CONCISE COMMUNICATION

Canadian Pediatric Antimicrobial Stewardship Programs: Current Resources and Implementation Characteristics

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Antimicrobial stewardship programs (ASPs) became an accreditation requirement for Canadian hospitals in 2013. Pediatric programs are in various stages of program development and implementation, with 93% of surveyed Canadian academic pediatric hospitals having established ASPs. The programs varied in their team composition, implementation of stewardship strategies, and measured metrics.

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Up to 75% of hospitalized pediatric patients receive antibiotics,[1] and inappropriate use has been associated with unnecessary costs, avoidable adverse effects, and the development of infections with antibiotic-resistant organisms.[2] Seven years after the publication of guidelines for the development of institutional antimicrobial stewardship programs (ASPs),[3] Newland et al[4] found that 42.1% of freestanding children's hospitals in the United States had established comprehensive continuous ASPs with varying resources, structures, and approaches to stewardship. Of the remaining sites, 36% were in the process of developing a program.[4]

Antimicrobial stewardship became a required organization practice (ROP) in Canada for hospital accreditation in 2013.[5] The extent to which ASPs have been implemented in children's hospitals in Canada remains unknown. We sought to determine the team structure and resources allocated, strategies utilized, as well as quantitative and qualitative metrics utilized by ASPs in Canadian academic pediatric centers.

METHODS

Study Design

We conducted a cross-sectional survey of all 16 academic pediatric hospitals in Canada. The online survey was developed and study data were collected and managed using REDCap electronic data capture tools hosted at the Hospital for Sick Children.[6] Survey links were sent to the physician and pharmacy ASP leaders at each site, and any discrepancies between responses from the same center were resolved by contacting respondents directly. The project was approved as a Quality Improvement Project by the Quality and Risk Management Department at the Hospital for Sick Children, Toronto, Canada. The survey was initially distributed in May 2015, and the results were updated on January 24, 2017.

Survey

Infectious diseases (ID) physicians and pharmacists with direct experience in ASP development and management were involved in developing and piloting the survey. Questions were guided by published surveys regarding ASP implementation and guidelines for the development of hospital-based ASPs (Supplementary Material).

The ASP leaders were asked if their site had a formal ASP (as defined by the respondent) and when it was established. The multidisciplinary team composition, as well as previous ASP-specific training and funding for each ASP member (in full-time equivalents, FTE) was ascertained. Each respondent was also asked to indicate the types of antimicrobial stewardship strategies used within their hospital. Finally, process measures and metrics that were monitored at each site were collected.

Hospital Characteristics

Of the 16 children's hospital sites, 2 sites were freestanding hospitals, 3 hospitals were merged with a maternal health center, and the remainder were pediatric programs within larger adult medical centers. Hospital institutional information was collected from each site's corporate website and through direct contact with the ASP leader if more details were required.

Statistical Methods

The ASP characteristics from the updated survey (2017) were summarized using descriptive statistics. Univariable analyses were conducted using the Spearman correlation coefficient for continuous variables and the χ^2 or the Fisher exact test for dichotomous variables. Pearson correlations were calculated to determine the relationship between various hospital characteristics and total available FTE funding for ASPs and hospital-wide use of prospective audit and feedback (PAF). Statistical analyses were performed using SPSS Statistics for Macintosh, version 24.0 software (IBM, Armonk, NY). P values $< .05$ were considered statistically significant.

RESULTS

A total of 26 ASP leaders representing 15 of the 16 pediatric hospitals responded to the survey (institution response rate 94%). Respondents included ID physicians (n = 17, 65%) and pharmacists (n = 9, 35%), with 9 sites submitting > 1 survey.

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Less than half of the respondents had additional training in antimicrobial stewardship: physicians (n = 7, 41%) and pharmacists (n = 4, 44%). Hospital sizes ranged from 38 beds to 484 beds, including neonatal intensive care units (NICUs) and pediatric intensive care units (PICUs). All sites had a PICU and NICU; all sites performed pediatric surgeries; and 7 sites were transplant centers (Table 1).

ASP Development and Implementation

All but 1 hospital (n = 14, 93%) had an ASP by the time of the second survey in 2017. Among them, 3 ASPs were established between the first and second survey dates, and 5 ASPs existed prior to the implementation of the Accreditation Canada ROPs in 2013. All ASPs included an ID physician and most included both an ID physician and a dedicated pharmacist (n = 9, 64%). Of all the teams, 10 ASP teams (71%) were interdisciplinary; other team members included a microbiologist (n = 3, 21%), a data analyst (n = 3, 21%), or information technology (IT) support (n = 2, 14%). The amount of financial support for each ASP was also highly variable, with a median 0.7 FTEs (range, 0.0–1.8 FTE) being allocated overall to ASPs. Among sites reporting individual FTEs, there was a median ID physician FTE of 0.1 (range, 0.0–0.4 FTE) and median pharmacist FTE of 0.5 (range, 0–1.2 FTE). We observed a trend toward increased total combined FTE support with increasing hospital size, but this did not reach statistical significance ($P = .08$) (Table 1).

ASP Strategies

The most common ASP strategies used hospital-wide were clinical guidelines (n = 14, 93%), order sets (n = 12, 80%), and formulary restriction (n = 11, 73%). These 3 strategies were also the most commonly used in the PICU and NICU settings. Prospective audit and feedback (PAF) was used in at least 1 area in 8 hospitals (53%), including 5 sites using this strategy hospital-wide. We found no association between the number of hospital beds ($P = .29$), year of ASP inception ($P = .12$), total ASP FTE support ($P = .22$), ID physician FTE support ($P = .78$), or pharmacist FTE support ($P = .25$) and implementation of hospital-wide PAF (Figure 1).

ASP Metrics

In this study, 12 ASPs (86%) monitored antimicrobial usage using days of therapy (DOT) and/or cost (n = 12, 86%). Most programs monitored antimicrobial resistance (AMR) or had an antibiogram. All ASPs monitored *Clostridium difficile* infections (CDI), and 5 sites monitored additional antibiotic-related infections including methicillin-resistant *Staphylococcus aureus* (n = 3), vancomycin-resistant *Enterococcus* (n = 2), carbapenem-resistant *Enterobacteriaceae* (n = 1), and *Stenotrophomonas* (n = 1). Moreover, 8 sites (57%) monitored the documentation of ASP recommendations and/or adherence to ASP recommendations, and 11 ASPs (79%) had data management systems in place to track various metrics and process measures (Table 1).

DISCUSSION

To our knowledge, this survey is the first to document the implementation of ASPs and the current status of antimicrobial stewardship across Canadian academic pediatric centers. Four years after the implementation of Accreditation Canada standards to establish hospital ASPs, we found that 93% of hospitals represented by survey respondents had a formal ASP in place, but we detected significant variability in team composition, strategies used, and metrics monitored. Our results provide essential benchmarking information for centers planning to establish or expand programs, and they emphasize the need for standardized metrics for comparing antimicrobial use and the effects of ASPs between centers.

We observed significant variability in the amount of personnel support for the ASPs in our survey. The median overall total combined 0.7 FTE remained unchanged compared to 2015 when fewer formal ASPs existed. Our results indicated that more funding was generally available for pharmacists (median FTE, 0.5) than for physicians (median FTE, 0.1). Similarly, Newland et al[4] also reported that almost all established ASP teams included both a physician and a pharmacist. Furthermore, the median number of total FTE allotted to a program was 0.63 (range, 0.1–1.8 FTE), with physicians having a median FTE of 0.25 (range, 0.1–0.5 FTE), while pharmacists had a median FTE of 0.5 (range, 0.1–1.5 FTE).[4]

Overall, Canadian children's hospitals utilized at least 1 core recommended strategy (ie, prospective audit with intervention and feedback, formulary restriction, and preauthorization),[3,7] including one-third of sites that implemented hospital-wide PAF. In contrast, among surveyed US freestanding children's hospitals, these core strategies were implemented among 87% of hospitals, of which 21 sites used PAF.[4] The drivers influencing the adoption of certain strategies remain unclear. Our logistic regression analysis did not reveal any correlation between the use of hospital-wide PAF and hospital size or various characteristics of the ASPs.

Identification of measurable performance indicators that can be used to evaluate processes and outcomes of an ASP is an essential component of a successful ASP. In adults, commonly used ASP metrics include DOT, defined daily doses, antimicrobial costs, AMR, adverse events, and CDI.[8] However, some metrics may be less meaningful in the pediatric setting. We found significant variation in the metrics collected and monitored by pediatric ASPs across Canada. As such, there is a necessity for both a description of the best metrics to assess the impact of pediatric ASPs and publication of these findings for benchmarking and quality improvement initiatives.

Our high institutional response rate provides a broad overview of the pediatric inpatient ASP landscape in Canada, covering major metropolitan areas and representing a variety of hospital

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TABLE 1. Hospital and Antimicrobial Stewardship Program (ASP) Information for Participating Sites

Site	Formal ASP (Year)	ID MD FTE	Phm FTE	Other Members FTE	Formulary Restriction or Pre-Authorization[a]	Prospective Audit & Feedback[a]	Antimicrobial Use	Documentation[b]	Hospital Size (No. of Beds)	Transplant Center
1	Yes (2010)	0.4	1.0		Yes	Yes	DOT, cost	No	≥300	SOT & BMT
2	Yes (2015)	0.1	0.4		No	Yes	Cost	Yes	100–149	No
3	Yes (2011)	0.2	0.6	Data analyst (0.1) IT support (0.1) Microbiologist (0.1)	Yes	Yes	Cost	Yes	150–199	No
4	Yes (2014)	0.2	0.5		Yes	Yes	DOT, cost	Yes	150–199	No
5	Yes (2015)	0.2	No Phm		Yes	No	DOT	No	100–149	SOT & BMT
6	No[c]	N/A	N/A		Yes	No	N/A	N/A	100–149	SOT & BMT
7	Yes (2013)	0.3	1.2	Data analyst (0.2) Microbiologist (0.1)	No	Yes	DOT, cost	Yes	150–199	SOT & BMT
8	Yes (2014)	0.1	No Phm		Yes	No	Cost	Yes	100–149	No
9	Yes (2016)	0.3	0.5		Yes	No	DOT	No	200–249	SOT
10	Yes (N/A)	N/A	N/A	RN (FTE unknown) Microbiologist (FTE unknown)	Yes	Yes	DOT	Yes	≥300	SOT & BMT
11	Yes (2013)	0.1	0.1		Yes	No	No	No	100–149	SOT & BMT
12	Yes (2007)	0.1	0.5	Data analyst (0.1) IT support (0.1) Microbiologist (0.1)	Yes	Yes	DOT, cost	Yes	100–149	No
13	Yes (2014)	0.1	1.0		Yes	No	Cost	Yes	<100	No
14	Yes (2017)	0.0[d]	No Phm		No	Yes	No	No	<100	No
15	Yes (2014)	0.0[d]	No Phm		Yes	Yes	DOT	No	<100	No

NOTE. ID MD, infectious disease physician; FTE, full-time equivalent; BMT, bone marrow transplant; DOT, days of therapy; N/A, not available; IT, information technology; Phm, pharmacist; RN, registered nurse; SOT, solid organ transplant.

[a]Strategy used in any part of the hospital.

[b]Monitoring of either recommendations or adherence to recommendations.

[c]Previous 12-month pilot program using prospective audit/feedback with 0.6 Phm FTE (not permanently funded).

[d]ID MD involved but not funded.

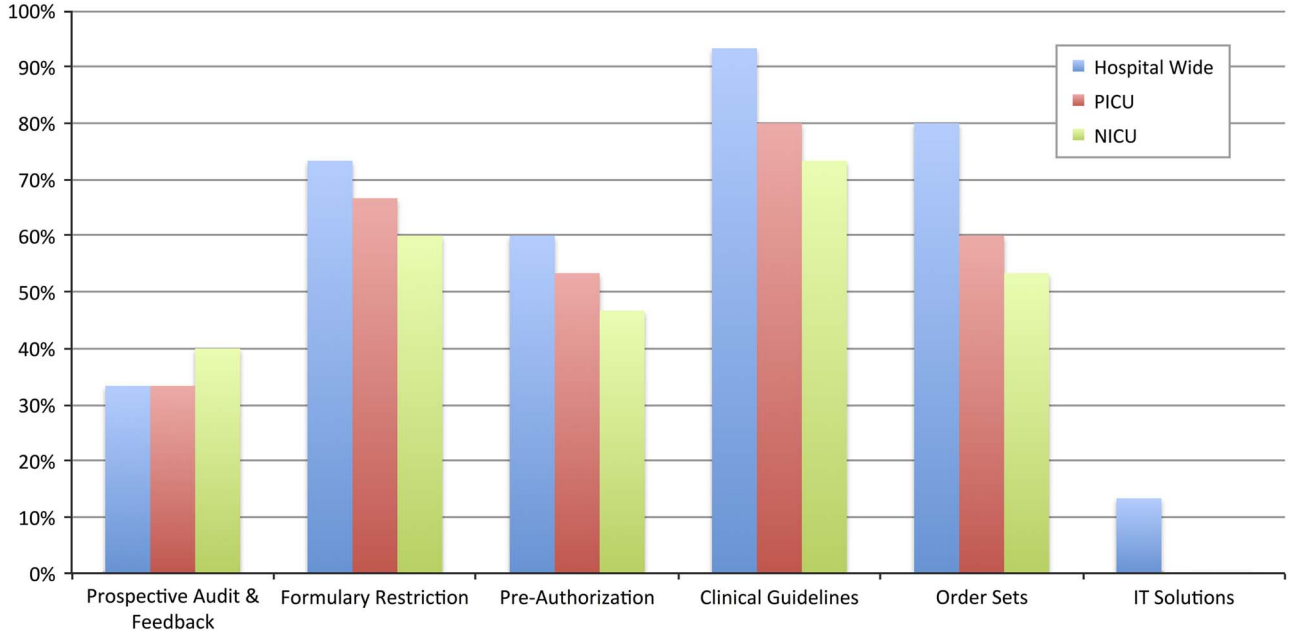


FIGURE 1. Summary of ASP Strategies/Models Across All Sites (N = 15)

funding models. However, our findings may not reflect the scenario for a substantial proportion of Canadian children admitted to other pediatric wards within adult hospitals, where stewardship practices may differ significantly. In addition to identifying optimal strategies and metrics for pediatric-specific antimicrobial stewardship, future studies need to assess the impact of Canadian pediatric ASPs and determine whether they are in line with emerging pediatric and adult literature that demonstrate improved prescribing patterns and patient outcomes (eg, institutional resistance patterns, fewer adverse events, and decreased antimicrobial costs).[8–10]

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SUPPLEMENTARY MATERIAL

To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2017.292

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