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3 **Title page**
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6 **Title:** Landscape of Antimicrobial Stewardship Programs in Ontario, Canada
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Landscape of Antimicrobial Stewardship Programs in Ontario, Canada

Background:

Antimicrobial resistance is an important public health issue globally and in Canada. To understand the current state of antimicrobial stewardship in Ontario healthcare facilities, the Antimicrobial Stewardship Program (ASP) at Public Health Ontario (PHO) conducted a voluntary survey of hospitals in the province.

Methods:

The Ontario ASP Landscape survey was distributed online to hospitals targeting front-line ASP clinicians and was open for five weeks in fall 2016. Email and telephone reminders were used to encourage responses. Descriptive analysis was performed at an aggregate level and by hospital type. Mental Health and ambulatory sites were excluded.

Results:

The response rate was 74% (97/131 organizations). Of these, 93% have a formal ASP or are in the process of implementation. Just over half (56%) identified appropriate antibiotic use as part of the organization's quality improvement plan or as a strategic goal/priority. Half (50%) of ASPs do not have designated resources; those that do are under resourced with respect to physician and pharmacist staffing. The scope of ASP strategy implementation is variable however implementation of Infectious Disease Society of America (IDSA) recommended interventions such as prospective audit and feedback appears to have increased since 2013. Fifty-one percent of ASPs track defined daily dose (DDD), 56% track expenditures and 39% track days of therapy (DOT).

Conclusions:

Most Ontario hospitals have a formal ASP but there are opportunities for improvement. Future efforts should increase the priority of and improve resource allocation for ASPs so that programs can continue to grow in scope and impact.

Keywords: antimicrobial stewardship; antibiotic stewardship; antimicrobial stewardship programs; implementation; hospitals; Canada

Introduction

Antimicrobial resistance (AMR) is an important public health issue and has been highlighted as a serious global threat to human health.^{1,2} AMR has also been identified as an area of significant concern for the Government of Canada, the Ministry of Health and Long-Term Care of Ontario (MOHLTC) and Public Health Ontario (PHO).³

Antimicrobial Stewardship can be defined as coordinated interventions designed to improve and measure the appropriate use of antimicrobial agents by promoting the selection of the optimal antimicrobial drug regimen including dosing, duration of therapy, and route of administration.⁴ The main goals of an antimicrobial stewardship program (ASP) are to optimize clinical outcomes related to antimicrobial use while minimizing toxicity and other adverse events. ASPs also aim to reduce AMR in individual patients and in the population by limiting selective pressure on microbial populations through improved prescribing.

Since 2013, antimicrobial stewardship has been an Accreditation Canada Required Organizational Practice (ROP) for facilities providing inpatient acute care, inpatient cancer, inpatient rehabilitation and complex continuing care services (CCC).⁵ To help build, grow and enhance local ASPs, PHO compiled a comprehensive list of 32 antimicrobial stewardship tools, interventions and activities (“strategies”). These strategies are organized into five categories: prescribing guidance, clinical, microbiology-related, structural/process and formulary-related strategies and publically available online (<http://www.publichealthontario.ca/asp>).

While previous provincial surveys have found that the proportion of Ontario hospitals with ASPs increased over time, from being “rare” in 2007 to about 32% in 2011, there still exists significant opportunity for improvement in both the scope and maturity of hospital ASPs.⁶⁻⁸ To gain an understanding of the current landscape of hospital ASPs, how they have evolved since 2013 and barriers to further advancing ASPs, PHO conducted a voluntary survey of hospitals in fall 2016.

Methods

The Ontario ASP Landscape survey, developed by the PHO ASP based on previous surveys of hospital ASPs and with input from stakeholders, asked organizations about structural (program components and infrastructure) and strategic (program activities) elements of their ASP. The survey was piloted with a small number of individuals involved in hospital ASPs (e.g., pharmacists, program leads) and refined based on their feedback prior to dissemination. The survey was approved by ethics and privacy at PHO.

The survey was open for five weeks (September 19th – October 24th, 2016) and was administered online using FluidSurveys (www.fluidsurveys.com). Respondents also had an option to complete the questions on paper and fax their completed survey.

This survey was distributed to all hospitals with the instructions that it should be completed by the individual responsible for antimicrobial stewardship in their organization and that there should be only one response per organization unless there are multiple sites and submission of site-specific responses

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3 was desired. Any sites that identified as primarily providing mental health or ambulatory services were
4 excluded from the analysis as ASPs are not a ROP for this type of organization.
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7 To target those responsible for antimicrobial stewardship, a distribution list was created based on a
8 hospital organization list from the MOHLTC Health Analytics branch, PHO contacts known to be involved
9 with antimicrobial stewardship with their organization, the Antimicrobial Stewardship Hospital
10 Pharmacists of Ontario Network distribution list (an independent email distribution list of stewardship
11 and ID pharmacist in Ontario hospitals) and with assistance from PHO Infection Prevention and Control
12 regional teams. An invitation to participate was distributed via email. Targeted email and telephone
13 reminders were used to encourage response rates. There were no monetary incentives offered for
14 participation.
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18 The survey had 29 questions and adaptive questioning was used to simplify the survey; only
19 respondents who reported having a formal ASP were presented questions about program structure but
20 all respondents were presented questions about ASP strategies since many of these activities can be
21 implemented in the absence of a formal ASP. All respondents were asked whether or not each strategy
22 had been implemented at their organization and, if so, the year of implementation. A definition of each
23 strategy was included in the survey and respondents were directed to the PHO website for further
24 details. The survey also included questions about challenges to implementing or advancing local
25 stewardship programs. Efforts were made to eliminate unintended duplicate responses for
26 organizations/sites by contacting the organization to determine which response should be used.
27 Incomplete responses were included after following-up with the hospital and clarifying. Hospital type
28 was classified as per Ontario Hospital Association (OHA) definitions.⁹ If an organization/corporation had
29 multiple sites, classification was by largest hospital type.
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35 Descriptive statistics were calculated using Microsoft Excel 2010 (Version 14.0.6024.1000). The
36 methodology of this survey has been reported according to criteria specific to online surveys.¹⁰
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39 **Results**

40 **Hospital Characteristics**

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42 Ninety-seven of 131 eligible hospital organizations responded resulting in a 74% overall response rate.
43 The responses were primarily completed by physicians or pharmacists directly involved in antimicrobial
44 stewardship activities. Small community hospitals had the lowest response rate (61%) while acute
45 teaching hospitals had the highest response rate (91%). Of those that responded, 88% (85/97) reported
46 having a formal ASP, 5% (5/97) were in the process of implementation and 7% (7/97) did not have a
47 formal ASP. Just over half of formal ASPs were established in 2013 or earlier; the vast majority of these
48 were in acute teaching and large community hospitals.
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53 **ASP Structural Elements in Ontario**

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55 Almost all hospital organizations with a formal ASP (85) or in the process of implementing one (5) have a
56 multidisciplinary Antimicrobial Stewardship Committee (82%, 74/90), physician (87%, 78/90) and
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3 pharmacist champions (97%, 87/90). Of these hospital ASPs, 70% (63/90) have guidance documents
4 that help direct program development. Over half (56%, 46/90) include appropriate antibiotic use as part
5 of their organization's quality improvement plan or as an organizational strategic goal or priority.
6 Twenty-one percent of respondents identified lack of prioritization of appropriate antibiotic use as a
7 barrier to moving their ASP forwards.
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11 Half of organizations with a formal ASP or in the process of implementing one (50%, 45/90) reported not
12 having any designated funding/resources for their program. More acute teaching hospitals reported
13 having designated resources as compared with the other hospital types. Only three small community
14 and two CCC and Rehabilitation hospitals reported having designated resources; two of these had
15 resources specifically allocated for an ASP physician and/or pharmacist. Few organizations (11%, 5/45)
16 reported having dedicated resources for Information Technology professionals or other
17 administrative/program support. A number of respondents submitted comments identifying resource
18 constraints as a significant barrier to advancing their ASP. Table 3 describes physician and pharmacist
19 resource allocation in further detail for acute teaching and large community hospitals.
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23 **Implementation of Antimicrobial Stewardship Strategies**

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25 Table 4 shows the frequency of antimicrobial stewardship strategies that have been implemented in
26 Ontario hospitals as of 2016. The most frequently implemented strategies are therapeutic drug
27 monitoring (86%), antibiograms (81%) and automatic stop orders (80%). Figure 1 shows the
28 implementation of selected stewardship strategies in 2013 compared with 2016. These selected
29 strategies reflect PHO ASP strategies most closely aligned with the Infectious Diseases Society of
30 America (IDSA) recommendations for implementation of an antibiotic stewardship program. These
31 strategies were designated as strong recommendations with moderate quality evidence for the general
32 adult in-patient population.¹²
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37 **Measuring ASP Impact**

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39 With respect to antimicrobial utilization, 56% of ASPs in Ontario hospitals measure expenditures, 51%
40 track defined daily doses (DDD) and 39% track days of therapy (DOT). ASP interventions and acceptance
41 rates are tracked by 57% and 44% of hospitals respectively. Many hospitals also include tracking of
42 antimicrobial resistance (77%) and rates of *C.difficile* infection (74%) as part of their antimicrobial
43 stewardship activities. One third (33%) of respondents identified lack of ability to report ASP metrics and
44 nearly two-thirds (64%) cited work effort required to report ASP metrics as ongoing challenges to
45 advancing their local ASP.
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49 **DISCUSSION**

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51 Antimicrobial resistance has been recently highlighted to be a serious risk to human health globally. As a
52 result, there has been increased interest in antimicrobial stewardship as a mitigating strategy for
53 reducing the overall burden of AMR. In Canada, because hospitals electing to undergo accreditation with
54 Accreditation Canada are required to demonstrate that an ASP is in place to optimize antimicrobial use,
55 it is not surprising to see that implementation of ASPs has increased from very few hospitals having a
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3 formal program in 2007 to almost all either having implemented or in the process of implementing
4 formal ASPs by 2016.⁶ Of these, just over half (56%) of programs were established in 2013 or earlier,
5 with the majority of these more mature programs being in acute teaching and large community
6 hospitals.
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10 The detailed nature of this survey provides significant insight into the current state of ASP structure in
11 Ontario hospitals as well as areas for growth. Elevating the priority and visibility of ASPs and optimizing
12 resource allocation for hospital ASPs are two such opportunities: 56% (46/88) reported that appropriate
13 antibiotic use is a strategic goal, priority or part of the organization's quality improvement plan, 44%
14 (40/90) had specific resources allocated for ASP physician(s) and/or pharmacist(s) FTEs. This is similar to
15 results of a recent national survey of over 4000 US Acute Care hospitals by the Centers for Disease
16 Control and Prevention (CDC)¹³, which found that in terms for hospital leadership commitment for
17 antibiotic stewardship, 52.6% had a written statement of support and 31.7% had salary support. These
18 results highlight the importance of leadership commitment in building robust programs: both written
19 statement of support and salary support independently predicted implementation of all seven CDC Core
20 Elements of Hospital ASPs, which are the recommended components for successful stewardship
21 programs. Unique to our survey are additional insights on the level of resource allocation for ASP
22 physicians(s) and pharmacist(s). In 2016, the Association of Medical Microbiology and Infectious Disease
23 (AMMI) Canada released business case recommendations for Inpatient Antimicrobial Stewardship
24 Programs in Acute Care, Cancer Care, Rehabilitation and Complex Continuing Care.¹⁴ For larger
25 institutions (acute teaching, large community), the recommendation is 1.0 physician and 3.0
26 pharmacists for every 1000 beds. For smaller institutions and CCC and rehabilitation hospitals, the
27 recommendation is that there be a minimum of 0.1 physicians and 0.3 pharmacists allocated. In
28 contrast, this survey found that acute teaching hospitals with designated resources (12/15) reported an
29 average of 0.57/1000 physician FTEs per 1000 beds and 2.16 pharmacist FTEs per 1000 beds ; large
30 community hospitals with designated resource (28/45) reported an average of 0.65 physician FTEs per
31 1000 beds and 2.55 pharmacist FTEs per 1000 beds. Only 3 of 28 small community hospitals and 2 of 11
32 CCC and Rehabilitation hospitals reported having any designated resources. In addition, AMMI Canada
33 also recommends designated resources for administrative/program support and data analysis which
34 very few organizations reported in this survey. Accordingly, there is significant opportunity for
35 improvement in resource allocation for hospital ASPs in Ontario.
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45 All respondents reported implementing one or more stewardship strategies whether or not they have a
46 formal ASP in place, however, the overall scope of implementation is variable. In 2016, the IDSA
47 released evidenced-based guidelines to implementing an antibiotic stewardship program which is a
48 helpful framework for highlighting a subset of the 32 PHO strategies. For the general adult in-patient
49 population, there are a number of strong recommendations with moderate-quality evidence that have
50 related PHO ASP strategies (Figure 1). It is encouraging to see that implementation of impactful
51 strategies such as prospective audit and feedback has increased over time and is now in place in the
52 majority of responding organizations.¹² Interestingly, the proportion of responding organizations that
53 have implemented prospective audit and feedback (65%) in this survey is very similar to that reported in
54 the CDC survey (63%).¹³
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3 Also consistent with the CDC survey is that measurement of program impact is an area for further
4 development. Tracking and reporting antibiotic utilization is considered a core component of hospital
5 ASPs yet a substantial proportion of respondents to our survey reported either lack of ability to report
6 ASP metrics or the work effort required to report ASP metrics as barriers to advancing ASP. The
7 proportion collecting defined daily dose (51%), antimicrobial expenditures (56%) and days of therapy
8 (39%) was very similar to the CDC survey which reported 60% using either purchase data or defined
9 daily dose and 37% measuring days of therapy.
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13 Whereas it is clear that individual hospital ASPs in Ontario need more infrastructure and support for
14 measurement of local program impact, this is also true at the provincial level. To effectively plan,
15 evaluate and strengthen antimicrobial stewardship programs on a systems level, the ability to compare
16 and benchmark antibiotic utilization is critical.^{15,16} Although a coordinated system for synthesizing and
17 benchmarking hospital antimicrobial use data in Ontario is not yet in place, the current heterogeneity in
18 antimicrobial utilization measurement and requirement for risk-adjustment will need to be addressed in
19 the future to support a meaningful region-wide antibiotic use surveillance program. For these reasons,
20 policy actions to encourage strengthening of individual hospital program measurement as well as efforts
21 to standardize and improve data quality are needed.
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26 While a key strength of this voluntary survey is the overall response rate of 74%, within range of
27 previously reported acceptable response rates (50-75%),¹⁷ there are several limitations that should be
28 noted. First, responses were self-reported and not externally validated. Small community hospitals were
29 under represented introducing potential bias towards organizations with formal and potentially more
30 well-established ASPs in the overall results. Another important limitation is that while organizations had
31 the option to submit site-specific responses, most were at the organizational level, therefore any
32 differences in how strategies are implemented at different sites within organizations were not captured.
33 Finally, since PHO's 32 antimicrobial stewardship strategies are not mutually exclusive, some overlap
34 and differences in interpretation should be expected despite descriptions being provided within the
35 survey. One example would be degree of implementation for a strategy such as allergy verification;
36 while many organizations may already have an established process for clarification and documentation
37 of allergy status some may not have indicated that they systematically implemented this strategy if they
38 were contemplating more advanced techniques such as penicillin skin testing. Furthermore, this survey
39 does not provide insight into the extent or fidelity of implementation of any given strategy. For example,
40 prospective audit and feedback can be operationalized in a variety of ways from rotating between
41 services to performing this intervention for all in-patients and details such as this was not captured in
42 this survey.
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49 Consistent the CDC survey,¹³ this survey suggests that many hospital ASPs in Ontario have established a
50 foundation for their ASP but additional senior leadership sponsorship including increased support for
51 program impact measurement will be required to advance stewardship programs to the next level. In
52 this survey, the impact of stewardship program elements on antimicrobial utilization or other outcomes
53 could not be determined. Further work is underway to explore the relationship between specific
54 structural and strategic elements on drug utilization in a subset of Ontario hospitals that chose to
55 participate in this follow-up study.
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In conclusion, while the majority of Ontario hospitals have a formal ASP, there remain significant opportunities for improvement. Future efforts should focus on ways to optimize resource allocation so that programs can continue to grow in scope.

Confidential

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Table 1. Characteristics of responding organizations

Characteristic	No. (%) of Responses (n=97)	Total No. (%) in Ontario* (N=131)
Hospital Type		
Acute Teaching	15 (15)	16 (12)
Large Community	44 (45)	57 (44)
Small Community	27 (28)	44 (34)
CCC & Rehab	11 (11)	14 (11)
Region**		
North	22 (23)	36 (27)
West	11 (11)	19 (15)
Central-West	14 (14)	18 (14)
Central	31 (32)	34 (26)
East	19 (20)	24 (18)
Organizations with >1 site***	38 (39)	-
Number of In-Patient Beds***		
>200	46 (47)	-
100-200	12 (12)	-
51-99	19 (20)	-
<50	20 (21)	-

*refers to hospital organizations excluding mental health and ambulatory

**defined according to PHO Regional Infection Prevention and Control (IPAC) office boundaries¹¹

*** this information was self-reported

Table 2: Presence formal antimicrobial stewardship programs by hospital type

Hospital Type	No. (%) with formal ASP	No. (%) in process of implementing a formal ASP
Acute Teaching (n=15)	14 (93)	-
Large Community (n=44)	41 (93)	-
Small Community (n=27)	21 (78)	4
CCC & Rehab (n=11)	9 (82)	1
Total (N=97)	85 (88)	5 (5)

Table 3. Resource allocation for acute teaching and large community hospital ASPs reporting designated resources

Hospital Type (n)*	No. (%) with Designated Resources for ASP	No. (%) with Resources allocated for ASP Physician and/or Pharmacist FTE	Average Physician FTE**	Average Pharmacist FTE**
Acute Teaching (n=14)	12 (86)	12 (86)	0.57/1000 beds	2.16/1000 beds
Large Community (n=41)	28 (68)	26 (63)	0.65/1000 beds	2.55/1000 beds

*n = number of responding organizations with formal ASP

**average full-time equivalent (FTE) calculation includes all hospitals reporting designated resources

Table 4. Frequency of Antimicrobial Stewardship Strategy Implementation

	% of Respondents				
	Acute Teaching (n=15)	Large Community (n=44)	Small Community (n=27)	CCC & Rehab (n=11)	Overall (n=97)
Prescribing Guidance Strategies					
Intravenous to oral conversion	73	82	63	45	71
Disease-specific treatment guidelines/pathways/algorithms and/or associated order forms	67	82	56	73	71
Empiric antibiotic prescribing guidelines	80	66	48	64	63
Prescriber education	87	68	33	45	59
Facilitation of appropriate and timely antimicrobial administration in severe sepsis/septic shock	47	55	33	9	42
Clinical decision support systems/computerized physician order entry	33	9	7	9	12
Clinical Strategies					
Therapeutic drug monitoring (with feedback)	80	89	85	82	86
Dose optimization	80	84	63	55	74
De-escalation and streamlining	73	70	59	45	65
Prospective audit with intervention and feedback	80	82	33	55	65
Targeted review of redundant therapy or therapeutic duplication	33	70	67	36	60
Identification of inappropriate pathogen/antimicrobial combinations ("bug-drug mismatch")	47	68	52	64	60

Targeted review of patients with <i>Clostridium difficile</i> infection	33	77	41	55	58
Preventing treatment of non-infectious conditions	40	59	26	27	43
Targeted review of patients with bacteremia/fungemia	47	55	26	18	41
Scheduled antimicrobial reassessments ("antibiotic time-outs")	27	36	26	18	30
Microbiology Related Strategies					
Antibiograms	93	93	70	45	81
Cascading microbiology susceptibility reporting	80	80	15	18	55
Strategic microbiology results reporting	80	70	26	27	55
Promotion of timely and appropriate microbiologic sampling	67	61	44	18	53
Improved diagnostics	80	57	30	18	49
Structural/Process Related Strategies					
Automatic stop orders	53	89	89	64	80
Drug use evaluation/medication use evaluation	60	52	41	64	52
Surgical antibiotic prophylaxis optimization	87	61	19	9	47
General antimicrobial order forms	7	32	30	36	28
Systematic antibiotic allergy verification	7	34	11	55	26
Improved antimicrobial documentation	13	23	22	36	23
Checklists	27	11	4	36	14
Formulary Related Strategies					
Formulary review/streamlining	67	80	85	45	75
Formulary automatic substitution/therapeutic interchange policies	67	84	67	36	71
Formulary restriction	73	59	41	36	54
Formulary restriction with preauthorization	40	34	15	27	29

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Figure 1. Comparison of selected antimicrobial stewardship strategies. Percentage of strategies implemented as of 2013 and 2016. Organizations that responded “not known” to year of implementation were excluded from this analysis.

