-conditions-maladies-affections/tuberculosis-2014-tuberculose/index-eng.php#a3.
10. Alberta Medical Association [Internet]. Guidelines for the management of acute bronchitis. 2008 update. Edmonton, AB: Alberta Medical Association; 2008. Available from: http://www.topalbertadoctors.org/download/378/acute_bronchitis_guideline.pdf.
11. Rosenfield RM, Picirrilo JF, Chandrasekhar SS, et al. Clinical practice guideline update: Adults sinusitis executive summary. Otolaryngol Head Neck Surg. 2015 Apr;152(4):598-609.

Advancing surveillance of antimicrobial resistance: Summary of the 2015 CIDSC Report

Amaratunga K[1,2], Tarasuk J[1], Tsegaye L[3], Archibald CP[1] on behalf of the 2015 Communicable and Infectious Disease Steering Committee (CIDSC)* Antimicrobial Resistance (AMR) Surveillance Task Group[4]

Abstract

Background: Antimicrobials are essential for the treatment and control of infectious diseases and therefore, the development and spread of antimicrobial resistance (AMR) is a global health concern. It is recognized that robust AMR surveillance is necessary; however, current gaps in national surveillance programs need to be addressed to enable better evidence-informed program and policy decisions.

Objective: To describe how an AMR Surveillance Task Group prioritized national AMR surveillance data requirements for high priority AMR organisms for human health in Canada and made recommendations on addressing the current data gaps.

Methods: The 2015 AMR Surveillance Task Group examined the data requirements for previously identified first priority organisms and assessed whether the current system met, partially met or did not meet these requirements. Information was summarized into synopsis tables and a ranking process was used to prioritize the data requirements and develop specific recommendations to address the gaps.

Results: First priority organisms identified for AMR surveillance are: *Clostridium difficile,* Extended-spectrum β-lactamase-producing organisms, Carbapenem-resistant organisms (*Acinetobacter* + Enterobacteriaceae species), *Enterococcus* species, *Neisseria gonorrhoeae*, *Streptococcus pyogenes* and *S. pneumonaea*, *Salmonella* species, *Staphylococcus aureus*, *Mycobacterium tuberculosis* and *Campylobacter* species. For these organisms, there were 19 high priority data requirements identified: 10 of these requirements were met by the current surveillance systems, seven were partially met and two were unmet. For the two high priority data metrics in the community setting, the Task Group recommended conducting a point-prevalence community-based study (i.e., every five years) to follow infection rates of *C. difficile* infection, and community level antibiogram data on an annual basis for susceptibility data for Enterobacteriaceae species (*E. coli* and *Klebsiella*) causing genito-urinary infections. There were eight medium priority data requirements identified: one requirement was met by the current surveillance system, five were partially met and two were unmet. The medium priority unmet data requirements included susceptibility of infection isolates for *C. difficile* (diarrheal disease) and infection rates for Enterobacteriaceae species causing genito-urinary tract infections in community settings. It was noted that the feasibility of obtaining this medium priority data in the community setting was low. The Task Group identified bloodstream infections as the top priority site of infection for AMR surveillance in the health care setting given the high morbidity and mortality associated with bloodstream infections. The importance of collecting susceptibility data on *N. gonorrhoeae* in the community was underscored given the rise in resistance and that the current surveillance system only partially collects this data. The Task Group recommended that a review of the national AMR surveillance data requirement priorities should occur on an ongoing basis and when new issues emerge.

Conclusion: While current national surveillance programs either capture or partially capture many of the identified data requirements for first priority organisms, several gaps still remain, especially in community settings. A national review of the recommendations of the Task Group is underway.

Affiliations

[1] Centre for Communicable Diseases and Infection Control, Public Health Agency of Canada, Ottawa, ON

[2] The Ottawa Hospital and University of Ottawa, Department of Medicine, Division of Infectious Diseases, Ottawa, ON

[3] Schulich School of Family Medicine and Dentistry, University of Western Ontario, London, ON

[4] See Acknowledgements section for a full list of Task Group members

***Correspondence:** cidsc_secretariat@phac-aspc.gc.ca

Suggested citation: Amaratunga K, Tarasuk J, Tsegaye L, Archibald CP on behalf of the 2015 Communicable and Infectious Disease Steering Committee (CIDSC) Antimicrobial Resistance (AMR) Surveillance Task Group. Advancing surveillance of antimicrobial resistance: Summary of the 2015 CIDSC Report. Can Comm Dis Rep. 2016;42(11):232-7.

Introduction

Resistant strains of bacteria have emerged since antibiotics were first introduced. The development of antimicrobial resistance (AMR) presents increasingly serious and complex challenges to clinical practice and public health in the prevention, control and treatment of infectious diseases in both humans and animals.

Surveillance is fundamental to understanding the current state and progression of AMR. For several years, the Public Health Agency of Canada (PHAC) has worked with provinces and territories on a number of surveillance programs to monitor AMR and ongoing antimicrobial use (AMU) in hospitals and community-based settings, as well as veterinary and agricultural settings (1-4). A key commitment of the Federal Action Plan on AMU and AMR in Canada is to merge the different surveillance systems into a common focal point through the Canadian Antimicrobial Resistance Surveillance System (CARSS), launched in 2014 (5). CARSS provides an integrated picture of AMU/AMR in Canada based on surveillance data from PHAC's nine surveillance systems and laboratory reference services and is now published yearly (6). In addition to addressing AMR in specific high-risk populations such as Indigenous peoples, analyzing surveillance data with a sex and gender-based focus have been noted for future considerations.

The Communicable and Infectious Disease Steering Committee (CIDSC) of the Pan-Canadian Public Health Network Council (which represents federal, provincial and territorial partners) has identified AMR as a priority along with the need for robust surveillance systems to inform effective AMR prevention and control programs and policies. In 2014, CIDSC established an expert-based Task Group to develop recommendations to address common health care acquired infections and operational issues related to surveillance of AMR. The Task Group identified key elements of a pan-Canadian AMU-AMR approach to the human health aspects of surveillance and established a list of organisms for AMR surveillance ranked by first, second and third priority of importance (**Table 1**).

Table 1: Priority organisms considered for AMR surveillance[1]

First priority	Second priority	Third priority
Clostridium difficile	*Aspergillus* species	*Aeromonas* species
ESBL-producing organisms[2]	*Bacteroides* species	*Chlamydia pneumoniae*
Carbapenem-resistant organisms (*Acinetobacter* + Enterobacteriaceae species)[3]	*Candida albicans*	*Cryptococcus neoformans*
Enterococcus species	*Chlamydia trachomatis*	*Haemophilus influenza*
Neisseria gonorrhoeae	*Helicobacter pylori*	Non-tuberculosis mycobacteria (pulmonary)
Streptococcus pyogenes *Streptococcus pneumoniae*	*Pseudomonas aeruginosa*	
Salmonella species	Group B *Streptococcus*	
Staphylococcus aureus	*Shigella* species	
Mycobacterium tuberculosis		
Campylobacter species		

[1] As developed and accepted by the CIDSC AMR Surveillance Task Group, December 2014 (unpublished report)
[2] Extended-spectrum β-lactamase (ESBL)-producing organisms: Enterobacteriaceae species (*Klebsiella, E. coli*), *Pseudomonas*. Others to consider: *Providencia stuartii, Citrobacter, Serratia, Proteus, Enterobacter*
[3] Carbapenem-resistant organisms (CROs): Enterobacteriaceae species (*Klebsiella, E. coli*), *Pseudomonas, Acinetobacter*

In 2015, a new CIDSC expert-based task group, the CIDSC AMR Surveillance Task Group was formed to develop advice and recommendations on the priority data requirements (data metrics) needed to support a robust AMR surveillance system for each of the first priority organisms identified in human health. This article summarizes the CIDSC AMR Surveillance Task Group's findings in the Report to CIDSC: the Antimicrobial Resistance Surveillance Data Requirements for Priority Organisms (7).

Methods

The Task Group members included Canadian infectious diseases clinicians, infection prevention and control practitioners, medical microbiologists, public health practitioners and AMR experts. The Task Group first reviewed and summarized the surveillance data requirements for the first priority organisms. A ranking process was then conducted to prioritize the data requirements and specific recommendations to address these gaps in the surveillance data were developed.

Phase 1: Review of surveillance data requirements

The CIDSC AMR Surveillance Task Group reviewed the following surveillance data requirements for each of the first priority organisms:

- Site of infection (refers to the syndrome or type of specimen to collect [e.g., bloodstream infection, genito-urinary tract infection, etc.]).
- Data source (refers to the surveillance system that provides data).
- Data variable of interest (as measured by infection rate, colonization rate or susceptibility of organism).
- Priority and relevance (refers to the importance of this measure for each organism and whether this is the most suitable measure).
- Feasibility (refers to whether it is possible to collect the data required).
- Rationale for measure (as required).
- Antibiotics to consider for testing (as required).
- Other considerations (as required).

For each organism reviewed, the CIDSC AMR Surveillance Task Group selected the site of infection(s) deemed to be of national importance and/or which aligned with the World Health Organization (WHO) global AMR surveillance requirements (8).

Phase 2: Development of synopsis tables

A discussion summary was prepared for each organism including a description of the existing surveillance system(s) and respective system limitations. This summary also included a subjective ranking of the priority of the data requirement(s) and a recommendation according to the expert opinion of the Task Group members. A synopsis table was created from this information for each first priority organism that featured:

- The setting (health care [i.e., acute care hospitals] or community [i.e., setting where primary health care is provided, including long term care facilities]).
- The required data metric:

    - Infection rate (incidence and/or prevalence),
    - Colonization rate (incidence and/or prevalence),
    - The organism's antibiotic susceptibility information.
- A rating of the priority of the data requirement (high, medium, low).
- An assessment of whether the current surveillance system meets the identified need (meets needs, partially meets needs, does not meet needs or a brief description if the data metric is considered low priority).
- Action required to fill identified gaps, if any.
- The feasibility to implement the proposed new action to fill the identified gap.

For the infecting and colonizing isolates, the type of antibiotic susceptibility chosen was based on available laboratory information, clinical relevance and WHO reporting (9). The susceptibility data of interest was provided as susceptible/intermediate/resistant (SIR) data rather than minimum inhibitory concentrations (MIC).

Table 2 shows a sample synopsis table for one priority organism, *C. difficile*, with grey bars showing the health care and community settings with types of data required underneath.

Table 2: Sample synopsis table for *Clostridium difficile* (Diarrheal illness)

Setting and Required Data Metric	Priority of Data Metric	Current Surveillance System	Feasibility
Healthcare setting			
Infection Rate	High	Meets needs	High
Susceptibility of infection isolate	Medium	Meets needs	High
Colonization Rate & Susceptibility of colonization isolate	Low	Current surveillance system does not collect and/or report	Not assessed
Community setting			
Infection Rate	High	Does not meet	Medium
Susceptibility of infection isolate	Medium	Does not meet	Low
Colonization Rate and Susceptibility of colonization isolate	Low	Current surveillance system does not collect and/or report	Not assessed

Phase 3: Identification of priority data requirements and recommendations

A three-step process was undertaken to examine the most important data requirements and the feasible next steps:

Step 1: The list of data requirements was stratified by priority (high, medium, low). Priority in this instance referred to an assessment of the overall importance of the data requirement for national AMR surveillance, as deemed by a consensus of Task Group members.

Step 2: The list of data requirements from Step 1 was further stratified by status of current surveillance system. The Task Group assessed the status of the corresponding surveillance system in place and whether it currently collected and/or reported on the priority data metric identified. For each data requirement, the corresponding national surveillance system currently in place was categorized into: meets needs, partially meets needs or does not meet needs.

Step 3: The list of data requirements from Step 2 was further stratified by a feasibility measure as categorized as: high, medium or low feasibility, or not assessed. Feasibility was determined by the amount of person-time effort and financial resources that will be needed to accomplish the proposed action to fill the required data gap.

Recommendations were developed through examination of the three-step process, discussion and consensus-building.

Results

High priority data requirements

For the first priority organisms, the CIDSC AMR Surveillance Task Group identified 19 high priority data metrics required for a robust national AMR surveillance system. Of these, 10 were met, seven were partially met and two were not met by the current surveillance system.

Meets needs

The Task Group examined the 10 of 19 high priority metrics for which the existing national surveillance systems met the required needs. When assessed for feasibility, eight had high feasibility for collecting the data and no new action was required (as no gaps were identified) and two had medium feasibility to continue to collect the required data, subject to ongoing availability of resources.

Partially meets the needs

The Task Group then examined the seven of 19 high priority metrics for which the existing national surveillance systems partially met the required needs (**Table 3**). Of these, four were bloodstream infections in health care settings (susceptibility of infection isolates for *Enterococcus*; infection rates and susceptibility of infection isolates for Enterobacteriaceae species *E. coli* and *Klebsiella;* infection rates of *S. aureus*; and susceptibility of infection isolates for *S. aureus*); two were in community setting (susceptibility of infection isolates for *S. aureus;* susceptibility of infection isolates for *Neisseria gonorrhoeae*); and one was in both the community and healthcare setting (susceptibility of infection isolates for *Streptococcus pneumoniae* [invasive disease]). In assessing what was needed to meet requirements, six could be met with high or medium feasibility and one with low feasibility. The high priority data metric with low feasibility was identified for susceptibility of infection isolate of *N. gonorrhoeae* in the community.

Table 3: High priority data metrics where current surveillance systems partially meet the needs

Organism	Setting	Priority data metric	Current surveillance system	Feasibility
Enterococcus: (Bloodstream infections) - VRE identified as most important)	Health care	Susceptibility of infection isolate	Partially meets needs	High
Enterobacteriaceae species: *Escherichiae coli* and *Klebsiella* (Bloodstream infections)	Health care	Infection rate and susceptibility of infection isolate	Partially meets needs	Medium
Staphylococcus aureus (Bloodstream infections)	Health care	Infection rate	Partially meets needs	Medium
S. aureus (Bloodstream infections) (MRSA identified as most important)	Health care	Susceptibility of infection isolate	Partially meets needs	Medium
S. aureus (Other infection sites including bloodstream infections and colonization sites) (MRSA identified as most important)	Community	Susceptibility of infection isolate	Partially meets needs	Medium
Streptococcus pneumoniae (Invasive disease)	Health care and community	Susceptibility of infection isolate	Partially meets needs	Medium
Neisseria gonorrhoeae	Community	Susceptibility of infection isolate	Partially meets needs	Low

Abbreviations: VRE, Vancomycin-resistant Enterococci; MRSA, methicillin resistant *Staphylococcus aureus*

Does not meet the needs

The Task Group then examined the two of 19 high priority metrics for which the existing national surveillance did not meet the required needs (**Table 4**). These two metrics were for infection rates of community-based surveillance of *C. difficile* and susceptibility of infection isolates for Enterobacteriaceae species. In both cases, the feasibility to address the actions required to fill the data gap was identified as medium.

Table 4: High priority data metrics where current surveillance systems do not meet needs

Organism	Setting	Priority data metric	Current surveillance system	Feasibility
Clostridium difficile (Diarrheal disease)	Community	Infection rate	Does not meet needs	Medium
Enterobacteriaceae species *Escherichiae coli* and *Klebsiella* (Genito-urinary tract infections)	Community	Susceptibility of infection isolate	Does not meet needs	Medium

Medium priority data requirements

Among the first priority organisms, the Task Group identified eight medium priority data metrics; four in a health care setting, three in community settings and one in both health care and community settings (**Table 5**). Among these, there was one data metric for which the existing surveillance systems fully met the needs and five data metrics (four in hospital settings), for which the current surveillance systems partially met the needs. One of the data metrics in the community setting that partially met the need was infection rates for *S. aureus*; and the feasibility to meet this data need was deemed low. There were two data metrics, both in community settings, for which the current surveillance system did not meet the needs. These were for susceptibility of infection isolate for *C. difficile* and infection rates for Enterobacteriaceae species, specifically, *E. coli* and *Klebsiella* genito-urinary tract infections in the community.

Table 5: Medium priority data metrics

Organism	Setting	Priority data metric	Current surveillance system	Feasibility
Clostridium difficile (Diarrheal disease)	Health care	Susceptibility of infection isolate	Meets needs	High
Enterobacteriaceae species *Escherichiae coli* and *Klebsiella* (colonization sites)	Health care	Susceptibility of colonization isolate	Partially meets needs	Medium
Pseudomonas species and *Acinetobacter* species (Bloodstream infections)	Health care	Susceptibility of infection isolate	Partially meets needs	Medium
Pseudomonas species and *Acinetobacter* species (colonization sites)	Health care	Susceptibility of colonization isolate	Partially meets needs	Medium
Campylobacter species	Health care and community	Susceptibility of infection isolate	Partially meets needs	Medium
Staphylococcus aureus (Other infection sites [including Bloodstream infections] and colonization sites)	Community	Infection rate	Partially meets needs	Low
C. difficile (Diarrheal disease)	Community	Susceptibility of infection isolate	Does not meet needs	Low
Enterobacteriaceae species *E. coli* and *Klebsiella* (Genito-urinary tract infections)	Community	Infection rate	Does not meet needs	Low

Low priority data requirements

Among the first priority organisms, the Task Group identified 14 low priority data metrics (data not shown). Some surveillance systems currently collect or partially collect these low priority data metrics and it was acknowledged that their ongoing priority may need to be reviewed.

Recommendations

The Task Group recommended that efforts be focused on high and medium priority data metrics where the current surveillance systems partially met or did not meet the data requirements and where there was a medium to high feasibility to address the data gaps identified.

There was consensus among the Task Group members that given their high morbidity and mortality in the health care setting, top priority should be given to AMR surveillance of bloodstream infections from *Enterococcus* species, Enterobacteriaceae species (*E. coli* and *Klebsiella)* and *Staphylococcus aureus*. This recommendation is in keeping with WHO recommendations for AMR surveillance (9). While the current national surveillance system partially collects data on organisms with a specific resistance pattern deemed currently most important (e.g., methicillin resistant *Staphylococcus aureus* or MRSA) it was noted that ideally, the rate of <u>all</u> bloodstream infections caused by these organisms in the health care setting should be collected (with medium feasibility) and in order to monitor for emerging resistance, all available susceptibility patterns should also be identified.

For the two high priority data metrics in the community setting, the Task Group recommended conducting a point-prevalence community-based study (i.e., every 5 years) to follow infection rates of *C. difficile* infection, and community level antibiogram data on an annual basis for susceptibility data for Enterobacteriaceae species (*E. coli* and *Klebsiella*) causing genito-urinary infections. In addition, it was recommended that collecting community-based susceptibility data on *N. gonorrhoeae* was a high priority given its rise in resistance and the fact that the current surveillance system only partially collects this data. However, the feasibility to collect this data more fully was deemed low given logistical and clinical limitations.

Overall, the Task Group also recommended that a review of the national AMR surveillance data requirement priorities occurs on an ongoing basis and as new issues emerge. Further recommendations regarding medium and low priority data requirements can be found in the full report.

Discussion

The CIDSC AMR Surveillance Task Group conducted a thorough assessment and prioritization process to identify national priority AMR surveillance data requirements and data gaps in first priority AMR organisms. It found that, for just over half of the high priority data metrics (10/19) identified, the existing surveillance systems met the required needs.

When comparing surveillance data for first priority AMR organisms in different settings, community level AMR data was identified as a major gap for national surveillance. Currently this lack of surveillance data results in knowledge gaps in understanding the burden of AMR infection in the community setting. Bloodstream infections were identified as the top priority site of infection for AMR surveillance for several organisms in the health care setting. In light of the fact that AMR and AMU is ever-changing, the Task Group recommended that a review of the national AMR surveillance data requirement priorities should occur on an ongoing basis and as new issues emerge.

The Task Group report has been submitted to the Pan-Canadian Public Health Network Council and is currently under examination. Through the mandate of the Pan-Canadian Public Health Network Council, next steps will include establishing federal, provincial and territorial roles and responsibilities to address these gaps.

Acknowledgements

The authors gratefully acknowledge the work of all the 2015 CIDSC Antimicrobial Resistance Surveillance Task Group members:

John Conly, University of Calgary; Charles Frenette, McGill University; Greg German, Health Prince Edward Island; Jennie Johnstone, Public Health Ontario; Paul N. Levett, Saskatchewan Disease Control Laboratory; Warren McIsaac, University of Toronto (until March 2015); Jessica Minion, Regina General Hospital; Lindsay E. Nicolle, University of Manitoba; David Patrick, British Columbia Centre for Disease Control; Virginia Roth, University of Ottawa (until April 2015); Nadine Sicard, ministère de la Santé et des Services sociaux du Québec; Kimberley Simmonds, Alberta Health.

Public Health Agency of Canada: Kanchana Amaratunga, Chris Archibald (Chair), Jacqueline Arthur (Secretariat), Christine Cryan (Secretariat), Rita Finley, Rebecca Irwin, Michael Mulvey, Jill Tarasuk (Secretariat).

Conflict of interest

None. Dr. Kanchana Amaratunga is one of the Guest Editors for this issue and recused herself from taking editorial decisions on this manuscript. Editorial decisions were made by the Editor-in-Chief, Dr. Patricia Huston and the other Guest Editor, Jacqueline Arthur.

Funding

This work was supported by the Public Health Agency of Canada.

References

1. Gravel D, Archibald CP, Pelude L, Mulvey M, Golding G. Antimicrobial resistance surveillance in Canadian hospitals, 2007-2012. Can Comm Dis Rep. 2014;40(S2):6-13. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40s-2/dr-rm40s-2-surv-1-eng.php.

2. Finley R. Antibiotic recommendations of office-based physicians, 2007-2011. Can Comm Dis Rep. 2014;40(S2):14-22. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40s-2/dr-rm40s-2-surv-2-eng.php.
3. Finley R. Antibiotic purchasing by Canadian hospitals, 2007-2011. Can Comm Dis Rep. 2014;40(S2):23-28. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40s-2/dr-rm40s-2-surv-3-eng.php.
4. Avery BP, Parmley EJ, Reid-Smith RJ, Daignault D, Finley RL, Irwin RJ. Canadian integrated program for antimicrobial resistance surveillance: Retail food highlights, 2003-2012. Can Comm Dis Rep. 2014;40(S2):29-35. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/14vol40/dr-rm40s-2/dr-rm40s-2-surv-4-eng.php.
5. Public Health Agency of Canada in collaboration with the Canadian Food Inspection Agency, Canadian Institutes of Health Research, Health Canada, Agriculture and Agri-Food Canada, Industry Canada, and National Research Council Canada. Summary of the Federal Action Plan on Antimicrobial Resistance and Use in Canada. Can Comm Dis Rep. 2015;41(S4):19-22. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/15vol41/dr-rm41s-4/overview-apercu_04-eng.php
6. Ebrahim M, Gravel D, Thabet C, Abdesselam K, Paramalingam S, Hyson C. Antimicrobial use and antimicrobial resistance trends in Canada: 2014. Can Comm Dis Rep. 2016;42(11):227-31. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/16vol42/dr-rm42-11/ar-02-eng.php.
7. Pan-Canadian Public Health Network, The Communicable and Infectious Disease Steering Committee Task Group on Antimicrobial Resistance Surveillance[Internet]. Report to CIDSC: the Antimicrobial Resistance Surveillance Data Requirements for Priority Organisms. Ottawa ON: PHAC; Apr 2016. Available from: http://www.phn-rsp.ca/pubs/arsdrpo-dsecrao/index-eng.php#cidsc.
8. World Health Organization (WHO) [Internet]. Global Antimicrobial Resistance Surveillance System: Manual for early implementation. Geneva: WHO; 2015. Available from: http://apps.who.int/iris/bitstream/10665/188783/1/9789241549400_eng.pdf.
9. World Health Organization (WHO) [Internet]. Antimicrobial resistance: Global report on surveillance. Geneva: WHO; 2014. Available from: http://www.who.int/drugresistance/documents/surveillancereport/en/.

Advancing antimicrobial stewardship: Summary of the 2015 CIDSC Report

Khan F[1], Arthur J[1*], Maidment L[1], Blue D[2] on behalf of the 2015 Communicable and Infectious Disease Steering Committee (CIDSC) Antimicrobial Use (AMU) Stewardship Task Group[3]

Abstract

Background: Antimicrobial resistance (AMR) is recognized as an important global public health concern that has a cross-cutting impact on human health, animal health, food and agriculture and the environment. The Communicable and Infectious Disease Steering Committee (CIDSC) of the Pan-Canadian Public Health Network (PHN) created a Task Group on Antimicrobial Stewardship to look at this issue from a Canadian perspective.

Objective: To summarize the key findings of the Task Group Report that identified core components of antimicrobial stewardship programs, best practices, key challenges, gaps and recommendations to advance stewardship across jurisdictions.

Methods: Search strategies were developed to identify scientific literature, grey literature and relevant websites on antimicrobial stewardship. The information was reviewed, and based on this evidence, expert opinion and consensus-building, the Task Group identified core components, best practices, key challenges and gaps and developed recommendations to advance stewardship in Canada.

Results: The four components of a promising antimicrobial stewardship initiative were: leadership, interventions, monitoring/evaluation and future research. Best practices include a multi-sectoral/multipronged approach involving a wide range of stakeholders at the national, provincial/territorial, local and health care organizational levels. Key challenges and gaps identified were: the success and sustainability of stewardship undertakings require appropriate and sustained resourcing and expertise; there is limited evidence about how to effectively implement treatment guidance; and there is a challenge in ensuring accessibility, standardization and consistency of use among professionals.

Recommendations to the CIDSC about how to advance stewardship across jurisdictions included the following: institute a national infrastructure; develop best practices to implement stewardship programs; develop education and promote awareness; establish consistent evidence-based guidance, resources, tools and training; mandate the incorporation of stewardship education; develop audit and feedback tools; establish benchmarks and performance targets for stewardship; and conduct timely evaluation of stewardship programs.

Conclusion: Findings of this report will inform a more systematic approach to addressing antimicrobial stewardship Canada-wide.

Affiliations

[1] Centre for Communicable Diseases and Infection Control, Public Health Agency of Canada, Ottawa, ON

[2] Office of the Chief Medical Officer of Health, Edmonton, AB

[3] See Acknowledgements section for a full list of Task Group members

***Correspondence:** jacqueline.arthur@phac-aspc.gc.ca

Suggested citation: Khan F, Arthur J, Maidment L, Blue D on behalf of the 2015 Communicable and Infectious Disease Steering Committee (CIDSC) Antimicrobial Use (AMU) Stewardship Task Group. Advancing antimicrobial stewardship: Summary of the 2015 CIDSC Report. Can Comm Dis Rep. 2016;42(11):238-41.

Introduction

Antimicrobial resistance (AMR) is recognized as an increasingly significant global health issue that threatens the effective prevention, control and treatment of a wide spectrum of infections. In Canada, the emergence of antimicrobial resistant organisms has been identified as a major concern in health care settings and among at-risk populations. Since AMR may emerge in bacteria as a response to selective antimicrobial pressure (i.e., when bacteria is in the presence of an antimicrobial drug), there is a potential risk that fewer and fewer antimicrobials will remain effective in the future. Unnecessary antibiotic treatment has been shown to account for a substantial burden of inappropriate antimicrobial use in Canada (1-4). Due to growing concern about the link between antimicrobial usage (AMU) and AMR, a shift towards more prudent use of antimicrobials has been one of the areas emphasized in combatting the spread of AMR (5-8).

Antimicrobial stewardship is the responsible planning and management of resources in order to prevent and moderate the development of AMR. Antimicrobial stewardship initiatives and related programs typically address issues related to AMU in order to limit the spread of AMR and conserve the effectiveness of existing antimicrobials. Stewardship is applied in different settings and can also encompass activities outside the human health sector in a One Health model. The Report recognized that parallel action is needed in veterinary, food animal health and in the agriculture sectors; however, its focus was limited to human health settings.

The Pan-Canadian Public Health Network (PHN) represents Canada's national public health infrastructure to address such public health concerns. In 2014/2015, the PHN began identifying components of a pan-Canadian public health framework on AMR, focusing its attention on the key elements of stewardship pertaining to AMU in human health. The Communicable and Infectious Disease Steering Committee (CIDSC) Task Group on Antimicrobial Use Stewardship was mandated by the CIDSC under PHN to identify core components of a pan-Canadian stewardship approach, identify key challenges and gaps and recommend ways to promote stewardship across jurisdictions.

The objective of this article is to summarize the *CIDSC Task Group Report on Antimicrobial Use Stewardship* (9), which identifies the core components of antimicrobial stewardship programs and best practices in human health settings in Canada, highlights the challenges and gaps and presents a series of recommendations to advance antimicrobial stewardship in Canada.

Methods

The Antimicrobial Use Stewardship Task Group was composed of infectious disease experts, family and other clinical physicians, epidemiologists, microbiologists and public health experts. Search strategies were developed to identify scientific literature, grey literature and relevant websites on antimicrobial stewardship and were supplemented by additional information provided by members. Material was reviewed, and based on this evidence, expert opinion and consensus-building, the Task Group identified core components, best practices, key challenges and gaps and developed recommendations to advance stewardship in Canada.

Results

The search strategies resulted in over 400 articles which were reviewed and summarized for discussion by the Task Group. For the purposes of the Report, antimicrobial stewardship was defined as "coordinated interventions designed to promote, improve, monitor and evaluate the judicious use of antimicrobials in order to preserve their future effectiveness and promote and protect human health" (9,10).

Core components

Promising stewardship programs suggest that strong interdisciplinary public health action and political engagement can lead to a measurable decrease in AMR and improved optimal AMU in health care settings. While more research is clearly needed to validate this and related findings in community settings, four core components of promising antimicrobial stewardship programs and initiatives emerged: leadership, interventions, monitoring and evaluation and research (**Table 1**).

Table 1: Description of the four core components of antimicrobial stewardship

Core component	Description
Leadership	Successful stewardship undertakings are grounded in accountability, appropriate and sustained resources and expertise, adequate support and training and involve specialists in an interdisciplinary manner.
Interventions	Effective stewardship interventions are multipronged and comprehensive. They consist of awareness, education and guidance. Furthermore, they include various tools such as diagnostic tools, providing evidence-based timely information and engaging multiple target groups for maximum effect.
Monitoring and evaluation	To establish the appropriate use of antimicrobials, the literature consistently identifies the critical role of benchmarks, audit and evaluation systems.
Future research	Includes knowledge creation, translation and mobilization. Expertise from across research disciplines must be leveraged in order to address information gaps and ensure that evidence is available and applied for greatest impact.

Initiatives and best practices

The Task Group identified successful stewardship programs that had been evaluated both within Canada and from other countries. The Canadian initiatives are summarized in **Table 2**. After reviewing these programs, the Task Group concluded that strong interdisciplinary public health action and political engagement can lead to a measurable decrease in AMR and improved optimal AMU in health care settings.

Table 2: Examples of best practices for antimicrobial stewardship in Canada[1]

Level of intervention and name	Program description	Outcome
Alberta and British Columbia Do Bugs Need Drugs? (Initiated in Grande Prairie, Alberta) (7)	The program has a dual focus: to provide educational resources to physicians, nurses and pharmacists in community hospitals and long-term care facilities; and to provide public education on AMR risk and AMU to the general public.	A multimedia approach using print materials, advertising campaigns and continuing education and awareness for all ages and a variety of health professionals results in a positive reach to many target audiences.
Quebec Multipronged educational strategy on antibiotic prescribing	Guidelines were disseminated using a multidisciplinary and mostly web-based strategy, including having downloadable versions on a dedicated website and promotion by professionals and experts during educational events.	Concise, user-friendly science-based guidelines prepared by credible organizations, endorsed by professional organizations and actively promoted have a significant impact on reducing inappropriate antimicrobial prescribing practices in the community.

Table 2 continued

Level of intervention and name	Program description	Outcome
Ontario Treating respiratory infections in the community	A community-wide, multidisciplinary educational strategy was used in Ontario with the objectives of enhancing adoption of clinical guidelines and improving AMU.	Elements of success were the development of user-friendly and credible materials, education of the public, pharmacists and clinicians and support given to motivated local health professionals in coordinating educational elements.
Ontario Reducing *C. difficile* in Intensive Care Units (Initiated in Mount Sinai Hospital, Toronto, ON)	The main intervention techniques were the use of an infectious disease physician or pharmacist leader, the distribution of relevant in-hospital educational materials to health care professionals, then prospective audit and feedback in the Intensive Care Units.	Key success factors were appropriate human resources for effective leadership, decision support, prospective audit and feedback, as well as knowledge exchange via peer-to-peer communication.

[1] These are highlights of only some of the programs in Canada. For a more complete list of initiatives in both Canada and abroad, refer to the full Report (9)

Key challenges and knowledge gaps

After identifying the core components of effective stewardship and reviewing successful stewardship programs and initiatives, important challenges and knowledge gaps emerged in the Task Group discussion (**Table 3**). For example, the success and sustainability of stewardship undertakings require appropriate and sustained resourcing and expertise (something which may not always be possible in a given setting or jurisdiction) and gaps exist concerning treatment guidance, its benefits, how to implement it, as well as ensuring accessibility, standardization and consistency of use among professionals.

Table 3: Current challenges and gaps in antimicrobial stewardship

Challenges
Appropriate resourcing: The success and sustainability of stewardship undertakings requires appropriate and sustained resourcing and, in particular, appropriate expertise (something which may not always be possible in a given setting or jurisdiction).
Access and consistency of guidelines: Canadian physicians have reported difficulty locating relevant resources regarding AMR in general and regarding testing protocols. Different guideline documents are available for different prescribing professionals.
Follow up of effectiveness of treatments/programs: Integration of test-of-cure (re-culturing at the site of infection to determine if infection is still present) into guidance documents. The lack of standardized indicators makes it difficult to determine the effectiveness of the programs/campaigns.
Gaps
Lack of training: Educational and training initiatives regarding stewardship targeted at all prescribing professionals are needed.
Identifying when not to prescribe: More research is required to determine whether producing prescriber guidance on when not to prescribe antibiotics would be beneficial and how to implement it.
Need for rapid diagnosis: Rapid point-of-care diagnostic tools that distinguish bacterial from viral infections and identify and characterize resistant bacteria are needed to guide appropriate use of antimicrobials.

Recommendations

Based on the core components, best practices, current challenges and gaps, the Task Group developed recommendations to advance antimicrobial stewardship in Canada (**Table 4**). Implementation of the Report recommendations will need to take into account current developments in the policy and program research domains.

Table 4: Recommendations to CIDSC for core components of antimicrobial stewardship practices in Canada

Core component	Recommendation(s) to CIDSC
Leadership	A National infrastructure (e.g., governance, network, resources, etc.) be put in place to support provinces and territories in the development of stewardship programs in both health care and community settings.
Interventions	Best practices, benchmarks or standards for education and awareness activities that require the engagement of multiple prescribers, and have a dual focus on prescribers and users. The consistency and availability of guidance; information, tools and training for prescribing professionals and users be comprehensive, available and consistent to support local prescribers. Universities, colleges and technical schools that train future prescribers incorporate mandatory stewardship education and continuing education curricula for prescribing professionals.
Monitoring and evaluation	Evidence-based audit and feedback tools be developed to support prescribers and that guidance for prescribers be evaluated, adapted and implemented at regional and local levels Benchmarks be established for optimal antimicrobial use by type of infection and populations at greatest risk for infection and that jurisdictions work together to establish performance targets for stewardship in hospital and other settings; and that timely evaluations of stewardship programs be conducted and publicly accessible.
Future research	Further evidence about prescribing behaviours of professionals be collected, shared and mobilized so that specific interventions for these professions can be implemented. Changes be made to health care practitioners' practice regulations and that further evidence will need to be gathered to guide and support such changes.

The Task Group also identified two additional considerations. First, that patient safety, avoidance of unwanted side effects and effective infection prevention and control practices are all important factors further contributing to antimicrobial stewardship initiatives. Second, the Task Group suggested that the evaluation of stewardship programs and initiatives be promoted with granting agencies and be considered for inclusion as part of AMU/AMR priorities for funding.

Conclusion

The Task Group identified that leadership, appropriate interventions, monitoring and evaluation, the need for more knowledge about effective stewardship—and the evidence-base that will advance it—are key components of promising antimicrobial stewardship programs and initiatives. There are a number of key challenges and existing knowledge gaps that can be addressed by the Task Group recommendations that have been put forward. These are currently under consideration by governments and health care experts.

Better managing antimicrobial use is a shared responsibility among multiple stakeholders including public health and health care professionals, health care organizations, local, provincial, territorial, national governments, the research community and others who provide and use antimicrobials and who care for the people who use them. The development, promotion and implementation of initiatives to promote optimal use of antimicrobials across Canada will require collaboration among all of these stakeholders, helping to create synergies that will effectively combat AMR.

Acknowledgements

The authors gratefully acknowledge the 2015 CIDSC Task Group on AMU Stewardship members for their contributions and expert advice:

Dean Blue (Co-Chair), Office of the Chief Medical Officer of Health, Alberta; John Conly, Alberta Health Services and University of Calgary; Gary Garber, Public Health Ontario; Greg German, Health Prince Edward Island; Melissa Helferty, Ministry of Health and Long Term Care, Ontario; David Patrick, British Columbia Centre for Disease Control; Jeff Powis, Michael Garron Hospital, Toronto ON; Richard Rusk, Manitoba Health, Seniors and Active Living; Nadine Sicard, ministère de la Santé et des Services sociaux, QC

Public Health Agency of Canada: Kanchana Amaratunga, Jacqueline Arthur (Secretariat), Christine Cryan (Secretariat), Monika Dankova, Rita Finley, Katie Freer (until August 2015), Robert Gervais, Edward Gertler, Leanne Maidment (Co-Chair), Stephanie Mehta (Secretariat), Valerie Sarazin (Secretariat – until July 2015), Shari Silber (Secretariat), Christine N. Soon, Deepika Sriram (Secretariat – until October 2015), Geneviève Tremblay (until August 2015)

Conflict of interest

None. Jacqueline Arthur is one of the Guest Editors for this issue and recused herself from taking editorial decisions on this manuscript. Editorial decisions were made by the Editor-in-Chief, Dr. Patricia Huston and the other Guest Editor Dr. Kanchana Amaratunga.

Funding

This work was supported by the Public Health Agency of Canada.

References

1. Wang E, Einarson T, Kellner J, Conly J. Antibiotic prescribing patterns for respiratory tract infections in preschool children in Saskatchewan: Evidence for overprescribing for viral syndromes. Clin Infect Dis. 1999;29:155-60.
2. Nicolle LE. Infection prevention issues in long-term care. Curr Opin Infect Dis. 2014;27(4):363–69.
3. Silver SA, Baillie L, Simor AE. Positive urine cultures: A major cause of inappropriate antimicrobial use in hospitals? Can J Infect Dis Med Microbiol. 2009;20(4):107–11.
4. Leis JA, Rebick GW, Daneman N, Wayne GL, Poutanen SM, Lo P, Larocque M, Shojania KG, McGeer A. Reducing antimicrobial therapy for asymptomatic bacteriuria among noncatheterized inpatients: A proof-of-concept study. Clin Infec Dis. 2014;58(7)980–3.
5. Moody J, Cosgrove SE, Olmsted RN, Septimus E, Aureden K, Oriola S. et al, Antimicrobial stewardship: A collaborative partnership between infection preventionists and health care epidemiologists. Am J Infect Control. 2012;40:94–5.
6. McKay RM, Vrbova L, Fuertes E, Chong M, David S, Dreher K et al. Evaluation of the Do Bugs Need Drugs Program in British Columbia: Can we curb antibiotic prescribing? Can J Infect Dis Med Microbiol. 2011;22(1):19–24.
7. Carson M, Patrick DM. Do Bugs Need Drugs? A community education program for the wise use of antibiotics. Can Comm Dis Rep. 2015;41(Suppl 4):5–9. Available from: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/15vol41/dr-rm41s-4/overview-apercu_01-eng.php.
8. British Columbia Centre for Disease Control [Internet]. Do Bugs Need Drugs? Annual evaluation report 2013/14. Vancouver BC: BCCDC; 2014. Available from: http://www.bccdc.ca/NR/rdonlyres/2CE3760F-4A41-4F7E-89DC-2F8CD39A6F92/0/201314DBNDAnnualEvaluationReport_FINAL_amended.pdf.
9. Pan-Canadian Public Health Network, The Communicable and Infectious Disease Steering Committee Task Group on Antimicrobial Use Stewardship [Internet]. Report to CIDSC: Antimicrobial Stewardship: Final Report to the Public Health Network Council. Ottawa ON: PHAC; Apr 2016. Available from: http://www.phn-rsp.ca/pubs/anstew-gestan/index-eng.php.
10. National Institute for Health and Care Excellence (NICE) [Internet]. UK Committee Task Group on Antimicrobial Use Stewardship. Antimicrobial Stewardship: Systems and Processes for Effective Antimicrobial Medicine Use. [updated: 2015 Aug 18; cited 2016 Oct 10]. Available from: https://www.nice.org.uk/guidance/ng15.

At United Nations (UN), global leaders commit to act on antimicrobial resistance

Source: Joint News release; September 21, 2016. Office of the President of the General Assembly, World Health Organization/ Food and Agriculture Organization/World Organization for Animal Health At United Nations (UN), global leaders commit to act on antimicrobial resistance: Collective effort to address a challenge to health, food security, and development. Available at: http://who.int/mediacentre/news/releases/2016/commitment-antimicrobial-resistance/en/. (Summary, accessed September 25, 2016).

World leaders today signalled an unprecedented level of attention to curb the spread of infections that are resistant to antimicrobial medicines. For the first time, Heads of State committed to taking a broad, coordinated approach to address the root causes of antimicrobial resistance (AMR) across multiple sectors, especially human health, animal health and agriculture. This is only the fourth time a health issue has been taken up by the UN General Assembly (the others were HIV, noncommunicable diseases, and Ebola). The high-level meeting was convened by the President of the 71st session of the UN General Assembly, H.E. Peter Thomson.

Countries reaffirmed their commitment to develop national action plans on AMR, based on the "Global Action Plan on Antimicrobial Resistance" — the blueprint for tackling AMR developed in 2015 by WHO in coordination with the Food and Agriculture Organization of the United Nations (FAO) and the World Organisation for Animal Health (OIE). Such plans are needed to understand the full scale of the problem and stop the misuse of antimicrobial medicines in human health, animal health and agriculture. Leaders recognized the need for stronger systems to monitor drug-resistant infections and the volume of antimicrobials used in humans, animals, and crops, as well as increased international cooperation and funding. They pledged to strengthen regulation of antimicrobials, improve knowledge and awareness, and promote best practices — as well as to foster innovative approaches using alternatives to antimicrobials and new technologies for diagnosis and vaccines.

"Antimicrobial resistance poses a fundamental threat to human health, development, and security. The commitments made today must now be translated into swift, effective, lifesaving actions across the human, animal, and environmental health sectors. We are running out of time," said Dr Margaret Chan, Director-General of WHO.

Common and life-threatening infections like pneumonia, gonorrhoea, and post-operative infections, as well as HIV, tuberculosis, and malaria are increasingly becoming untreatable because of AMR. Left unchecked, AMR is predicted to have significant social, health security, and economic repercussions that will seriously undermine the development of countries.

They stressed that affordability and access to existing and new antibiotics, vaccines and other medical tools should be a global priority and should take into account the needs of all countries.

Investigation of *Escherichia coli* harboring the *mcr-1* Resistance Gene - Connecticut 2016

Source: Vasquez AM, Montero N, Laughlin M, Dancy E, Melmed R, Sosa L, et al. Investigation of Escherichia coli harboring the mcr-1 Resistance Gene - Connecticut, 2016. Morb Mortal Wkly Rep. 2016 Sep 16;65(36):979-80. Available at: http://www.cdc.gov/mmwr/volumes/65/wr/mm6536e2.htm. (Summary, accessed September 25, 2016).

In 2015, scientists reported the emergence of the plasmid-encoded *mcr-1* gene conferring bacterial resistance to the antibiotic colistin, signaling potential emergence of a pandrug-resistant bacterium. In May 2016, *mcr-1*-positive *Escherichia coli* was first isolated from a specimen from a United States patient. In collaboration with Centers for Disease Control and Prevention (CDC), the Pennsylvania Department of Health conducted an investigation to guide contact tracing and swab screening for bacteria with the *mcr-1* gene in the patient's household and in two facilities where she had frequent, extensive, and prolonged (≥7 days) interactions with health care personnel. Transmission risk was stratified into higher-risk and lower-risk categories based on the nature and duration of contact. All 20 higher-risk contacts completed screening; among the 98 lower-risk contacts, 78 agreed to testing. To determine whether transmission was occurring between patients, the state health department offered to conduct point prevalence studies at the two high-risk facilities. One facility declined; the other offered testing to 18 patients residing in the same unit where the index patient had received care. Seven patients completed screening.

No bacteria with the *mcr-1* gene were detected among the 105 persons screened. In addition, no colistin-resistant organisms were detected among 51 ESBL-producing isolates prospectively collected over a 30-day period from the four facilities to which the index patient was admitted in 2016. These findings suggest that the risk for transmission from a colonized patient to otherwise healthy persons, including persons with substantial exposure to the patient, might be relatively low.

It is not known how the patient became colonized, especially in the absence of an epidemiologic link to known persons or places with identified *mcr-1*. Nonetheless, as more surveillance systems with broader testing are established, it is anticipated that *mcr-1* will be identified with increasing frequency. The emergence of these novel resistance mechanisms highlights the urgency of a more global and comprehensive approach to antimicrobial stewardship and preventing transmission of antibiotic-resistant pathogens between persons and institutions.

CCDR

CANADA COMMUNICABLE DISEASE REPORT

Public Health Agency of Canada
130 Colonnade Road
Address Locator 6503B
Ottawa, Ontario K1A 0K9
ccdr-rmtc@phac-aspc.gc.ca

To promote and protect the health of Canadians through leadership, partnership, innovation and action in public health.

Public Health Agency of Canada

Published by authority of the Minister of Health.

This publication is also available online at

http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/16vol42/index-eng.php

Également disponible en français sous le titre :
Relevé des maladies transmissibles au Canada