Original Article

Clinicians' Attitudes Towards an Antimicrobial Stewardship Program at a Children's Hospital

Leslie M. Stach,[1] Erin B. Hedican,[2,3] Joshua C. Herigon,[2,3] Mary Anne Jackson,[2,] and Jason G. Newland[2,3]

Departments of [1]Pharmacy, and, [2]Pediatrics, Section of Infectious Diseases, University of Missouri-Kansas City School of Medicine, Children's Mercy Hospitals and Clinics, and [3]Center for Clinical Effectiveness, Quality Improvement, Children's Mercy Hospitals and Clinics, Kansas City, Missouri

Corresponding Author: Jason G. Newland, MD, Section of Infectious Diseases, Children's Mercy Hospital and Clinics, 2401 Gillham Road, Kansas City, MO 64108. E-mail: jnewland1@cmh.edu.

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Background. In pediatrics, limited data are available on how to develop and implement an antimicrobial stewardship program (ASP). In addition, no data exist on clinicians' impression of such programs. The objectives of this study were to describe the development and implementation of an ASP in a children's hospital and to describe the thoughts and attitudes of the clinicians interacting with the ASP.

Methods. A qualitative description of the development and implementation of an ASP is provided. In addition, 2 years after the implementation of a prospective-audit-with-feedback ASP, an electronic survey was administered to clinicians to assess their attitudes toward the ASP.

Results. A 5-step process for developing this ASP included the following: team development; selecting the stewardship strategy(ies) and antimicrobials to monitor; establishing a method to identify patients; program evaluation; and implementation. Of 365 participants surveyed, 205 (56%) responded, and 80% (160 of 199) had never worked with an ASP before its implementation. Clinicians agreed that the ASP decreased inappropriate use of antibiotics (84%, 162 of 194), improved the quality of patient care (82%, 159 of 194), and provided knowledge and education about appropriate antibiotic use (91%, 177 of 194). Negative feelings regarding the ASP included the following: 11% (22 of 194) felt a loss of autonomy; 6% (12 of 194) felt that it interfered with clinical decision-making; and 5% (9 of 194) felt threatened. Clinicians thought that to further decrease inappropriate antibiotic use, guidelines of empiric antibiotic choices (80%, 152 of 189) should be developed, and better training in medical school and residency should be provided (80%, 152 of 189). Finally, our clinicians felt that the problem of antibiotic resistance and inappropriate antibiotic use was worse nationally than at our institution.

Conclusions. A prospective-audit-with-feedback ASP was successfully developed and implemented at a children's hospital. The ASP was perceived by clinicians to reduce inappropriate antibiotic use and to improve the quality of care of hospitalized children, with minimal loss of physician autonomy or interference in clinical decision-making.

Key words. Antimicrobial Stewardship; Implementation; Pediatrics; Survey

In 1941, penicillin was introduced into clinical medicine and was quickly viewed as a miracle drug. However, within 1 year of its initial use, bacteria were discovered that were resistant to this new drug [1]. Rapid development of bacterial resistance to penicillin represented what would become a common theme for

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antibiotic development and use. Over the next 70 years, as each new antibiotic has been introduced to clinical practice, resistant bacteria have emerged shortly thereafter [2]. Most recently, the identification of extensively resistant bacteria are threatening the effectiveness of our current antibiotic armamentarium [3, 4]. Clinicians now have a glimpse of what being a physician was like before the introduction of penicillin.

Although the pharmaceutical industry has lagged in the development of new antibiotics, resistance mechanisms in bacteria continue to expand and now include multidrug-resistant (MDR) *Acinetobacter* sp., MDR *Pseudomonas aeruginosa*, and vancomycin-resistant *Enterococcus* [5]. To help preserve the effectiveness of antibiotics, the Infectious Diseases Society of America (IDSA) and the Society of Healthcare Epidemiology of America published guidelines on the development of institutionally based antimicrobial stewardship programs (ASP) [6]. Due to the lack of data on pediatric ASPs, the guideline specifically requested that more research be done on the implementation and impact of ASP in children.

Although data exists on the impact of ASPs, a limited amount of information has been published on the process to develop and implement an ASP [7–11]. Furthermore, only 1 study has evaluated the impressions and attitudes of clinicians affected by such programs [12]. The objectives of our study were as follows: (1) to describe the structure and implementation process used in the development of a pediatric prospective-audit-with-feedback program at a tertiary care children's hospital, and (2) to assess pediatric clinicians' attitudes toward the program 2 years after its implementation.

METHODS

Study Design

A qualitative description of the steps taken to develop and implement the ASP are provided. In addition, an electronic survey was administered to assess the clinicians' attitudes regarding the ASP and its potential benefit after implementation of the ASP. This study was approved by the Institutional Review Board at Children's Mercy Hospitals and Clinics (CMH).

Setting

The ASP was developed at a 317 bed tertiary care, free-standing children's hospital that serves a 5-state, 100-county region. The hospital contains a 68-bed neonatal intensive care and a 27-bed pediatric intensive care unit. Approximately 15 000 admissions occur each year and include children with malignancy, complex congenital heart disease (600 annual open heart procedures), and those requiring liver, kidney, and bone marrow transplants. The medical staff comprises approximately 600 staff physicians. In addition, the hospital trains 100 residents and 65 fellows annually.

ASP Survey

The assessment of the clinicians' attitudes toward the ASP was obtained through an anonymous, electronic survey administered 2 years after the implementation of the program. The survey was offered to physicians, fellows, residents, and nurse practitioners affected by the actions of the ASP. The 29-question survey was designed by the medical director and pharmacist who developed the ASP. Clinicians were asked questions related to the following: the positive and negative impact of the ASP; how the ASP should interact with clinicians; ways to improve the program; and beliefs about the prevalence of antibiotic resistance. A 5-point Likert scale was used with options ranging from "Strongly agree" to "Strongly disagree." Strongly agree and agree were combined when the responses were dichotomized. The survey was distributed electronically on April 1, 2010, and 2 reminders were distributed via e-mail on April 14, 2010 and April 30, 2010.

Statistical Methods

Proportions were calculated for all responses, and 2-sample difference in proportion tests as well as χ^2 test were performed to identify significant differences in response rates. *P* values less than or equal to 0.05 were considered statistically significant. All statistical analyses were conducted using STATA, version 11.2.

RESULTS

ASP Development and Implementation

Plans to initiate an ASP began by seeking approval from the hospital administration. The Section Chief presented data from published papers on the potential clinical and financial benefit to the Chief Operating Officer of the institution. Approval was obtained, and negotiations resulted in 0.3 full-time equivalence (FTE) for an infectious diseases (ID) physician and 1 FTE for a clinical pharmacist. After obtaining administrative support for the ASP, a detailed plan and timeline were developed. The first step involved the formation of a multidisciplinary team. Core members of the ASP, an ID physician, and a pediatric residency-trained clinical pharmacist were hired 18 months before the ASP implementation. Infection preventionists and the Microbiology Director were consulted on the development of the ASP. Finally, a data analyst (0.5 FTE) was hired to conduct an ongoing evaluation of the program.

The second step was to determine the type of program to be developed and which antimicrobials to be monitored. A prospective-audit-with-feedback program was chosen as the core strategy because it is the preferred core strategy recommended by the IDSA guideline, and it was believed this method would have the greatest acceptance among the clinical staff [6]. The antibiotics chosen to be monitored included those recommended by the Centers for Disease Control's 12-step program to prevent antimicrobial resistance among hospitalized children and others chosen by the ASP director due to their broad-spectrum nature (Table 1) [13].

The third step involved determining the mechanism in which patients were going to be identified. The Information Systems Department was engaged, and a report was created in the electronic medical record (EMR) to identify patients who received 1 of the monitored antibiotics for 2 calendar days, the time when relevant culture data is available. The EMR report was easy to build and took from 2 to 15 minutes to populate. Testing of this report ensured that no patients were being missed. Finally, before implementing the program, the average number of patients to be reviewed daily was assessed.

Table 1. Antibiotics Monitored by the ASP

Extended spectrum cephalosporins	Ceftriaxone
	Cefotaxime
	Ceftazidime
	Cefepime
Carbapenems	Meropenem
	Imipenem/cilastatin
Fluoroquinolones	Ciprofloxacin
	Levofloxacin
	Moxifloxacin
Extended spectrum penicillins	Piperacillin/tazobactam
	Ticarcillin/clavulanate
Aminoglycosides	Tobramycin
	Amikacin
Anti-MRSA	Vancomycin
	Linezolid
	Daptomycin
Miscellaneous	Aztreonam
	Ampicillin/sulbactam
	Amoxicillin/clavulanate

Abbreviations: ASP, antimicrobial stewardship program; MRSA, methicillin-resistant *Staphylococcus aureus*.

The fourth step was to develop and implement an evaluation process for the program. Before the start of the program, a data collection form was created for each patient review that would capture information such as antibiotics being prescribed, dose of the antibiotic, indication for its use, recommendations made, and compliance with those recommendations. In addition, a mechanism to determine the days of therapy per 1000 patient days was identified [18]. The evaluation aspect of the program was further refined after program implementation by developing an electronic database for data collection.

The final step in implementing the program was communicating the goals and logistics of the ASP to the affected clinical services in the hospital. This was done through 3 mechanisms. First, a grand rounds presentation from a national expert was given to introduce the hospital to the concepts and mechanism of antimicrobial stewardship. Second, 6 months before the implementation of the program, the medical director and ID pharmacist met with each individual section and presented how the program would function, the goals of the program, and answered any questions related to the program. Finally, 1 week before the start of the program, flyers that described the program and listed the antibiotics that would be monitored were placed throughout the hospital.

ASP Daily Activities

The details of the logistics of the program are depicted in Figure 1. In this program, the clinical pharmacist reviewed the charts of patients populated in the EMR report to assess appropriateness of use of the antibiotic(s) administered. The review included pertinent history and physical findings, necessitating initiation of antibiotics such as culture data, radiographic findings, significant laboratory values, as well as dosing and intended duration.

Communication with the team/clinician was a key aspect of our program. After the clinical pharmacist's review and discussion with an ID physician, a recommendation was then communicated, generally in person, to the prescribing team or clinician. In some instances, clinicians disagreed with initial recommendations, so a compromise recommendation was determined and an agreement was reached. In addition, a

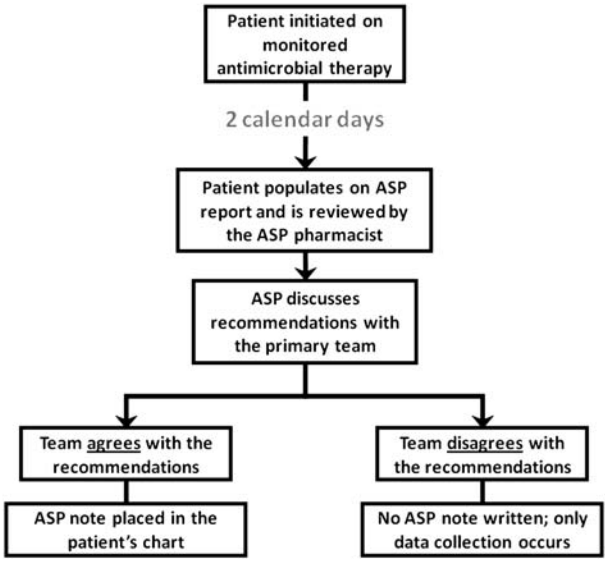

Figure 1. Depicts the logistics of the prospective-audit-with-feedback antimicrobial stewardship program developed and implemented at Children's Mercy Hospitals and Clinics. Abbreviation: ASP, antimicrobial stewardship program.

clinician may initially accept the ASP recommendation but not actually implement it. If it was determined that going against the ASP recommendation was a detriment to patient care, a repeated intervention was made. Agreement of the plan was documented in the patient chart to serve as a reminder to the physicians of the ASP recommendations. Compliance with the ASP's recommendations was captured.

Continued follow up of patients who presented on the daily report was not expected; however, in cases where susceptibilities were not available until a later date, the patients were continually monitored. In addition, if duration of a therapy was recommended, a check for discontinuation was performed.

ASP Survey

Of the 365 clinicians surveyed, 205 (56%) completed some aspect of the survey. Response rates in the groups of clinicians surveyed were as follows: 59% (98 of 166) of attending physicians, 38% (10 of 26) of fellows, 71% (71 of 101) of residents, and 36% (26 of 72) of nurse practitioners. The most common responders were female, attending physicians, and clinicians who have been employed at the hospital for 1 to 5 years. General pediatrics was the most common specialty that responded to the survey (Table 2). Previous exposure to antimicrobial stewardship was limited, because only 15% (29 of 199) of responders ever worked in an institution with a formal ASP. A definition of ASP was not provided to the clinicians; therefore, there may have been a variety of interpretations.

Table 2. Demographics of Respondents

	n = 205 (%)
Gender	
Female	130 (63)
Job description	
Attending physician	98 (48)
Resident physician	71 (35)
Nurse practitioner	26 (13)
Fellow physician	10 (5)
Years at hospital	
< 1 year	37 (18)
1–5 years	95 (46)
6–10 years	30 (15)
11–20 years	43 (21)
Years practicing medicine	
< 1 year	24 (12)
1–5 years	62 (30)
6–10 years	35 (17)
11–20 years	84 (41)
Primary specialty	
General pediatrics	95 (48)
Neonatology	25 (13)
Hospital medicine	18 (9)
Gastroenterology	12 (6)
Hematology/oncology	12 (6)
General surgery	11 (6)
Pediatric intensive care	8 (4)
Other*	24 (12)
Previous ASP exposure	*n* = 199
No	160 (80)
Frequency of interactions with ASP	*n* = 199
Once a week	42 (21)
Twice a week	33 (17)
Three times a week	23 (12)
Once every other week	34 (17)
Once a month	25 (13)
Less than once a month	20 (10)
Never	18 (9)

Abbreviations: ASP, antimicrobial stewardship program.
*Cardiology, otolaryngology, neurology, nephrology, pulmonology, infectious diseases.

Clinicians had a positive view of the ASP (Figure 2). Most agreed that the ASP had both improved the use (83%, 161 of 194) and decreased the inappropriate use (84%, 162 of 194) of antibiotics. Furthermore, 82% (161 of 194) agreed that the ASP had improved the quality of patient care. When asked if the ASP led to practice changes, 66% (124 of 189) believed this had occurred; residents were more likely to respond

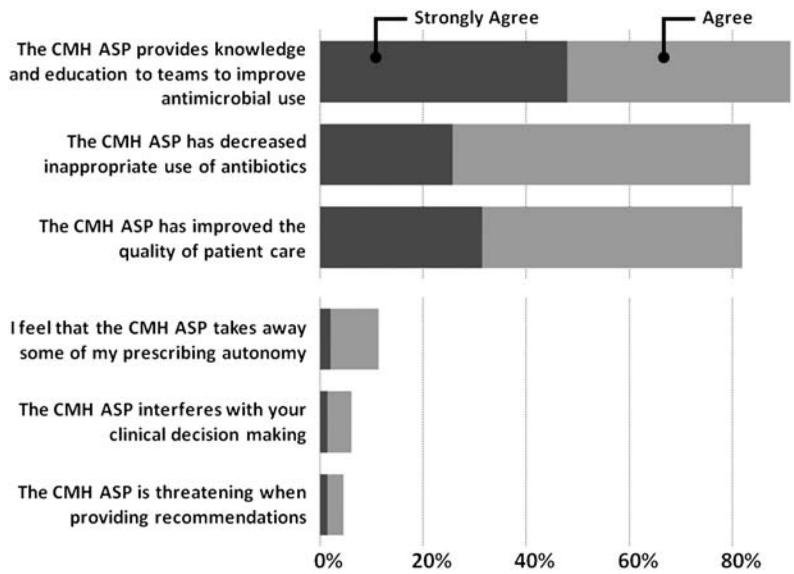

Figure 2. Positive and negative feelings of clinicians regarding the antimicrobial stewardship program. Abbreviations: ASP, antimicrobial stewardship program; CMH, Children's Mercy Hospitals and Clinics.

affirmatively to this statement than attending physicians (77% [50 of 65] vs 57% [54 of 94]; $P = .01$).

A major goal of the program was to provide education to those affected by the program. Among all clinicians, 90% (177 of 194) agreed that the ASP succeeded in this area. Among the residents and fellows, 96% (72 of 75) agreed that the program provided education vs 88% (86 of 98) of the attending physicians ($P = .062$). In addition, 83% (62 of 75) of residents and fellows felt more education on antibiotic use during residency would further aid in decreasing inappropriate antibiotic use.

We evaluated negative feelings that could exist in regards to the ASP (Figure 2). The most common negative feeling was the removal of prescriber autonomy (11%, 22 of 194). We identified that 6% (12 of 194) felt the ASP interfered with clinical decision-making and that 5% (9 of 194) of our respondents thought the program was threatening when providing recommendations. Only 3% (2 of 75) of the residents and fellows vs 7% (7 of 96) of the attending physicians felt the ASP was threatening ($P = .3$).

Because communication was a core value of our ASP, we sought to identify the best mechanisms in which to communicate with the clinicians and teams. We found that 61% (116 of 189) did not have a preference on whether the ID physician or pharmacist delivered the ASP recommendation. However, 23% (44 of 189) preferred the physician alone and 15% (29 of 189) preferred both the physician and pharmacist. No one chose ASP pharmacist alone. In terms of how the communication took place, most clinician (54%, 102 of 189) thought a page or a face-to-face interaction was appropriate. However, 40% (76 of 189) appreciated a face-to-face interaction. Time of day for interaction was not an issue for 65% (124 of 189) of responders, which suggested that before, during, or after rounds was acceptable. Finally, 74% (71 of 96) of the attending physicians felt it acceptable to be informed of ASP recommendations through the residents or nurse practitioners.

To develop additional mechanisms to improve the use of antibiotics, we asked respondents to select mechanisms that they thought would decrease inappropriate antibiotic use (Figure 3). The most common methods chosen were to develop empiric antibiotic guidelines (80%, 152 of 189) and to provide better training in medical school or residency (80%, 152 of 189). In particular, a majority (64%, 94 of 152) of the clinicians believed that better training in both medical school and residency would improve antimicrobial use versus medical school (6%, 9 of 152) or residency (32%, 49 of 152) alone ($P < .001$).

Finally, we assessed the perception of antibiotic resistance of our clinicians. Overall, 99% (195 of 196) of practitioners agreed that inappropriate use of antibiotics contributes to antimicrobial resistance. Antibiotic resistance was thought to be a problem in pediatrics more on the national level (100%, 196 of 196) than locally at CMH (88%, 173 of 196; $P < .001$). In regards to overuse of antibiotics, 97% (191 of 196) agreed that overuse was a problem in the

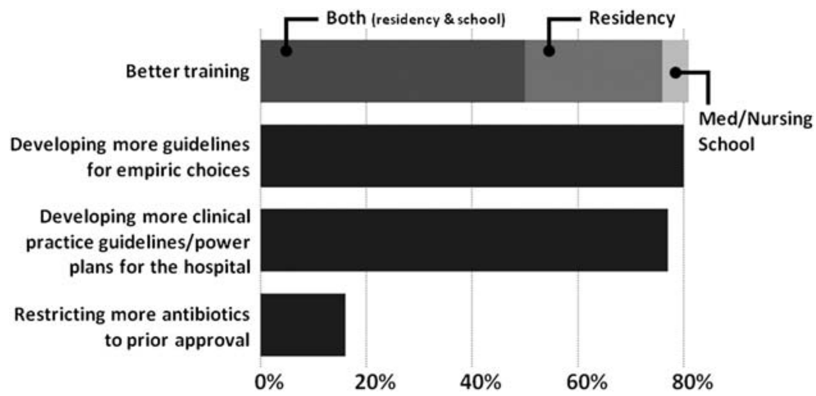

Figure 3. Clinicians' beliefs of the best strategies to decrease the inappropriate use of antibiotics. A clinician could choose more than one strategy.

United States, whereas only 62% (121 of 196) agreed that antibiotics are overused at CMH ($P < .001$).

DISCUSSION

Our investigation found positive attitudes towards our prospective-audit-with-feedback ASP among pediatricians directly impacted at our institution. Clinicians believed that the ASP improved the quality of care for hospitalized children, with minimal negative impact on clinical decision-making and autonomy. This is the first study in pediatrics to assess such attitudes among pediatric clinicians and to describe the steps necessary for developing and implementing a prospective-audit-with-feedback ASP.

Prospective-audit-with-feedback is the preferred core ASP strategy recommended by the IDSA [6]. Although studies have been performed in pediatrics demonstrating the benefit of a prospective-audit-with-feedback ASP on antibiotic use, none have described in depth the process needed to develop and implement a program [7, 14, 15]. We have illustrated 5 steps to be taken to start a program: (1) developing a team; (2) determining the stewardship strategy(ies) and antimicrobials to monitor; (3) establishing a method of identifying patients; (4) designing an evaluation of the program; and (5) implementing the program.

Many barriers have been identified to preclude the development of ASPs. Barriers reported in a survey of pediatric ID clinicians included a lack of funding, lack of time, and loss of prescriber autonomy [16]. In addition, this survey found that over one half of the hospitals planning an ASP believed that loss of prescriber autonomy was a significant barrier. Our study should be reassuring because the perceived loss of autonomy was minimal and the overall impression of the program was positive.

Although data are available in pediatrics on the clinical benefit of ASPs, we are unaware of any studies that assess the impressions of pediatricians who are affected by these programs [7, 10, 14, 15, 17]. A survey that evaluated neonatologists' views on antimicrobials identified only 15% who worked with an ASP. This study, although insightful on areas in which antimicrobial stewardship could be useful, did not evaluate the attitudes of those clinicians working with an ASP [8]. The only study in an adult institution evaluated 440 clinicians and pharmacists who practiced with a phone-based preauthorization program. Despite a different ASP design, results from this study were similar to our investigation: 89% of their clinicians believed that the ASP improved patient outcomes and only 19% felt a loss of autonomy [12].

An important finding in our study was the overall positive impression that clinicians had of the ASP; more than 80% of clinicians believed that the program was improving antibiotic use and improving the overall quality of care of hospitalized children. Data from our program support the improvement in antibiotic use because an average monthly decline of 18% has been realized for the antibiotics monitored by the ASP [18]. Improvement in the quality of care of hospitalized adult patients has been demonstrated as a result of ASPs. For example, adult institutions that have experienced an increase in the incidence of hospital-acquired *Clostridium difficile* infections have observed a marked decrease in this nosocomial infection after the implementation of an ASP [19–21]. In an era in which the Center for Medicaid Services focuses on developing innovative programs that reduce costs through better care, ASPs appear to be one type of program that is suitable to achieve such goals.

Communication was a focus area in the development and daily operations of the ASP. We were particularly interested in the mode of communication and found that although a majority of respondents thought that either a page or in-person communication was acceptable, 40% appreciated a face-to-face conversation about the ASP recommendations. Also, a majority of clinicians did not have a preference regarding the person (pharmacist or ID physician) who delivered the recommendation, but not a single respondent preferred to hear from the pharmacist alone. Previously, Gross et al [11] demonstrated that recommendations from a pharmacist-led ASP resulted in more appropriate recommendations, greater cure rates, and less treatment failures than recommendations from ID fellows. Our survey data, taken in context with this previous research, suggest that pharmacists are vital components for successful ASPs; however, support from an ID physician is also necessary.

A major goal of our program was to increase antimicrobial education among participating clinicians, including resident and fellow physicians. According to our survey, many of our staff agreed that our ASP had fulfilled this goal. In addition, data from our program show that the percentage of recommendations per month has significantly decreased, suggesting that education has occurred [18]. Both the residents and attending physicians believed that more education during medical school and residency would improve the use of antibiotics. In a study involving residents at an adult institution, 90% wanted more education on antibiotic use and 67% requested more feedback on their antibiotic choices [22]. These data illustrate 2 important points about education: (1) ASPs can provide needed education through its day-to-day operation, and (2) more formal education regarding antimicrobial use is wanted by trainees and attending physicians; ASPs should develop curricula to address this need.

In both pediatric and adult studies, antimicrobial use and resistance have been perceived as less problematic at the facility in which one currently works compared with other facilities or national data [8, 9, 22]. We found a similar attitude among our practitioners, because they believed that both resistance and antibiotic use were worse nationally than at our local institution. In our institution, the presence of an ASP likely gives some confidence that the antibiotic use and resistance is less of a problem, although this is only part of the explanation; this view was also observed in another study among clinicians who worked in institutions without ASPs [8]. Although it is human nature for individuals to have a more positive view of their own current situation, in regards to antibiotic use and resistance, we must remain vigilant in teaching that the continued use and misuse of antibiotics locally will affect antibiotic resistance.

This study has several limitations. The steps we used to implement our ASP may not be generalizable to other institutions, especially those that operate in larger adult systems. Although this information and our survey can give other institutions some guidance on how to develop an ASP, local knowledge of the institutional culture, clinicians' attitudes, and available resources are imperative to creating a successful ASP. In addition, it was not mandatory to answer all questions, and therefore some clinicians skipped questions. Finally, the response rate for this survey was not optimal, possibly leading to some response bias. However, because a response rate of approximately 60% or more was present in the 2 groups most likely to interact with the program—attending physicians and residents—we believe that the results provide a representative picture of those who are most affected by program activities.

CONCLUSIONS

A prospective-audit-with-feedback ASP was successfully developed and implemented at a tertiary care children's hospital. The ASP has been well received among the practicing clinicians, and they believe that it improves the quality of care of hospitalized children. Although each institution's ASPs are unique, this study provides insight into the development of these programs as well as the potential impressions from those who are affected by them.

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