Antimicrobial stewardship: a Canadian perspective

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Abstract

Purpose – The purpose of this paper is to explore the current state of antimicrobial stewardship implementation and development within Canada at both a federal and provincial level.
Design/methodology/approach – Narrative review.
Findings – There have been several prominent conferences and reports in Canada regarding the development and implementation of antimicrobial stewardship programs over the past two decades. However, despite the knowledge that there is a need for standardization of programs across Canada with accurate mechanisms and infrastructure in place for implementation and evaluation of these programs, there is still a lack of consistency across the country. In addition pharmacy information regarding inpatient and outpatient antimicrobial use is not uniformly reliable. Recently, the Public Health Agency of Canada using the Pan-Canadian Public Health Network as a vehicle organized a task group to help facilitate the working relationships among the provincial, territorial and federal governments in terms of implementing antimicrobial stewardship programs. This network has the potential to enhance and standardize programs across the country.
Originality/value – This paper looks at Canadian policy regarding antimicrobial stewardship at a federal as well as provincial level. Historic conferences, reports and discussions are highlighted emphasizing the progressive changes over the past two decades and highlight many of the challenges that Canada continues to face.

Keywords Policy, Patient safety, Public health, Antimicrobial stewardship
Paper type Viewpoint

Introduction

One of the most concerning threats to public health is the rapid rise in rates of antimicrobial resistant organisms (ARO) (Centers for Disease Control, 2013; Huttner *et al.*, 2013). The inability to treat common infections caused by multiple or extensively drug resistant organisms has become a reality and is a serious threat to the treatment of infectious diseases on a global basis (Boucher *et al.*, 2009). This topic is frequently presented at international infectious diseases meetings and conferences and the World Health Organization (2015) recently released its global action plan on antimicrobial resistance which will hopefully galvanize a cohesive worldwide plan to combat this issue.

Healthcare institutions are places where extensive antibiotic usage occurs, albeit not always appropriately. Countries and facilities where there are limited controls on

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prescribing practices have been associated with higher reported frequencies of AROs (Pallares *et al.*, 1993). The economic burden associated with antimicrobial resistance is difficult to estimate and few reports have been published looking at modeling these costs (Birnbaum, 2003). While there is a lack of recent Canadian literature on healthcare costs associated with ARO vs antimicrobial sensitive organisms, in the USA it is estimated that the yearly cost of AROs to the American healthcare system ranges from $21-$34 billion (Filice *et al.*, 2010; Mauldin *et al.*, 2010; Roberts *et al.*, 2009).

The Pan-Canadian Public Health Network (PHN) is an intergovernmental agency that was developed to optimize public health management across Canada and enable the federal, provincial and territorial governments to work together in a strategic manner. Recently, in 2014-2015, the Public Health Agency of Canada (PHAC), using the PHN as a vehicle, began to establish elements of a framework for dealing with antimicrobial resistance. Priority has been placed on collection of data that would be used to create a surveillance system and on the necessary elements of antimicrobial use and stewardship in humans. A specific group within PHAC, the Communicable and Infectious Disease Steering Committee (CIDSC) was established to facilitate the planning process.

Antimicrobial Stewardship can be viewed in a variety of ways and have different meanings to different healthcare providers, administrators and the general public. In Canada, antimicrobial stewardship is considered to be the responsible planning and management of resources in order to prevent and moderate the development of antimicrobial resistance (Public Health Agency of Canada, 2015a). The most recent report from CIDSC (Public Health Agency of Canada, 2015a) provides definitions of stewardship from the clinical, public health, systems and governance perspectives and can be referred to for definitions of all terms relevant to antimicrobial stewardship in Canada.

While there has been progress over the past two decades in Canada with respect to the development of antimicrobial stewardship techniques and strategies, there is still work required in using stewardship across the care continuum and developing a "Pan-Canadian" approach to stewardship that can be evaluated and measured in a standardized fashion. The aforementioned PHN and its task group shows promise in achieving these goals. The historic development process of antimicrobial resistance and stewardship in Canada will be presented in an effort to provide a unique perspective from which to gauge the future.

Background and national trends for ARO in Canada

In both Canada and worldwide there are several important AROs including methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin resistant enterococci (VRE), extended spectrum β-lactam (ESBL) resistant enteric gram-negative bacilli (*E.coli-Klebsiella-Enterobacter* species) and carbapenem resistant enterobacteriaceae.

In addition to these organisms, there are several other pathogens that have demonstrated antimicrobial resistance in Canada, including multi-resistant *Neisseria gonorrhoeae*, resistant *Shigella* and *Salmonella* species, and penicillin-resistant *Streptococcus pneumoniae* (PRSP). Some species such as ESBL producing gram-negative organisms are more common in community settings while MRSA and VRE have historically been found more frequently in healthcare settings. Over the last decade or more, community-associated MRSA strains are becoming more frequent and are altering the presence of strains found in hospital patients (Gardam, 2000; Gilbert *et al.*, 2006).

In recent years we have started to encounter nearly totally resistant microbes containing NDM-1. NDM-1 refers to New Delhi metallo-β-lactamase-1, which is an enzyme which creates resistance to one of our remaining class of antimicrobials, the carbapenems. The original description and designation of NDM-1 (Yong *et al.*, 2009) was in Sweden and a paper in *The Lancet Infectious Diseases* a year later described cases that were connected on a global basis (Kumarasamy *et al.*, 2010). There have been several reports of NDM-1 from Canada, including from the provinces of Alberta, British Columbia and Ontario (Mulvey *et al.*, 2011; Peirano *et al.*, 2011, 2014; Tijet *et al.*, 2011). An outbreak has been described in Edmonton, Alberta with multiple cases of both an NDM-1 containing *K. pneumoniae* and a multi-resistant *Acinetobacter* species with associated morbidity and mortality (Chandran *et al.*, 2012).

The proportion of *S. aureus* infections reported as MRSA varies tremendously between the USA and Canada: in 2012 in Canada the rate of MRSA infections across the country was 2.17 percent, in the USA it was 23.99 percent (Centers for Disease Control, 2014; Public Health Agency of Canada, 2015b). The Canadian Nosocomial Infection Surveillance Program (CNISP) is a collaborative effort of the Canadian Hospital Epidemiology Committee, a subcommittee of the Association of Medical Microbiology and Infectious Disease Canada and the Centre for Communicable Diseases and Infection Control of the PHAC. In 2014, CNISP released a summary of MRSA trends in Canada from 2008 to 2012 (Public Health Agency of Canada, 2014). Rates have been declining since 2008 with skin and soft tissue infections being the most common source of MRSA. Totally, 9 percent of patients with a non-bloodstream MRSA infection died and 25 percent of patients with MRSA in their bloodstream died within 30 days of the initial positive culture.

In Canada, there has been no documented resistance of MRSA to the antibiotics vancomycin, linezolid, daptomycin and tigecycline (Public Health Agency of Canada, 2014). In the USA, the 14th case of vancomycin resistant *S. aureus* (VRSA) since 2002 was reported in 2015 (Walters *et al.*, 2015). These resistant bacteria are thought to be caused by the transfer of vancomycin resistant genes from VRE to MRSA (Walters *et al.*, 2015). While VRSA has not been documented in Canada, the possibility for cases exists, especially if rates of MRSA and VRE were to increase, at least in part associated with antimicrobial usage.

The first isolate of VRE in Canada was reported in 1993 and the first outbreak, reported in the autumn of 1995 involving 38 patients, the majority of whom were receiving dialysis and were colonized rather than infected (Lior *et al.*, 1996). Since then, VRE has been recognized in all the provinces across Canada, predominantly as colonization of patients found on surveillance cultures. With a similar reporting system to that described for MRSA, the overall incidence rate of VRE infections per 10,000 patient days in 1999 was less than 0.1 (Public Health Agency of Canada, 2015c). More recent data from 2009 shows rate of VRE infections of 0.31 per 10,000 patient days within the CNISP. This number increased to 0.61 in 2012, but since then has declined and the most recent data from 2014 report 0.45 VRE infections per 10,000 patients days (Public Health Agency of Canada, 2015b). The increase seen in the 2000s was likely partially associated with the use of broad-spectrum antibiotics such as cephalosporins and vancomycin.

Penicillin had predictable activity against *S. pneumoniae* since its introduction in the 1940s but since the 1990s the susceptibility of *S. pneumoniae* has shifted. Canadian studies reveal that *S. pneumoniae* strains with reduced susceptibility to penicillin (both intermediate and high-level resistance) have increased and up to 5 percent of

isolates had high levels of penicillin resistance in the late 1990s and early 2000s, with the prevalence of penicillin-resistant pneumococci (PRSP) varying considerably across Canada, with higher rates in Ontario and Quebec (Zhanel *et al.*, 1999, 2003). More recently across Canada, average rates of penicillin resistance among *S. pneumoniae* have decreased from 12 percent in 2011 to 10 percent in 2013 (Public Health Agency of Canada, 2015c). As its use has increased over the years for pneumonia and respiratory infections, macrolide resistance has increased dramatically over the years globally and rates of up to 30 percent have been reported in Canada (Karlowsky *et al.*, 2009). Across Canada in 2013 resistance to clarithromycin was reported to be 25 percent (Public Health Agency of Canada, 2015c). Given this finding, knowledge of antimicrobial use during the three months before infection has been suggested as the key determinant for assessing appropriate therapy for a patient presenting to the hospital with an illness for which *S. pneumoniae* is a possible cause (Vanderkooi *et al.*, 2005).

The Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS) tracks certain bacteria that reside in the intestines of both humans and animals in order to better understand the impact of antimicrobial use and subsequent resistance. In 2013, resistance among *Salmonella typhi* reported from human infections increased to 18 percent compared to 10 percent in 2012 (Public Health Agency of Canada, 2015d).

PHAC also has established an Enhanced Surveillance of Antimicrobial Resistant Gonorrhea (ESAG) program. In 2012 and 2013, there were seven and eight isolates respectively, found to be resistant to azithromycin and to have reduced susceptibility to cephalosporins (Public Health Agency of Canada, 2015c). While these numbers are low, if they continue to rise, resistance does pose a threat to our currently successful treatment of gonorrhea with dual therapy.

Clostridium difficile infection (CDI) while not an ARO can be a severe life threatening illness and is commonly associated with antimicrobial use and often acquired during inpatient admissions to hospital. The use of antimicrobials disrupts the intestinal flora providing *C. difficile* with a competitive advantage (as it frequently resides in the human gut) and facilitating overgrowth. It is associated with considerable costs to the Canadian healthcare system with one model estimating the annual cost to society (based on 2012 data) at $281 million, as well as substantial impacts on patient quality of life (Levy *et al.*, 2015). In Canada, according to data from CNISP, there has been an increase in the CDI rates per 1,000 patient admissions from 2007 to 2011 (Public Health Agency of Canada, 2013), though these numbers seem to be stable recently. In the USA, the death rate from CDI has been increasing since 1999 (Goldstein *et al.*, 2015). A recent literature review completed by an expert panel from the USA and Canada found that ASPs were beneficial in reducing rates of CDI and its subsequent complications (Goldstein *et al.*, 2015).

Antimicrobial stewardship: a Canadian perspective

Canadian Consensus Conference 1997 stewardship recommendations

In 1997, the Canadian Consensus Conference entitled "Controlling antimicrobial resistance. An integrated action plan for Canadians," used the term "antimicrobial stewardship" in its proceedings and made recommendations regarding public information on the risks and benefits of antimicrobials and the need for surveillance data in order to detect when and where antimicrobial resistance was occurring. Plans of action were discussed for healthcare professionals and public health officials in order to determine if there was success with stewardship programs and strategies to overcome

obstacles with their creation and implementation. Their original recommendations, that remain highly relevant today, are as follows (Health Canada and the Canadian Infectious Diseases Society, 1997):

(1) "To identify structures and key human resources at the care-setting and (local) regional levels that are/will be most responsible for coordinating the care of clients/patients/consumers affected by antimicrobial resistant organisms."

(2) "To improve funding and access to expert resources on antibiotic use in all Canadian health care settings. This will be accomplished by the creation of expert panels to promote local antibiotic-use protocols and to provide case consultations as an adjunct to existing provincial/territorial or regional public health networks."

(3) "To establish antibiotic stewardship and antibiotic use teams in all Canadian hospitals by:
   - incorporating them into accreditation standards; and
   - obtaining support from the medical and administrative leadership."

(4) "To establish antimicrobial usage, monitoring, and intervention programs at the long-term care institutional level:
   - short term: monitoring of antimicrobial usage;
   - intermediate term: monitoring antimicrobial appropriateness; and
   - long term: optimizing antimicrobial use.

(5) "To reduce overall antimicrobial usage (prescriptions) by 25% within 3 years by focusing on community-acquired respiratory infection."

Antimicrobial stewardship in Canadian hospitals 1998

Following the 1997 Consensus Conference and recognizing the need to develop, operationalize and maintain ASPs in Canada, a series of one day seminars on antimicrobial stewardship were regionally organized across Canada. The goals of the seminar series were to provide strategies that would optimize antibiotic prescribing in the acute care setting. The results of these regional consultations were published in a supplement in the *Canadian Journal of Infectious Diseases* entitled "Antimicrobial stewardship in Canadian health care institutions." The articles in this supplement (Bachand, 1998; Blondel-Hill and Fryters, 1998; Brown, 1998; Embil and Harding, 1998; Louie and Read, 1998; Mederski, 1998; Pitre and Conly, 1998; Rau, 1998; Richardson and Griffiths, 1998; Rotstein *et al.*, 1998; Stiver, 1998) provided a "snapshot" of what approaches were being used across Canada and outlined the various strategies that included combinations of the following: restricted formularies, automatic substitutions, automatic stop orders, treatment or dosage guidelines, drug utilization reviews, step-down programs, mandatory consultations, use of antimicrobial handbooks, antimicrobial order forms, "cascade" susceptibility reporting and various educational programs.

National Policy Conference 2002 And National Action Plan 2004 antimicrobial stewardship recommendations

Additional recommendations for stewardship were highlighted in the Canadian "National Action Plan to Address Antibiotic Resistance" published in 2004 by the Canadian Committee on Antibiotic Resistance following the broad consultation process

from the 2002 National Policy Conference on Antibiotic Resistance. Several of the relevant recommendations from that conference, taken directly from the report, are outlined as followed:

> Implement measures to facilitate the collection, analysis and reporting of the quantity and distribution of antibiotics being used in our human health care system to compare with other jurisdictions and to facilitate the formulation of appropriate interventions (Recommendation 8).
>
> Implement measures to facilitate the collection, analysis and reporting of antibiotic use monitoring data to track the use of antibiotics for growth promotion, prophylaxis and therapy in agriculture and aquaculture to compare with other jurisdictions and to facilitate the formulation of appropriate interventions (Recommendation 9).
>
> Obtain, analyze and disseminate data/information on antibiotic use in humans and animals in a timely manner and present it in standard formats which can be used for comparison (e.g. Defined Daily Dose) (Recommendation 10).

Pan-Canadian stakeholder consultations on antimicrobial resistance 2009

The 2002 National Policy Conference recommendations on antimicrobial stewardship were also reiterated and further focussed within a document published by the Canadian Committee on Antimicrobial Resistance in September 2009 entitled "The Pan-Canadian Stakeholder Consultations on Antimicrobial Resistance" (Canadian Committee on Antimicrobial Resistance, 2009). This document highlighted some of the progress that had been made in antimicrobial stewardship over the preceding ten years but also pointed out considerable work was still required.

The report identified several challenges that needed to be addressed following their broad consultation process and input from experts in antimicrobial stewardship. These challenges are taken directly from the report and include the following:

- "Develop a universally agreed to definition and understanding of antimicrobial stewardship across the continuum of care."
- "Develop a coordinated integrated inter-disciplinary Pan-Canadian approach to antimicrobial stewardship."
- "Develop and promote public and professional awareness of antimicrobial stewardship responsibilities and concerns."
- "Ensure that antimicrobial use is based on best available evidence."
- "Develop a comprehensive way of measuring antimicrobial use that is consistent across Canada across the continuum of care, and across sectors."

The report suggested the following solutions:

(1) "Creation of a National Antimicrobial Resistance Stewardship Working Group with broad stakeholder engagement to set standard guidelines:
   - involved setting goals and objectives; and
   - exploration of formalizing stewardship through policy setting and legislation."

(2) "Communication, Education and Enforcement:
   - central clearing house for information, education;
   - interdisciplinary forums;

- training of antimicrobial steward specialists; and
- employ enforcement through Accreditation Canada, legislation on the distinctiveness of antimicrobials, modify patent legislation, make Pharma responsible for ecologic collateral damage and tighten legislation for animal usage."

(3) "Surveillance:

- standardize measurement tools;
- develop real time feedback loop to prescribers; and
- promote research gap analysis."

Accreditation Canada required organizational practice under medication use on antimicrobial stewardship 2012

Antimicrobial Stewardship became a "Required Organizational Practice" for assessment in all organizations providing inpatient services in Canada in January, 2013 (Accreditation Canada, 2014). It was suggested that an ASP be comprehensive and evidence based, and a number of potential interventions were suggested including prospective audit and feedback, formulary of targeted antimicrobials and approved indications, education, guidelines and clinical pathways, antimicrobial order forms, dose optimization and parenteral to oral conversion. There were four major tests of institutional compliance with the required practice, and they are as follows:

(1) "The organization implements an antimicrobial stewardship program."

(2) "The program includes lines of accountability for implementation."

(3) "The program is inter-disciplinary involving pharmacists, infectious diseases physicians, infection control specialists, physicians, microbiology staff, nursing staff, hospital administrators, and information system specialists, as available and appropriate."

(4) "The program includes interventions to optimize antimicrobial use that may include audit and feedback, a formulary of targeted antimicrobials and approved indications, education, antimicrobial order forms, guidelines and clinical pathways for antimicrobial utilization, strategies for streamlining or de-escalation of therapy, dose optimization, and parenteral to oral conversion of antimicrobials (where appropriate)."

Selected provincial initiatives

There are many provincial initiatives which have been directed toward ASPs. An education program based in the community called "Do Bugs Need Drugs?" (Blondel-Hill, 2014) was initiated as a pilot program in Grand Prairie, Alberta, Canada in 1998-1999. The focus of this program was to provide educational resources to physicians, nurses and pharmacists in community hospitals and long-term care facilities, and to provide public education on antimicrobial resistance and the use of antimicrobials. This program has had an ongoing campaign encompassing multimedia approaches, print materials and continuing education. More recently, the provincial health authority, Alberta Health Services, has established a provincial program in stewardship that is administered through its five health zones. A clear vision and

mission statement and discrete objectives have been established. Future initiatives focus on having real time site-based information on antimicrobial utilization, prospective audit and feedback at larger sites, expanded use of support tools to aid clinicians in making appropriate prescribing choices (Bugs & Drugs© and Spectrum Calgary© smartphone app) and fostering the role of innovative enablers of stewardship (Alberta Health Services, 2016).

The "Do Bugs Need Drugs?" program was later adopted by British Columbia, and in long-term care centers in Alberta. There has been a reduction in antibiotic prescribing for respiratory tract infections in children in British Columbia since its induction (McKay *et al.*, 2011). There was also increased public knowledge of hand washing and awareness that viral infections do not require antibiotics.

In Quebec an educational strategy on antibiotic prescribing was implemented following an increase of CDI in the province. This was a series of user-friendly guidelines on when to prescribe antibiotics that were disseminated in a multidisciplinary and web-based approach. Following the use of these guidelines, in the post-intervention period, the total number of prescriptions per 1,000 population was 10.5 percent lower in 2007 than in 2003 (471 vs 526 per 1,000 population), while there was very little change in the other Canadian provinces (652 vs 643 per 1,000 population) (Weiss *et al.*, 2011).

In Ontario, Public Health Ontario implemented a series of workshops around the province from May to June, 2014 to provide support to various organizations to help them develop and sustain their ASPs. Several initiatives have been supported by the Ontario Agency for Health Protection and Promotion and the Ontario Ministry of Health and Long-Term Care with both a survey of activities on the state of antimicrobial stewardship in Ontario hospitals, and a major Consensus Conference held on planning for antimicrobial stewardship (Institute for Safe Medication Practices Canada, 2009). The major thrust of the final report was that hospitals should implement antimicrobial stewardship programs rather than committees and focus on six priority interventions:

(1) implementation of ASPs at the hospital level;

(2) antimicrobial stewardship activities scorecard;

(3) prospective audit with intervention and feedback at an individual patient and prescriber level;

(4) education/training needed to build antimicrobial stewardship capacity;

(5) data collection and feedback at an institutional or program level; and

(6) tailoring antimicrobial therapy including de-escalation, streamlining and IV to PO switches.

The report also commented on the consensus of participants to have dedicated human resources, ongoing education and training, timely access to quality data, appropriate IT support and measurement as a key component from which to judge progress. The next step was to implement these interventions using a sample of hospitals as a pilot study, and this is currently under discussion. Multiple sites within Ontario have ASPs targeting prescribing professionals and the goal of antimicrobial use reduction. The main interventions used are prospective audit and feedback, and use of infectious diseases physicians and pharmacists (Mount Sinai Hospital and the University Health Network, 2015).

Components of an antimicrobial stewardship program in Canada and its organization

The components of an ASP have been described in the literature. The Infectious Diseases Society of America and the Society for Healthcare Epidemiology of America have outlined their suggestions and emphasized the importance of basing programs on local resistance patterns and available resources (Dellit *et al.*, 2007).

Their recommendations are widely recognized and provide the foundation for the structure of ASPs in Canada. Some of the suggestions include creating a multidisciplinary antimicrobial stewardship team where there is collaboration between the team and hospital infection control and pharmacy. Hospital administration should also be involved to ensure corroboration at every level.

The two core strategies suggested to provide the foundation for an ASP are prospective audit with intervention and feedback, and formulary restriction and preauthorization.

Infrastructure available in Canada

In order to ensure effective programs, there must be processes in place to measure and monitor antimicrobial use in both acute care facilities and the community, and there must be infrastructure to support this. In Canada, hospital pharmacies have variable information and reporting systems that can make it difficult to collect standardized inpatient drug utilization information.

Data can be obtained from public and private sector clinical microbiology laboratories, and there are certain "marker" organisms that are collected across Canada in regional, provincial and national databases.

The National Microbiology Laboratory of the PHAC adds microbiologic expertise to research and surveillance of AROs. They provide support to provincial public health laboratories and hospitals to help confirm resistance to antimicrobials, they support outbreak investigations they conduct research to identify new technologies and methodologies that can influence antibiotic use and recognize resistant bacteria (Public Health Agency of Canada, 2015c). The Laboratory for Foodborne Zoonoses helps to identify public health risks of antibiotic resistance that arise through the interactions of humans, animals and the environment (Public Health Agency of Canada, 2015c).

Databases that are used for surveillance are CIPARS for animal and food-related organisms as mentioned previously. In addition the program selects bacteria taken from farms, meat processing plants, retail food sources and humans. They collect data and information in order to support the creation of evidence-based programs for enforcing responsible use of antibiotics in humans, animals and agriculture. They also identify mechanism to reduce spread of ARO among humans, animals and food (Public Health Agency of Canada, 2015c).

The CNISP network, with 62 hospitals from ten provinces currently participating in this surveillance network (Public Health Agency of Canada, 2015c) collects national data on hospital-acquired AROs through its participating hospitals and healthcare facilities.

There is also the ESAG designed to collect data on antibiotic resistant gonorrhoea and the Canadian Tuberculosis Laboratory Surveillance System that collects data on susceptibilities of tuberculosis isolates (Public Health Agency of Canada, 2015c) which adds to the surveillance systems available in Canada.

Within each province at various sites, there are Infection Prevention and Control Surveillance Units that collect specific ARO and *C. difficile* data. However, these surveillance systems are not standardized across the country.

Implementation of stewardship in Canada

In order to properly implement successful ASPs across Canada there will need to be standardization of processes. Healthcare facilities will require strong programs with multidisciplinary support, appropriate resources, training and support. There will need to be "buy-in" at every level from the front-line workers to hospital administration. Programs should include surveillance, education and effective use of guidelines and knowledge as well as a mechanism for evaluation the efficiency of such programs. Now that there is more involvement federally through the PHAC using the PHN and the CDISC task force, as mentioned previously, there is a potential for much greater expansion of ASPs across the country.

It has been recognized and addressed by the Chief Public Health Officer of Canada that AMR is a serious and increasing issue (Public Health Agency of Canada, 2015c). The recent creation of the Canadian Antimicrobial Resistance Surveillance System (CARSS) aims to provide an integrated national component to strengthening our surveillance system. Something that is critical to understanding the problem we are faced with. The 2015 CARSS report referenced several times throughout this narration (Public Health Agency of Canada, 2015c) was the initial step. It is a complete report on antimicrobial use and resistance using information from multiple Canadian surveillance systems and laboratory services, and is the first of its kind in Canada.

CARSS has been established to be a Pan-Canadian resource for surveillance of AROs. CARSS will oversee federal surveillance activities and their transformation as needs evolve. They will share this information across the country with all the provinces and territories, responding to needs identified by all internal and external stakeholders, hopefully providing a unifying approach to surveillance and stewardship. The surveillance information gleaned by CARSS can be used to create evidence-based action and responses within ASPs. This federal action plan is a promising step in unifying the information available to all the provinces and territories that they can use when creating goals for their ASPs based off of confirmed needs.

The structure of ASP implementation within each province and territory will depend on the organization of the healthcare delivery systems. Many Canadian provinces and territories are divided into healthcare regions (zones) or authorities. In these jurisdictions, the most practical strategy for implementation of ASPs would be in a regional or zonal implementation. Data collection could then be consistent across health regions and reported at a provincial/territorial level in order to better facilitate standardization.

Sharing of information and successful ASPs, as well as obstacles encountered across health regions or authorities, provinces/territories will also facilitate the implementation of successful ASP across the country.

Conclusions

There are still many gaps in knowledge and difficulty in implementing standardized ASPs across Canada. Since the initial conference on antimicrobial resistance in 1997 in which there was a discrete focus on stewardship, it has been clear that surveillance, education, implementation and standard evaluation of programs are critical for successful ASPs. However, many of these elements have still not been well established in many jurisdictions across Canada. While several provinces and territories have some programs in place there is no standardization, and collection of inpatient and outpatient antimicrobial use is certainly not consistent. Implementation of ASPs particularly in outpatient settings is difficult. There is often no pharmacy

support or expert opinion from practitioners experienced in ASPs in the community. Certain behaviors of antimicrobial prescribing often become ingrained based in part on patient expectations. These behaviors are difficult to alter when there is a lack of formalized outpatient programs.

The CIDSC report has made several recommendations that hopefully will help to facilitate creation of programs across Canada as well as enhanced surveillance and evaluation. Some of their recommendations for the future are the creation of a national infrastructure through public health programs to support provinces and territories in their efforts to develop effective ASPs, an increase in education tools for both medication prescribers and users; and mandatory education regarding antimicrobial stewardship in universities, colleges and technical schools.

Some of the greatest difficulties in Canada in creating ASPs are a lack of consistency in data collection and program funding availability. The recent development of CARRS and CIDSC will hopefully help provide availability of surveillance information nationally and implementation of standardized, evidence-based ASPs across Canada. However, a lack of financial resources to implement these programs as well as provide support for ASP pharmacists and infectious diseases physicians remains a challenge. Another issue encountered is in creating national databases for surveillance. Federal surveillance systems rely on input from medical care facilities in all provinces and territories, however, the federal government does not regulate protocols for healthcare surveillance within the different provinces/territories. Therefore, it can be difficult to obtain consistent information across the country.

There is also a paucity of formal standardized methods to evaluate ASPs thus making it difficult to know when programs are successful in implementing change and outcomes. Finally, a lack of literature on the impact of ASPs in changing outcomes of resistance renders it difficult to examine the cost-effectiveness of such programs which provides an ideal opportunity for future research.

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