


Original Article

Threatened efficiency not autonomy: Prescriber perceptions of an established pediatric antimicrobial stewardship program

Julia E. Szymczak PhD^{1,2} , Eimear Kitt MBBCh BAO (Hons)³, Molly Hayes PharmD⁴, Kathleen Chiotos MD, MSCE^{3,5}, Susan E. Coffin MD, MPH^{3,5,6}, Emily R. Schriver MS⁴, Ashley M. Patton BSN⁴, Talene A. Metjian PharmD⁴ and Jeffrey S. Gerber MD, PhD^{1,3,5}

¹Department of Biostatistics, Epidemiology and Informatics, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, ²Center for Clinical Epidemiology and Biostatistics, Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, ³Division of Infectious Diseases, The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, ⁴The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania, ⁵Center for Pediatric Clinical Effectiveness, The Children's Hospital of Philadelphia, Philadelphia, Pennsylvania and ⁶Division of Disease Control, Philadelphia Department of Public Health, Philadelphia, Pennsylvania

Abstract

Background: Implementing antimicrobial stewardship programs (ASPs) can be challenging due to prescriber resistance. Although barriers to implementing new ASPs have been identified, little is known about how prescribers perceive established programs. This information is critical to promoting the sustainability of ASPs.

Objective: To identify how prescribers perceive an established pediatric inpatient ASP that primarily utilizes prior authorization.

Methods: We conducted a cross-sectional survey administered from February through June 2017 in a large children's hospital. The survey contained closed- and open-ended questions. Descriptive statistics and thematic content analysis approaches were used to analyze responses.

Results: Of 394 prescribers invited, 160 (41%) responded. Prescribers had an overall favorable impression of the ASP, believing that it improves the quality of care (92.4% agree) and takes their judgment seriously (73.8%). The most common criticism of the ASP was that it threatened efficiency (26.0% agreed). In addition, 68.7% of respondents reported occasionally engaging in workarounds. Analysis of 133 free-text responses revealed that prescribers perceived that interacting with the ASP involved too many phone calls, caused communication breakdowns with the dispensing pharmacy, and led to gaps between approval and dispensing of antibiotics. Reasons given for workarounds included not wanting to change therapy that appears to be working, consultant disagreement with ASP recommendations, and the desire to do everything possible for patients.

Conclusions: Prescribers had a generally favorable opinion of an established ASP but found aspects to be inefficient. They reported engaging in workarounds occasionally for social and emotional reasons. Established ASPs should elicit feedback from frontline prescribers to optimize program impact.

(Received 7 November 2018; accepted 24 February 2019)

The implementation of antimicrobial stewardship programs (ASPs) is paramount to the optimization of antibiotic use in hospitalized children.^{1,2} Children's hospitals in the United States are increasingly implementing stewardship activities. In a 2011 national survey of 38 children's hospitals, 16 (38%) had a formal ASP and 15 (36%) were in the process of implementation.³ When this survey was repeated in 2016 with 52 children's hospitals, 49 (94%) reported having a formal ASP.⁴

The urgency surrounding the need for ASPs and the rapid increase in their number has stimulated research into the barriers to implementing these programs.^{5–8} Implementation is stymied by prescriber resistance due to a fear of threatened autonomy,^{9–11}

a hierarchical hospital culture,^{8,12} inadequate information technology resources,⁵ lack of dedicated personnel,⁹ and lack of leadership support.¹³ Most research on implementation in antimicrobial stewardship focuses on the experiences of new programs. We know less about prescriber perceptions of established ASPs. This information is critical to optimizing the ongoing impact of ASPs.

To investigate this issue, we conducted a cross-sectional survey of prescribers at a large freestanding children's hospital with one of the oldest pediatric ASPs in the United States. The objective of the study was to examine prescriber perceptions of the utility, efficiency, and value of the ASP.

Methods

Study design, sample, and recruitment

We conducted a cross-sectional survey of physicians and advanced practice providers (APPs) working at the Children's Hospital of

Author for correspondence: Julia E. Szymczak, Email: jszymcza@penmedicine.upenn.edu

Cite this article: Szymczak JE, et al. (2019). Threatened efficiency not autonomy: Prescriber perceptions of an established pediatric antimicrobial stewardship program. *Infection Control & Hospital Epidemiology*, 40: 522–527, <https://doi.org/10.1017/ice.2019.47>

Philadelphia (CHOP). Respondents eligible for inclusion included all physicians (attending physicians, fellows, and resident physicians) and APPs (ie, certified registered nurse practitioners [NPs] and physician assistants [PAs]) working at the hospital.

CHOP has had an ASP for 15 years.¹⁴ It is primarily a prior authorization program with >50 targeted formulary antimicrobials that require ASP approval prior to use, in addition to all non-formulary and inhaled antimicrobials. Prescribers are required to contact the ASP for antimicrobial approval from 7:00 AM to 10:00 PM daily. They are allowed to order all antimicrobials overnight without approval but must contact the ASP the following morning for approval of subsequent doses. Approvals are conducted by 2 full-time ASP pharmacists Monday through Friday, 9:00 AM to 5:00 PM. Infectious diseases (ID) fellows perform approvals from 7:00 AM to 9:00 AM and from 5:00 PM to 10:00 PM, Monday through Friday and on weekends and holidays. Antibiotic approvals are communicated to the pharmacy through a note placed in the patient's electronic medical record. Since 2012, the ASP pharmacists have performed daily audits with feedback for antimicrobials administered >72 hours (ie, "time out" recommendation). Infectious diseases attending physicians provide second review on antimicrobials that are not approved.

The survey was administered via research electronic data capture from February through June 2017.¹⁵ Respondents were recruited via e-mail. The survey was voluntary and no incentive was offered for participation. Reminder e-mails were sent 3 times during the study period. Respondents were made aware that the survey was being administered by the CHOP ASP team to inform improvement work. Because the study was undertaken as a quality improvement effort, the study was deemed exempt from institutional review board approval.

Survey instrument

Our survey instrument was designed in 2 stages. First, we conducted formative interviews with 15 prescribers. Second, we reviewed previous survey research on prescriber perceptions of the ASP.^{16–19} We identified thematic domains around which we designed our fixed-response survey questions, including knowledge of the ASP, perception of antibiotic approval mechanisms, frequency and reasons for working around ASP approvals, perception of value of the ASP, perception of communication with ASP staff, and level of trust in ASP recommendations. Once drafted, we circulated the instrument to a convenience sample of 7 physicians for comment on question comprehensibility and length. Modifications were made based on this feedback. The final instrument included 43 closed-ended questions, 18 open-ended prompts for respondents to further elaborate their answer to a closed-ended question, and 4 stand-alone open-ended questions. Closed-ended questions utilized 4- and 5-point Likert-type scales as well as true/false answer choices (see supplemental material online for survey instrument). All questions were optional.

Data analysis

Quantitative data were analyzed using Stata statistical software.²⁰ Descriptive statistics (frequencies, percentages, means, and SDs) were used to summarize the fixed-response questions. For survey items that were categorical in nature, clinician responses are presented as frequencies, and comparisons were made using the χ^2 test of significance at the level of $P < .05$. We collapsed ratings of "occasionally" with "rarely" and "strongly agree" with "agree" and "strongly disagree" with "disagree" for clarity of presentation.

Free-text responses were entered into NVivo 12 software for analysis.²¹ Two coders identified recurrent patterns in the data, developed codes, and applied them across the dataset in a process of line-by-line document review. Inter-coder reliability was periodically assessed, and disagreements were resolved by consensus.

Results

Respondents

Of 394 recipients, 160 (41%) completed the survey. Of all respondents, 46 (28.8%) were attending physicians, 43 (26.8%) were general pediatrics residents, 25 (15.6%) were fellow physicians, and 46 (28.8%) were advanced practice providers. Both general and subspecialist pediatric providers were well represented, with 37 (21.9%) working in general pediatrics, 27 (23.3%) in the neonatal intensive care unit (ICU), 18 (15.5%) in the pediatric ICU, 10 (8.6%) in oncology, 9 (7.8%) in the cardiac ICU, and 8 (6.9%) in surgery. Most respondents had been working at CHOP between 2 and 5 years ($n = 64$, 40%) and between 6 and 10 years ($n = 30$, 18.8%) years. In addition, 14 respondents (8.8%) had worked at the hospital for >30 years.

Closed-ended questions

Familiarity and interaction with ASP

Almost all of the respondents 140 (89%) reported being familiar or very familiar with the ASP. According to role, NPs were more likely to be unfamiliar with the program than other providers (25% vs 8% $P < .05$). Residents and NPs were most likely to confuse the role of ASP with ID consultation service (29%). Half of the respondents (51.7%) stated that they use the ASP to determine whether an ID consultation is necessary.

Perceptions of the value and trustworthiness of ASP

Overall, respondents had a favorable opinion about the value of the ASP, believing that it provides education to improve antibiotic use, improves the quality of patient care, improves clinical decision making, respects their clinical judgment, and facilitates appropriate antimicrobial use (Table 1). Most respondents reported trusting ASP personnel while finding them professional, credible, and fair. Most respondents ($n = 92$, 63%) did not feel that the ASP interferes with their clinical decision making. The most common criticism of the ASP was that it threatened efficiency (26.0% agreed).

Working around ASP approval

When asked how frequently they engage in workarounds to get antibiotics, even if they are against ASP recommendations (eg, by waiting to order restricted antibiotics until the ASP went home for the evening), 13 respondents (8.8%) selected "frequently," 101 (68.7%) selected "occasionally," and 33 (22.5%) reported that they "never" engaged in workarounds.

Open-ended questions

In total, 133 free-text responses were given by 66 respondents. Comments ranged in length from a sentence to multiple paragraphs. Systematic analysis revealed insights to further contextualize the responses to the closed-ended questions in 2 salient domains: (1) perceptions of the causes of inefficiency (mentioned by 44 respondents) and (2) reasons why prescribers engage in workarounds to ASP approval (mentioned by 34 respondents). Exemplar quotations for each domain are included in Table 2.

Table 1. Perceptions of Antimicrobial Stewardship Program

Survey Item	Agree, No. (%)	Neutral, No. (%)	Disagree, No. (%)	Total, No. (%) ^a
Positive Statements				
The ASP provides knowledge and education that helps improve my antibiotic use.	123 (83.7)	19 (12.9)	5 (3.4)	147 (100)
The ASP helps facilitate appropriate use of antimicrobials.	140 (95.3)	5 (3.5)	0 (0.0)	145 (100)
The ASP improves quality of patient care.	133 (92.4)	10 (6.9)	1 (0.7)	144 (100)
The ASP takes my clinical judgment seriously	104 (72.7)	34 (23.8)	5 (3.5)	143 (100)
The ASP improves my clinical decision-making.	107 (73.8)	37 (25.5)	1 (0.7)	145 (100)
The ASP is professional and cordial when discussing approvals.	135 (95.1)	6 (4.2)	1 (0.7)	142 (100)
I trust the recommendations made by ASP pharmacists.	120 (90.2)	13 (9.8)	0 (0.00)	133 (100)
I trust the recommendations made by ASP ID fellows.	125 (92.6)	9 (6.7)	1 (0.7)	135 (100)
I find the recommendations made by the ID pharmacists in the ASP to be credible and fair.	128 (89.5)	15 (10.5)	0 (0.00)	143 (100)
I find the recommendations made by the ID fellows in the ASP credible and fair.	136 (94.4)	8 (5.6)	0 (0.00)	144 (100)
Critical Statements				
The ASP interferes with my clinical decision making.	9 (6.2)	45 (30.8)	92 (63.0)	146 (100)
The ASP reduces my efficiency at work.	38 (26.0)	46 (31.5)	62 (42.7)	146 (100)

^aNumbers do not sum to 160 because data were missing for some questions.

Inefficiency

When describing their perceptions of inefficiency due to ASP, the most common criticism was a sense that the approval process required too many phone calls. Respondents described how the ASP approval process felt cumbersome at times and generated excessive phone calls. Needing to make multiple phone calls grew frustrating for many respondents, especially when they were caring for a particularly sick patient whom they were anxious about. In those cases, the wait to receive a phone call back was especially uncomfortable.

One of the major causes of inefficiency identified by respondents was communication breakdowns between the ASP team and the dispensing pharmacy. Numerous respondents described situations in which the ASP team or ID consult service had approved an antimicrobial but there was a delay in the note reaching the electronic health record. The dispensing pharmacy received the order but did not see the approval note, so they called the prescriber to verify. This additional phone call was seen as unnecessary and annoying.

Workarounds

Respondents identified a number of specific workarounds to ASP approval that they had engaged in, including repeatedly reordering 48-hour “rule-out” antimicrobials until a patient receives a full course, “stretching” a patient’s diagnosis to fit one of the ASP pre-approved indications, waiting until the evening to obtain the “overnight approval” indication (eg, stealth dosing), ordering a blood culture to facilitate approval and, for patients who were soon-to-be discharged, ordering restricted antibiotics to be filled as an outpatient to avoid the ASP approval process.

In elaborating the reasons why they engage in workarounds, respondents reported that they did not want to stop antimicrobials that appeared to be working on critically ill patients despite being culture negative and accommodating parent request for specific antimicrobials. Residents and NPs reported that they engaged in workarounds to satisfy the demands of their attending or specialty consult service (especially surgery), who may have disagreed with

ASP approval. While many described attempts to negotiate, sometimes they “gave in” and worked around ASP approval to minimize conflict.

Discussion

We conducted a cross-sectional survey of prescribers at a large freestanding children’s hospital with an established pediatric ASP that primarily utilizes prior authorization. Prescribers held a generally favorable impression of the hospital’s ASP, believing that it facilitated appropriate antimicrobial use. Respondents did not perceive that the ASP threatened their autonomy or disrespected their clinical judgment. They reported finding ASP personnel professional, credible, and trustworthy. Nevertheless, most respondents reported occasionally engaging in workarounds to ASP approval. The major critique of the ASP program was inefficiency. Respondents reported frustration surrounding the number of phone calls required, communication gaps with the dispensing pharmacy, and perceived delays in antibiotic administration. Workarounds occurred largely for social and emotional reasons.

Consistent with previous survey research on prescriber perceptions of ASPs, most respondents felt that the program improved their use of antimicrobials, served a useful educational function, and improved the quality of patient care.^{16–18,22,23} Much of the attitudinal research on restrictive ASP interventions, such as prior authorization, has found that prescribers express concern about the threat that these interventions posed to their autonomy and clinical judgement.^{16–18,22,24} Contention with a hierarchical culture, facing the social norm of noninterference surrounding prescribing, and antimicrobial steward discomfort with being thought of as the “antibiotic police” are oft-cited challenges to the implementation of restrictive stewardship interventions.^{25,26} The lack of prescriber buy-in to restrictive stewardship interventions can lead to workarounds such as “stealth dosing,” in which prescribers wait until the prior approval period has ended for the day to order off-guideline or unnecessary restricted antimicrobials.²⁷ Other studies have documented prescribing clinicians misrepresenting clinical

Table 2. Themes in Free-Text Responses and Sample Quotes

Theme	Subtheme	Sample Quotation
Inefficiency	Too many phone calls	(1) “There are times when I know I will get approval but I have to go through the motions of making the phone call and it is just another task on my long list of to-dos.” [Resident]
		(2) “Often I get a page from pharmacy that the antibiotics have to be approved even after I have spoken with someone from the ASP because there is a lag with the note. On a busy day, waiting for a call back to explain my reasoning can be challenging.” [Nurse practitioner]
		(3) “ASP approval takes too many phone calls, and I feel like the time spent waiting for callback is often long.” [Resident physician]
		(4) “It can be time consuming for a very busy front line clinician to page the team, wait for the call, etc. It’s valuable to have a conversation in many cases, but it can be very time-consuming in a busy unit.” [Nurse practitioner]
		(5) “I had an oncology kid come in with a sepsis like picture previously having been successfully treated with meropenem and I was told I needed approval before I could start it and I felt very frustrated because I was very busy with other kids and his admission and he was really sick and it was delaying his first dose of antibiotics.” [Attending physician]
	Miscommunication with dispensing pharmacy leads to delays	(6) “It does require an extra step and at time the communication between the clinician and the ASP clinicians doesn’t reach the pharmacy at the same rate. I find the pharmacy staff to be the most frustrating part of the whole process and at many times they delay the antibiotics reaching the patient in a timely manner.” [Resident physician]
		(7) “It feels like there are often delays in dispensing antibiotics even when they have either been approved or do not need approval (ie, overnight) because pharmacy is concerned about the duration of treatment listed in EPIC [why does that preclude dispensing a dose now?! This happens all the time!] or because of delays in the consult team writing the approval note. For instance, say your team spoke to a fellow who advised a treatment with three antimicrobials, so you ordered them . . . but it has been an hour and the note only mentions 2 of them. So your intern pages stewardship. Stewardship calls back 15 minutes later and tell you to go through the consult service that has already thought about this patient (you mentioned that to the other interns last week . . . but this intern never remembers. Sigh). So your intern pages the ID fellow. 15 minutes later the fellow calls back from the elevator . . . and 15 minutes later the approval goes in. Then the bedside nurse calls pharmacy. Then 45 minutes later the patient gets a medicine that was discussed hours ago.” [Attending physician]
Types of workarounds	Repeat 48 hour rule-out	(8) “There are times that we do repeat ‘rule-outs’ where patient ultimately receives a ‘full course’ of antimicrobials without getting official stewardship approval.” [Attending physician]
	Diagnostic stretching	(9) “If an attending specifically wants an antibiotic without a pre-approved indication, but there is one that could be stretched to fit the description then I might use the preapproved indication.” [Resident physician]
	Stealth dosing	(10) “I’ll wait until it’s overnight to be able to select the ‘one time overnight dose’ indication.” [Resident physician]
	Unnecessary blood culture	(11) “General surgeon wants 48 hours of post-op coverage for antibiotics even though that goes against ASP recommendations. I have drawn a blood culture to help get antibiotics.” [Nurse practitioner]
	Discharge ordering	(12) “Your specialist attending lets you know at 8p that she wants a patient discharged tomorrow with a 14-d course of Augmentin. Target time for discharge is 9:30 AM so that the patient can get to something early. I might suggest that the patient get her first dose at 6 AM or just starts the medication as an outpatient so as not to go through the approval process.” [Resident physician]
Reasons for workarounds	Don’t want to stop something that seems to work	(13) “Medical team wants to extend antibiotic coverage in a culture negative patient whose hemodynamics seem to have gotten better once antibiotics were placed. Every time we stop antibiotics, the patient becomes febrile (all cultures are negative) so we reorder for 48-h coverage.” [Attending physician]
	Doing everything possible	(14) “CICU attending has a strong preference to cover everything possible for a very sick/dying child with CHD.” [Resident physician]
	Parent request	(15) “Sometimes we work around ASP approval because a parent has a preference for an antibiotic because of known response/reaction to another medication.” [Attending physician]
	Attending disagrees	(16) “Sometimes certain attendings or surgeons insist on specific antibiotics or duration of treatment for more ‘soft call’ sepsis diagnoses. Asp/ID consult team don’t always agree and it’s up to the frontline clinician to try and manage expectations of the attendings and the asp/ID teams.” [Nurse practitioner] (17) “Certain surgical attendings want perioperative antibiotics given even if it not in the current recommendations. As APNs, we are often ‘stuck in the middle.’ This can be very frustrating and I have developed work arounds to decrease my frustration.” [Nurse practitioner] (18) “Sometimes an ortho attending is adamant about a patient receiving antibiotics, even though the particular patient may not qualify for any of the indications. When this happens, if the attending wants the patient on the antibiotic, we attempt a conversation with the attending regarding why it is recommended not to give the antibiotic, but even after that at times we still end up ordering it.” [Nurse practitioner]

information to get approval to prescribe the antimicrobials that they believe are appropriate.^{28,29}

Our study makes 3 key contributions. First, we found that respondents did not feel that the ASP threatened their autonomy or disrespected their clinical judgment. ASP personnel were seen as credible and fair in their approvals; there was a high level of trust in the recommendations made by the ASP. It is possible that prescriber fear of threatened autonomy diminishes with ASP age, as prescribers become more comfortable with the program over time. Because we do not have data on prescriber perceptions from the beginning of this ASP, we cannot directly attribute this attitude to duration of program existence. More experienced, long-standing ASPs have better uptake of interventions. For example, as Cosgrove *et al.* (2012) show in their multicenter study evaluating the impact of postprescription review and feedback, institutions with established and well-resourced ASPs decreased antimicrobial use significantly whereas institutions with less well-established ASPs did not.³⁰ More research is needed to investigate changing perceptions toward ASPs over time, the factors that shape these perceptions, and their impact on program outcomes.

Second, we found that despite not feeling that their autonomy was threatened by the ASP, prescribers still engaged in workarounds to evade the restrictions of prior authorization. Working around the ASP guidelines is largely conceptualized as a problem of prescriber resistance that emerges from a feeling that their autonomy is being threatened.²⁵ Our study illustrates that workarounds can persist even when prescribers are supportive of an ASP, an important issue to consider when evaluating a program. Free-text analysis revealed that the reasons given by prescribers for workarounds are more nuanced than an outright rejection of being told what to do by an outsider. Our respondents described several social and emotional influences that shape their decision to work around prior authorization: their sense of obligation to patients, managing their own fear related to clinical uncertainty, and being “stuck in the middle” between a superior and the ASP guidelines. Our respondents described making decisions in a system characterized by competing priorities, the navigation of which required attention to goals beyond the optimization of antimicrobial use.^{31–33}

The third contribution of our study is that it highlights the importance of efficiency as it relates to the implementation of ASP interventions. Two previous studies have found that prescribers perceive ASP interventions to be too time-consuming.^{10,16} Our study provides more detail on prescriber experiences of inefficiency. The repeated phone calls required to obtain approval were seen as burdensome, especially in the context of a busy day in which preapproval becomes one of many logistic hurdles clinicians face in providing care to their patients. Our respondents also identified occasional problems in communicating about prior authorization between the dispensing pharmacy and the ASP team. Both excessive phone calls and communication breakdowns are logistical challenges that can be addressed through thoughtful modifications to ASP procedures.

Although our study has limited generalizability because it was conducted at a single institution, our findings have relevance for ASPs in other settings. CHOP has a particularly restrictive ASP, with prior authorization as the main intervention. Most hospitals use a combination of strategies, with postprescription review and feedback as the primary approach.^{3,34,35} Both of these interventions communicate recommendations about antimicrobials in either a restrictive or persuasive manner. Our findings suggest that the way this communication is incorporated into the everyday


workflow of frontline prescribers is critical to their perception of the value of the program and, ultimately, to their level of engagement with ASP recommendations. This factor is likely to be important in hospitals that use both restrictive and persuasive interventions. Although we conducted this study in a pediatric hospital, many of the social dynamics we identified, including deference to senior colleagues, prescribing for emotional reasons and frustration with inefficient communication mechanisms, have been reported across many types of healthcare settings.²⁵

Our study demonstrates the value of investigating prescriber perceptions of established ASPs both in generating knowledge of how clinicians think about stewardship and in identifying process defects that can be addressed through systems redesign. Established ASPs should incorporate periodic “end user” assessments of program activities to determine areas in which improvement is needed. In general, there is a dearth of research on factors that influence sustainability in antimicrobial stewardship, despite this being identified as a critical challenge to the field of healthcare improvement.³⁶

Our study has several limitations. We were unable to assess response bias, and we did not have information on the characteristics of those who chose not to take the survey. Our survey instrument was not validated. Also, the number of respondents working in different clinical settings within the hospital were too small to permit meaningful comparisons, an analysis that could provide valuable insight. Despite these limitations, our relatively robust response rate and the iterative process we utilized to design our survey indicate that we have captured a meaningful range of responses.

This survey investigated the perceptions that prescribers held toward an established pediatric ASP that utilizes prior authorization. Respondents held the ASP in high regard and believed that it improved the quality of patient care. The primary critique of the prior authorization process was that it is inefficient. Engagement with prescribers via surveys that assess perceptions can identify areas for improvement to ensure that long-standing ASPs have maximum impact.

Supplementary material. To view supplementary material for this article, please visit <https://doi.org/10.1017/icc.2019.47>

Author ORCIDs. Julia E. Szymczak  0000-0002-3230-8670

Acknowledgments. We thank the anonymous respondents who took the time to fill out our survey. Drs. Szymczak, Coffin and Gerber receive support from the CDC Cooperative Agreement FOA#CK16-004-Epicenters for the Prevention of Healthcare Associated Infections.

Financial support. No financial support was provided relevant to this article.

Conflicts of interest. All authors report no conflicts of interest relevant to this article.

References

- Gerber JS, Newland JG, Coffin SE, *et al.* Variability in antibiotic use at children's hospitals. *Pediatrics* 2010;126:1067–1073.
- Levy ER, Swami S, Dubois SG, Wendt R, Banerjee R. Rates and appropriateness of antimicrobial prescribing at an academic children's hospital, 2007–2010. *Infect Control Hosp Epidemiol* 2012;33:346–353.
- Newland JG, Gerber JS, Weissman SJ, *et al.* Prevalence and characteristics of antimicrobial stewardship programs at freestanding children's hospitals in the United States. *Infect Control Hosp Epidemiol* 2014;35:265–271.

4. McPherson C, Lee BR, Terrill C, *et al.* Characteristics of pediatric antimicrobial stewardship programs: current status of the Sharing Antimicrobial Reports for Pediatric Stewardship (SHARPS) collaborative. *Antibiotics (Basel)* 2018;7(1). pii: e4.
5. Pakyz AL, Moczygemba LR, VanderWielen LM, Edmond MB, Stevens MP, Kuzel AJ. Facilitators and barriers to implementing antimicrobial stewardship strategies: results from a qualitative study. *Am J Infect Control* 2014;42(10 Suppl):S257–S263.
6. Kapadia SN, Abramson EL, Carter EJ, *et al.* the expanding role of antimicrobial stewardship programs in hospitals in the United States: lessons learned from a multisite qualitative study. *Joint Comm J Qual Patient Safety* 2018;44:68–74.
7. Cantey MJ, Gurses AP, Tamma PD, Cosgrove SE, Miller MA, Jump RLP. Implementing antimicrobial stewardship in long-term care settings: an integrative review using a human factors approach. *Clin Infect Dis* 2017;65:1943–1951.
8. James R, Luu S, Avent M, Marshall C, Thursky K, Buising K. A mixed methods study of the barriers and enablers in implementing antimicrobial stewardship programmes in Australian regional and rural hospitals. *J Antimicrob Chemother* 2015;70:2665–2670.
9. Perozziello A, Routelous C, Charani E, *et al.* Experiences and perspectives of implementing antimicrobial stewardship in five French hospitals: a qualitative study. *Int J Antimicrob Agent* 2018;51:829–835.
10. Cantey JB, Vora N, Sunkara M. Prevalence, characteristics, and perception of nursery antibiotic stewardship coverage in the United States. *J Pediatr Infect Dis Soc* 2017;6(3):e30–e35.
11. Broom J, Broom A, Plage S, Adams K, Post JJ. Barriers to uptake of antimicrobial advice in a UK hospital: a qualitative study. *J Hosp Infect* 2016;93:418–422.
12. Broom J, Broom A, Kirby E, Gibson AF, Post JJ. How do hospital respiratory clinicians perceive antimicrobial stewardship (AMS)? A qualitative study highlighting barriers to AMS in respiratory medicine. *J Hosp Infect* 2017;96:316–322.
13. Jeffs L, Thampi N, Maione M, Steinberg M, Morris AM, Bell CM. A qualitative analysis of implementation of antimicrobial stewardship at 3 academic hospitals: understanding the key influences on success. *Can J Hosp Pharm* 2015;68:395–400.
14. Metjian TA, Prasad PA, Kogon A, Coffin SE, Zaoutis TE. Evaluation of an antimicrobial stewardship program at a pediatric teaching hospital. *Pediatr Infect Dis J* 2008;27:106–111.
15. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform* 2009;42:377–381.
16. Seemungal IA, Bruno CJ. Attitudes of housestaff toward a prior-authorization-based antibiotic stewardship program. *Infect Control Hosp Epidemiol* 2012;33:429–431.
17. Bannan A, Buono E, McLaws ML, Gottlieb T. A survey of medical staff attitudes to an antibiotic approval and stewardship programme. *Intern Med J* 2009;39:662–668.
18. Stach LM, Hedican EB, Herigon JC, Jackson MA, Newland JG. Clinicians' attitudes towards an antimicrobial stewardship program at a children's hospital. *J Pediatr Infect Dis Soc* 2012;1:190–197.
19. Steinberg M, Dresser LD, Daneman N, *et al.* A national survey of critical care physicians' knowledge, attitudes, and perceptions of antimicrobial stewardship programs. *J Intensive Care Med* 2014;31:61–65.
20. StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP.
21. NVivo qualitative data analysis software. QSR International Pty Ltd. Version 12, 2016.
22. Salsgiver E, Bernstein D, Simon MS, *et al.* Knowledge, attitudes, and practices regarding antimicrobial use and stewardship among prescribers at acute-care hospitals. *Infect Control Hosp Epidemiol* 2018;39:316–322.
23. Flannery DD, Swami S, Chan S, Eppes S. Prescriber perceptions of a pediatric antimicrobial stewardship program. *Clin Pediatr (Phila)* 2014; 53:747–750.
24. Venugopalan V, Trustman N, Manning N, Hashem N, Berkowitz L, Hidayat L. Administration of a survey to evaluate the attitudes of house staff physicians towards antimicrobial resistance and the antimicrobial stewardship programme at a community teaching hospital. *J Glob Antimicrob Resist* 2016;4:21–27.
25. Szymczak JE, Newland JG. The social determinants of antibiotic prescribing. In: Barlam TF, Neuhauser MM, Tamma PD, Trivedi KK, eds. *Practical Implementation of an Antibiotic Stewardship Program*. Cambridge, UK: Cambridge University Press; 2018. Pp. 45–62.
26. Sikkens JJ, van Agtmael MA, Peters EJJ, *et al.* Behavioral approach to appropriate antimicrobial prescribing in hospitals: the Dutch Unique Method for Antimicrobial Stewardship (DUMAS) participatory intervention study. *JAMA Intern Med* 2017;177:1130–1138.
27. LaRosa LA, Fishman NO, Lautenbach E, Koppel RJ, Morales KH, Linkin DR. Evaluation of antimicrobial therapy orders circumventing an antimicrobial stewardship program: investigating the strategy of “stealth dosing.” *Infect Control Hosp Epidemiol* 2007;28:551–556.
28. Calfee DP, Brooks J, Zirk NM, Giannetta ET, Scheld WM, Farr BM. A pseudo-outbreak of nosocomial infections associated with the introduction of an antibiotic management programme. *J Hosp Infect* 2003;55:26–32.
29. Seemungal IA, Bruno CJ. Attitudes of housestaff toward a prior-authorization-based antibiotic stewardship program. *Infect Control Hosp Epidemiol* 2012; 33:429–431.
30. Cosgrove SE, Seo SK, Bolon MK, *et al.* Evaluation of postprescription review and feedback as a method of promoting rational antimicrobial use: a multicenter intervention. *Infect Control Hosp Epidemiol* 2012;33: 374–380.
31. Dixon-Woods M, Suokas A, Pitchforth E, Tarrant C. An ethnographic study of classifying and accounting for risk at the sharp end of medical wards. *Soc Sci Med* 2009;69:362–369.
32. Broom A, Gibson AF, Broom J, Kirby E, Yarwood T, Post JJ. Optimizing antibiotic usage in hospitals: a qualitative study of the perspectives of hospital managers. *J Hosp Infect* 2016;94:230–235.
33. Szymczak JE. Infections and interaction rituals in the organisation: clinician accounts of speaking up or remaining silent in the face of threats to patient safety. *Sociol Health Illn* 2016;38:325–339.
34. Kronman MP, Banerjee R, Duchon J, *et al.* Expanding existing antimicrobial stewardship programs in pediatrics: what comes next. *J Pediatr Infect Dis Soc* 2018;7:241–248.
35. Livorsi DJ, Heintz B, Jacob JT, Krein SL, Morgan DJ, Perencevich EN. Audit and feedback processes among antimicrobial stewardship programs: a survey of the Society for Healthcare Epidemiology of America research network. *Infect Control Hosp Epidemiol* 2016;37:704–706.
36. Lennox L, Maher L, Reed J. Navigating the sustainability landscape: a systematic review of sustainability approaches in healthcare. *Implement Sci* 2018;13:27.