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Original Article

A mixed-methods needs assessment for an antimicrobial stewardship curriculum in pediatrics

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Abstract

Objective: Antimicrobial stewardship (AS) education initiatives for multidisciplinary teams are most successful when addressing psychosocial factors driving antimicrobial prescribing (AP) and when they address the needs of the team to allow for a tailored approach to their education.

Design: We conducted a mixed-methods embedded study as a needs assessment, involving quantitative analysis of AS concerns observed by pharmacists through an audit while attending clinical team rounds, as well as qualitative semi-structured interviews based on the Theoretical Domain Framework (TDF) to identify psychosocial barriers and facilitators for antimicrobial prescribing for an inpatient general pediatric service. We analyzed the data using deductive and inductive methods by mapping the TDF to a model for social determinants of antimicrobial prescribing (SDAP) in pediatric inpatient health care teams.

Setting: The Clinical Teaching Unit (CTU) and Pediatric Intensive Care Unit (PICU), at a tertiary care pediatric hospital in Canada.

Participants: Interviews ($n = 23$) with staff and resident physicians, nurse practitioners, and pharmacists.

Results: Psychosocial facilitators and barriers for AS practice in the PICU and CTU which were identified included: *collaboration, shared decision-making, locally accessible guidelines,* and an overarching goal of *doing right by the patient and feeling empowered as a prescriber*. Some of the barriers identified included the *norm of noninterference, professional comparisons, limited resources, feeling inadequately trained in AS, emotional prescribing, and a pejorative monitoring system.*

Conclusions: Our findings identified barriers and facilitators to AS decisions on pediatric inpatient teams as well as actionable needs in psychosocial-based AS education.

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Introduction

Inappropriate antimicrobial use has been identified as a global health threat and is the major contributor to the rise of antimicrobial resistance in health care settings, communities, and across the One Health ecosystem.[1,2] To address the overuse of antimicrobials, health care organizations have adopted antimicrobial stewardship programs (ASPs) as required practices.[2] Antimicrobial stewardship programming pediatric hospitals have demonstrated that antimicrobial stewardship (AS) strategies can decrease antimicrobial utilization, prescribing errors, as well as cost or apparent negative impact on pediatric patient safety.[3–5]

Many ASPs are often based on policy- and practice-based interventions however recent research has shown that antimicrobial prescribing behaviors are influenced by psychosocial factors, such as attitudes, social expectations, norms, emotions, and beliefs.[6–9] However, these findings have rarely translated into incorporating social and behavioral determinants of antimicrobial prescribing (AP) for AS interventions,[10] especially in pediatric inpatient settings. For example, in patient-centered rounds at our hospital AP occurs within a wide social network with multiple interactions of team members such as senior and junior staff physicians and resident physicians, nurse practitioners (NPs), and

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pharmacists however, only occasionally, do consultants including infectious disease (ID) physicians participate.

Although education is one of the cornerstones of AS, passive measures (lectures, printed materials, updating antibiotic guidelines) have been found to be only marginally effective, and without sustained effect, in changing AP.[11–13] When designing AS educational interventions, research that seeks to understand the local culture and psychosocial factors affecting antimicrobial prescribing behaviours as well as how to engage multidisciplinary staff, has been shown to improve implementation and compliance.[7,8,14]

A validated framework for identifying the areas for behavioral change interventions is the implementation-relevant, theory-based approach called the Theoretical Domain Framework (TDF).[8] The TDF represents a number of domains and theoretical constructs that help the user categorize known barriers and facilitators to practice change and select implantation strategies in AS.[15] Another construct that refers to non-medical factors arising from the social environment influencing the choice to prescribe is the Social Determinants of Antimicrobial Prescribing (SDAP).[7,16] In pediatrics, four SDAPs have been identified: 1) relationship between clinicians, (social norms such as prescribing etiquette, hierarchy, and norm of noninterference) 2) relationships between clinicians and patients, (patient pressure or demand, environmental restraints on time they have for patient encounters) 3) risk, fear, uncertainty, identity, and emotion, (prescribing in the setting of managing uncertainty while navigating risk) and 4) perception and misperceptions of the problem, (how clinicians perceive the problem of antimicrobial use, resistance, their own and others' prescribing habits, and the role of guidelines in AS).[16] We sought to determine how can we tailor an AS educational curriculum for the pediatric intensive care unit (PICU) and clinical teaching unit (CTU) teams to address their needs to optimize uptake for an AS curriculum. The objectives of this research study were:

1. To explore the educational needs (*what, who, when, and how*) for the PICU and CTU teams regarding AS practice in their targeted learning environment.
2. To identify determinants of AP behavior for clinicians on the PICU and CTU teams.

Methods

We applied a mixed-methods study design using quantitative and qualitative approaches (Appendix A) to understand the determinants of current and desired behaviors around AP for patient-centered clinical rounds. The study was conducted in a 141-bed tertiary care pediatric hospital in Canada with the PICU and CTU teams.

Quantitative phase

The quantitative phase (August 1, 2016, and January 31st, 2017) included pharmacists on the PICU and CTU teams recording inappropriate AP on pre-piloted, anonymized AS concern cards as an audit (Appendix 2). An ID physician (first author CC) reviewed each clinical case for appropriateness and the data was collected using REDCap)[17,18] and analyzed using descriptive epidemiologic terms such as frequencies in Microsoft Excel™ (Version 16).

Qualitative phase

The qualitative phase (February-August 2017) included 23 semi-structured individual in-person interviews with PICU physicians, NPs and pharmacists (PICU group $n = 8$), hospital pediatricians and pharmacists (CTU group, $n = 11$), and senior resident physicians hereon referred to as residents who had completed both PICU and CTU rotations (resident group $n = 4$). Convenience sampling was used, and participants were recruited until theoretical saturation was attained. The semi-structured interview guide was developed based on the initial quantitative phase results as well as a literature search around drivers of AS and AP around the TDF and adapted to different healthcare professional groups (Appendix C).

All interviews (60-75 minutes each) were recorded, transcribed verbatim, and anonymized and coded in QSR International's *NVivo Qualitative Data Analysis Software* version 12.0.[19] Initially to ensure consistency in coding, three coders (CC, CG, and AK) independently coded one interview transcript, and nodes and sub-nodes were compared. Nodes are concepts identified in the data when coding the transcripts. A theme node would contain many references or topics related to that node. A sub-node is a pervasive idea that fits into a node identified in the data. One node may contain many sub-nodes. Two coders then coded all the remaining transcripts. The concepts arising from nodes and sub-nodes were then attributed to the domains of the TDF. Two researchers (authors CC and CG) analyzed the data using a pragmatic worldview (aimed at future actionable educational initiatives) and an abductive reasoning approach.[20] The deductive nodes were mapped to the TDF by analyzing the data line by line for the PICU and CTU respondents (for resident transcripts, some concepts were attributed to the CTU nodes and some to the PICU nodes depending on what their references were). Nodes and sub-nodes were identified according to frequency as well as impact and analyzed within each group (PICU physicians and nurse practitioners, CTU physicians, residents, and pharmacists) and across the two teams: the PICU and CTU. The inter-rater reliability was calculated, and sub-nodes with less than 95% agreement were resolved by discussion until consensus was achieved.

After coding data into TDF nodes, the TDF domains were categorized into SDAP clusters, according to the nodes that emerged from the TDF. Within each SDAP, overarching themes (that were formed by an aggregate of nodes) were generated inductively. This was then discussed with a third researcher (author AK) and the various themes were identified within these clusters and regrouped, as some of the domains such as emotion-generated nodes were applied to more than one SDAP. Re-analyzing the themes and nodes within the SDAPs was carried out until facilitators and barriers for AS practice for the PICU and CTU teams emerged within each SDAP and until additional analysis did not provide further insight into the relationship between themes.

The qualitative phase used the TDF and SDAPs to identify determinants of AP in the form of facilitators and barriers for AS practice. These facilitators and barriers alongside other information obtained from the quantitative phase of the study served as a needs assessment. The research for both the quantitative and qualitative components was approved by the Conjoint Health Research Ethics Board at the University of Calgary (REB16-1819). Informed consent was not required from individual patients to participate in the study.

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Table 1. Demographics of responses in the quantitative phase and respondents in qualitative phase

	PICU			CTU		
QUANTITATIVE PHASE						
Number of anonymous AS concerns 2017 $N = 73$	$n = 37$			$n = 36$		
QUALITATIVE PHASE		*n*	Identified as women (%)		*n*	Identified as women (%)
Interview Respondents $N = 23$	Nurse Practitioners	2	100	–	–	–
	Pharmacists	2	50	Pharmacists	5	100
	PICU Physicians	4	75	CTU Physicians	6	83
	Residents (PICU & CTU)		4			50

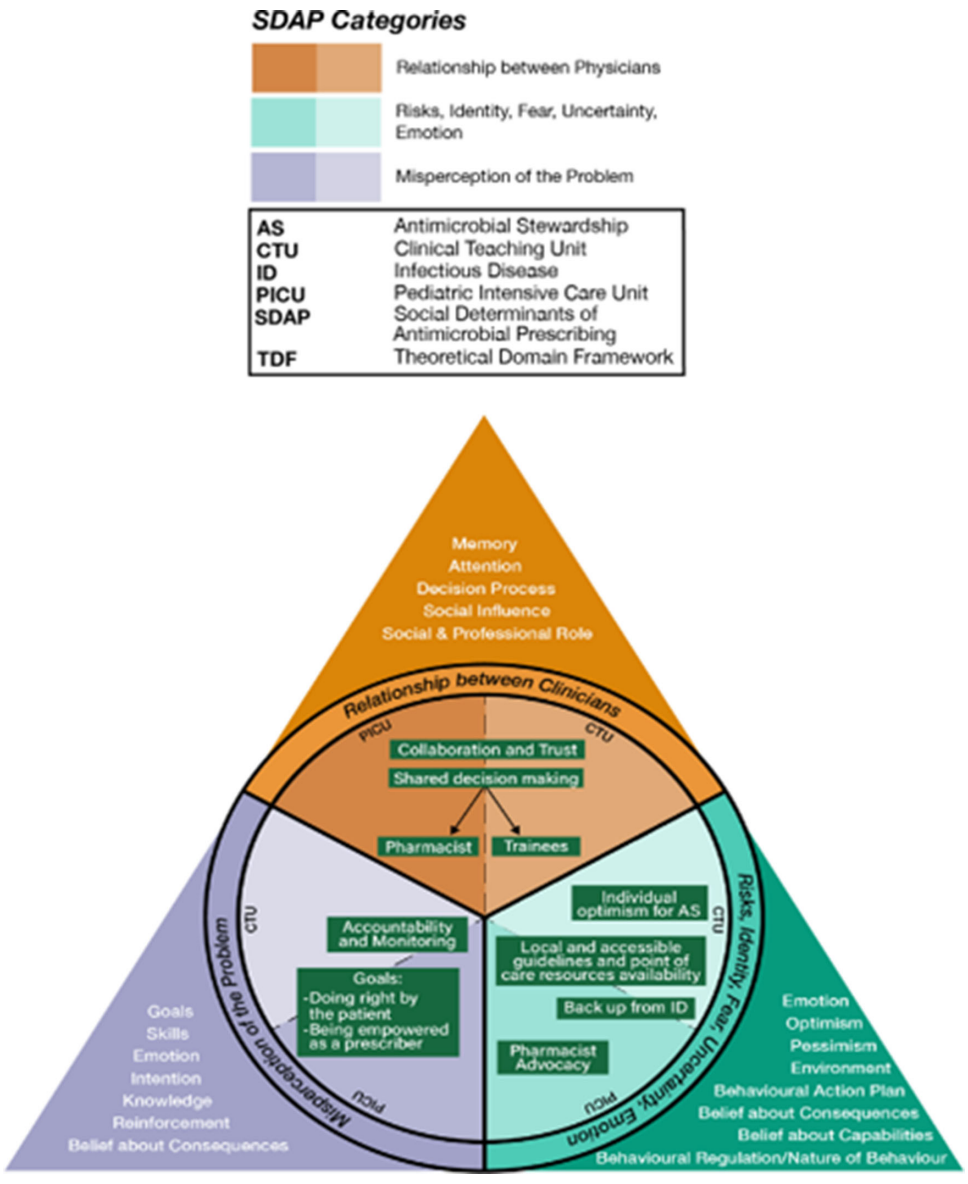

Figure 1. Facilitators for antimicrobial prescribing for the Pediatric Intensive Care Unit and Clinical Teaching Unit

Results

The results are described in the following sections: 1. Behavior determinants: Facilitators and Barriers to AP on the PICU and CTU, 2. Educational needs for the PICU and CTU. Since the quantitative data supported the qualitative data at multiple stages (triangulation), the results of both phases are presented below. The inter-rater reliability of the interview coding was considered high with over 95% agreement across all nodes and sub-nodes. The

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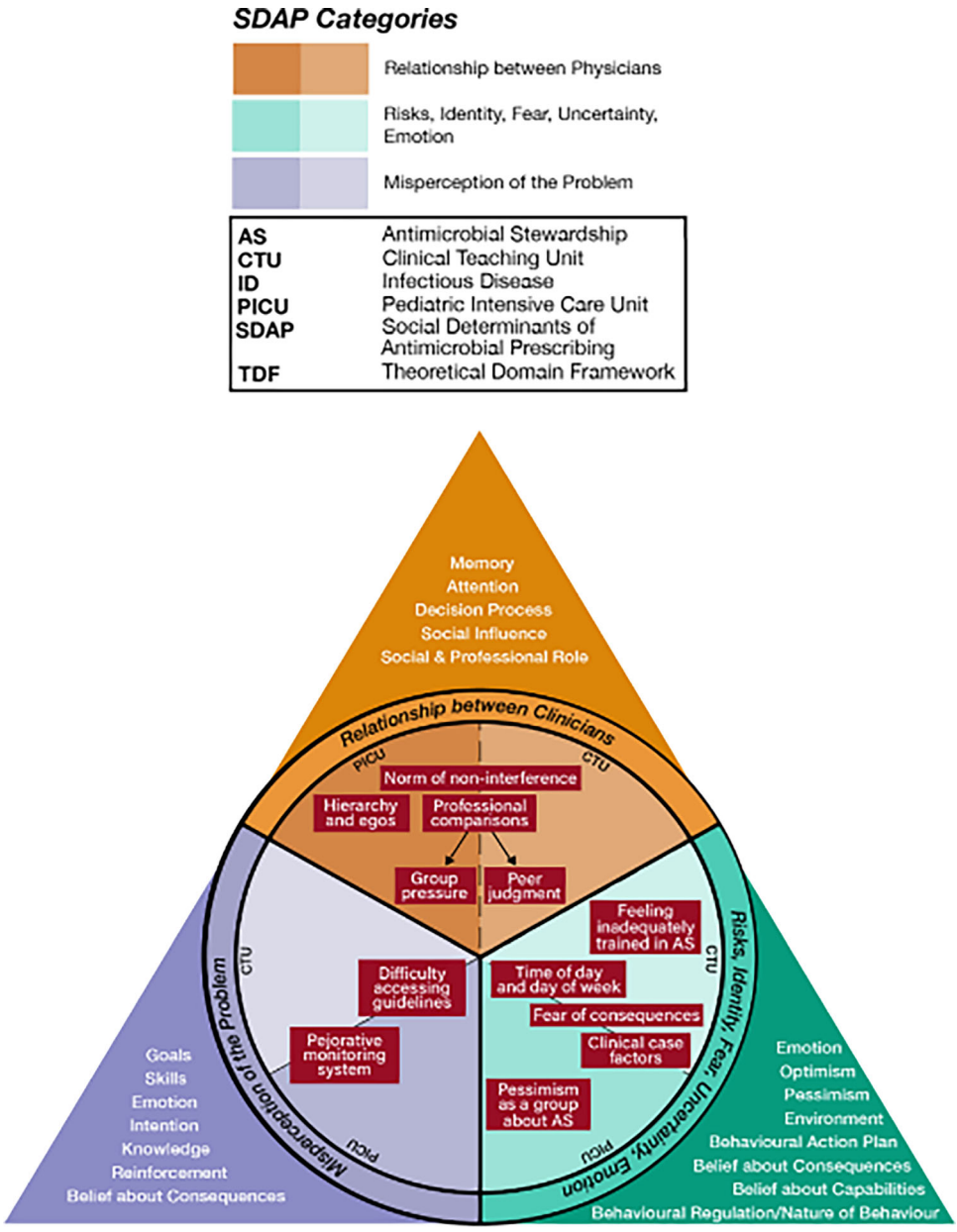

Figure 2. Barriers to antimicrobial prescribing for the Pediatric Intensive Care Unit and Clinical Teaching Unit

breakdown of the quantitative responses and qualitative respondents' characteristics is shown in Table 1.

Behavioral determinants of AP: facilitators and barriers

The analysis identified facilitators and barriers across each of the three identified SDAPs for AP in the PICU and CTU. Based on the TDF nodes that initially emerged, the codes clustered in the TDF domains within three of the SDAP groups as follows: SDAP1 – *Relationship between clinicians*, SDAP2 – *Risk, identity, fear, uncertainty, emotion,* and SDAP3 – *Misperception of the problem.* A pictorial description of how the TDF domains fit within the SDAP groups and the facilitators and barriers that emerged from this analysis are shown in Figures 1 and 2 respectively.

Facilitators across the various SDAPs to AP

Most facilitators to appropriate AP were common to both the PICU and CTU, such as *collaboration and trust, shared decision-making, guideline accessibility, accountability associated with AS,* and *the goals of feeling empowered as a prescriber and doing right by the patients (optimizing patient care).* These are outlined with corresponding quotes in Table 2.

Differences in facilitators between the PICU and CTU

Some facilitators were unique to each unit. The PICU relied more heavily on *shared decision-making and advocacy from pharmacy,* while the CTU *identified presence of trainees on the team as a facilitator* and as a group, felt more *optimistic about AS* compared to the PICU.

Collaboration and shared decision-making were valued by both the PICU and CTU, but the CTU physicians relied more on collaboration for AP. The PICU physicians saw collaboration as contributing to the discussion but viewed their role as the ultimate decision-makers on AP. Both the PICU and CTU physicians identified themselves as role models, but the CTU physicians saw

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Table 2. Themes arising for the Pediatric Intensive Care Unit (PICU) and Clinical Teaching Unit (CTU) teams as facilitators for antimicrobial prescribing (AP) and antimicrobial stewardship (AS) across three social determinants of antimicrobial prescribing (SDAP)

SDAP	Facilitator Theme	Quote relevant to the theme by PICU clinician	Quote relevant to the theme by CTU clinician
Relationship between clinicians	Collaboration and trust on team with Pharmacy and ID	*I think it kind of goes back to my relationship with the attending and if there's a trust there. If they don't trust me then they're not going to listen to anything I say. So, it's very dependent on the actual team I'm with. AS16_PICU_Pharmacist*	*I think there should be a collaboration, really, with the physicians and pharmacist in regard to who makes it. I wouldn't solely put it on the physician, or solely say the pharmacist should always be making it. AS7_CTU_Pharmacist* *I think having pharmacists that we can trust and an ID service who has our back is important. AS10_CTU_Physician*
	Shared decision-making with pharmacists (PICU) and trainees (CTU)	*I think the pharmacists in the ICU are vital to making these decisions. They have a lot more of a broader knowledge base of all of the medications and specifically the side-effect profile and the monitoring that needs to occur, so I think that the pharmacist's involvement in the decision making and the ordering process is key . . . . we will 99% of the time defer to their recommendations. AS5_PICU physician*	*Obviously, when we're doing teaching teams there's a resident involved too. I think that the resident and the medical students and the junior trainees on the team need to go through the process of deciding what antibiotics are appropriate because that's an important part of them learning and to take into account all the variables and the rationale for choosing certain antibiotics. AS10_CTU_Physician*
Risk, identity, fear, uncertainty and emotion	Local and accessible guidelines and point of care resources	*The guidelines that have been created for specific clinical presentation is are often referred to, like the pneumonia guideline, the empyema guideline, and we try to abide by those and they are easy to find in PICU AS20_Resident*	*I think if I had a single reference for some common infections then that could improve, it could probably improve my decisions and choices for antimicrobials and so I think the Spectrum app will be helpful for me. I've heard really good feedback from it. I think having more clinical practice guidelines that are vetted to our local population and resistance, like anti-microbiograms, I think that would be helpful as well. AS12_CTU_Physician*
	Individual optimism for AS	*I'm optimistic (about being a good steward) It makes clinical change, and it optimizes patient care. I think there's a lot of reasons why I could be good at it, or I really should be good at it. AS17_PICU Pharmacist*	*Yeah, I am optimistic about it. As I said, I think I'm still far from perfect, but I would like to continue to improve; so I think, through the next few years, I can still keep getting better. AS15_Resident*
Misperception of the problem	Goals of being empowered as a prescriber and optimally serving the patient	*I mean, the goal ultimately is to ensure the patients only get the antibiotics they need for as long as they need them and no more. AS11_PICU_NP*	*I think (the goal) should be that every patient gets antibiotics when they're required, treated with the right antibiotics for the right length of time. AS3_CTU_Pharmacist*
	Accountability and monitoring	*And I think there needs to be a separate antimicrobial stewardship service or ID physician, separate to the ID team, who's looking at patients on antimicrobials. AS16_PICU_Pharmacist_Apr_2017* *. . . some accountability for us if we aren't stepping down appropriately. Also tracking . . . so say, for example, we did become better antimicrobial stewardship. AS11_PICU_NP* *"Yes, I think it (a monitoring system) probably could (work), if it was done in the right way and was collegial." AS19_PICU_Physician*	*I think you have to be careful about doing that (monitoring system). You have to be very careful that people aren't feel they're being judged, or they're being penalized, or they're being embarrassed in front of trainees, would have to be done carefully. AS22_CTU_Physician*

the AP decision as a collaborative one, while the PICU physicians viewed themselves as the ultimate decision-makers who considered contributions from the team. This dynamic is tied into hierarchy as a barrier (Table 3).

> *"So the pharmacist can maybe bring up the fact that he wants to advocate for a different antibiotic, but because of the hierarchy, it'll be the intensivist that makes the decision, and we don't always necessarily change our mind even if we've been suggested that we should". AS19_PICU_Physician*

The PICU seemed to rely more heavily on actual shared decision-making with pharmacists (mentioned by all the PICU respondents). The PICU respondents identified the pharmacists as a source of information and education for AS. The CTU physicians identified pharmacists' presence as important, but relied on them less for AP decisions, and instead considered pharmacists to be "contributing" to decisions, especially around certain aspects such as dosage and duration.

> *"I think the pharmacist is very important and I do think they're terribly under utilized on the teams." AS10_CTU_Physician*

> *"Whether your attending is open to suggestions, or you have an attending who just wants to make their own decisions. Yeah, the dynamics of the team. If it's a team where everybody works together and everybody's opinion is valued, then it's good. If it's attendings' choice, then sometimes issues, I think, are not brought up that should be brought up.* AS3_Pharmacist

Barriers across the various SDAPs to AP

Barriers to appropriate AP in both the PICU and the CTU included: *Norm of noninterference and Professional comparisons*. Whereas these barriers were common to both the PICU and CTU, there were some subtle differences with the PICU identifying concerns with the *norm of noninterference* in AP from the second attending physician and their peer comparison was perceived as

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Table 3. Themes arising for the Pediatric Intensive Care Unit (PICU) and Clinical Teaching Unit (CTU) teams as barriers for antimicrobial prescribing (AP) and antimicrobial stewardship (AS) across three social determinants of antimicrobial prescribing (SDAP)

SDAP	Barrier Theme	Quote relevant to the theme by PICU clinicians	Quote relevant to the theme by CTU clinicians
Relationship between clinicians	Norm of noninterference (Presence of second attending in PICU or handover in CTU)	*If you have a leader who has a very big ego or a strong personality who's maybe less approachable, then the other team members like the second attending, the resident, the pharmacist may not be as comfortable sharing views that may not agree with that person AS5_PICU_Physician*	*One impact is it is difficult to sometimes change the plan when one attending has made a plan signing it over to the next attending that the second attending sometimes feels that perhaps their hands are tied a bit and that they will continue with the first attending's plan because that was the plan that was laid out. AS12_CTU_Physician*
	Professional comparison: Perceived group pressure (PICU) and Peer judgment (CTU)	*I know the expectations of my group and I prescribe antimicrobials based on that expectation, so I would probably tend to be less conservative in my antimicrobial choices, but I think just knowing the way my group practices, I think the decisions I make often are what I know other members of my group would expect based on the condition I'm treating. AS6_PICU_Physician*	*"Yeah, it definitely also depends on how much the physician relies on pharmacists, so if it's someone who doesn't like pharmacists to be involved then I probably won't make as much recommendations. Whereas it's a very good team relationship, like everyone voices their concerns whether it's valid or not, there's no judgment then it's a lot easier to talk about it and have a discussion and make" AS9_CTU_Pharmacist* *If you're missing that, and the child becomes even sicker because you stopped antibiotics, obviously a risk to the patient and family mistrust, I suppose. Judgment from other people as well, I suppose, if the child gets worse. AS4_CTU_Physician*
	Hierarchy and egos	*I do think, at the end of the day, it is hierarchical. The intensivist usually has the final say." AS11_PICU_NP* *"I guess you could say that there are stronger, more dominant personalities that are always present that may want to dominate or make decisions." AS20_Resident* *I should say, there's a lot of pressure from the group within which you practice. For instance, even times where I feel I would start narrower antibiotic coverage, I feel there may be a lot of criticism from my group from doing so. AS2_PICU_Physician*	*How about personality and egos?* *I haven't seen really a significant impact there. AS13_CTU_Phyisician*
Risk, identity, fear, uncertainty and emotion	Clinical factors: Clinically unstable child, diagnostic uncertainty	*Given the risks of further deterioration, its is sometimes easier to just keep the big gun antibiotic going for a set duration knowing that we have no idea what bug we are treating. So that's difficult. AS5_PICU_Physician* *In the absence of culture results, my default is always going to be to cover a hospital-acquired infection very broadly .... I don't sit and think about particular patients and what might be a better choice for them. PICU_Physician* *But a lot of fear plays into it, because the kids are so sick, so they don't want to miss anything. Like I said, even if they have a bug back, sometimes they won't narrow therapy. So a lot of fear-based prescribing. AS16_PICU_Pharmacist*	*"Can I do less," that's something that's easy to put off, instead of those ones where your kid is getting sicker and you're asking ID, "What should I do more?" That one, you're going to prioritize." AS10_CTU_Physician* *Sometimes it will be how sick the child was on presentation. For instance, if I was going to go higher than the usual dose for ceftriaxone, for instance. If they thought 50 per kilo would be okay, but we're going to use 80 or 100 because they looked terrible and they got 60 cc per kilo on presentation. So, I think how unwell they look helps to weigh us a little bit higher. AS9_CTU_Pharmacist*
	Resource limitations: Day of week (weekends) and night time	*"Well on weekends, we have less resources, so we don't have. I feel like we consult ID more at that time, or I think maybe we're not as good at being aware of antibiotics on the weekends, just because of our resource and our times, and the ... It's also the mentality of, "We're on the weekend. We're just kind of maintaining the course of care," you know?" AS1_PICU NP* *"... I'm sure Fridays are probably worse than Mondays as far as decision making goes" S2_PICU_Physician* *"I guess if you're running short on time, then sometimes the antimicrobial decisions are sort of rushed or maybe even put off till the next day if the rounds are getting too long and we're running short on time" AS6_PICU_Phyisician*	*"So definitely on weekends it's a more vulnerable time, so perhaps antimicrobial decisions are made with less research and less input on the weekends." AS13_CTU_Physician* *It influences my decision on nights to the daytime in that I often defer the decision as to whether the antibiotics are continued or not to the day team physician AS4_CTU_Physician* *I would maybe feel Mondays and Fridays and the weekend AS14_CTU_Pharmacist*

(*Continued*)

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Table 3. (*Continued*)

SDAP	Barrier Theme	Quote relevant to the theme by PICU clinicians	Quote relevant to the theme by CTU clinicians
	Fear of consequences: equating AS with the less safe choice	*I think the main factor is the safety of the patient. Because in the PICU our patients are very sick. So, I always feel a burden of responsibility that if I don't start antibiotics and this patient continues to deteriorate and dies, that is very avoidable and very sad in a first world country. So, I think it's the fear of, the main issue is the fear of a poor outcome. Especially when our patients already have so little reserve. AS6_PICU_Physician*	*Or fears. I think the biggest reservation and fear would be lack of evidence and so for example if we were to treat an E. coli bacterium in a neonate with seven days of IV antibiotics there is not enough literature to support that decision yet, and so I believe that there is a risk there to the patient and there is a risk to myself. For example, if the patient was to have a recurrent infection, then there's not very much evidence that I feel like I still have lots to learn in that regard. AS4_CTU -Physician*
	Feeling inadequately trained in AS to apply it in the local culture and context	*I don't know if I feel good at all. I think I know things but I don't know if I know a lot. I know some antimicrobial stewardship, I do antimicrobial stewardship, but I always feel like there's a lot more to learning and get better at. I don't know if I would say I'm very strong with it. AS17_PICU Pharmacist*	
	Pessimistic that as a group the team would become good stewards	*Maybe a bit less optimistic about PICU's ability. I think that there are definitely some strong physicians that are very reluctant to narrowing antibiotic and that that's really hard for the team to argue against. AS11_PICU_NP*	*I feel like I've had to train myself, for the most part. And I've had training from more experienced pharmacists. But I think there's always room to learn more? So, I would say, on a scale of one to 10, I may be . . . Seven? AS16_PICU_Pharmacist*
Misperception of the Problem	Inadequate AS education Difficulty accessing guidelines and staying informed	*Can you recall any specific educational initiatives or opportunities you have had for antimicrobial prescribing on PICU rounds? Interviewee: Not really. AS19 PICU_Physician I feel very poorly trained. I need a lot of help AS2_PICU_Physician*	
	Pejorative monitoring system	*I would worry a little bit about a monitoring system in that, oftentimes, a monitoring system perhaps doesn't quite capture all the details and all the smaller bits of information that go into choosing your antimicrobial for a specific patient, and I feel like that would make people worry and, perhaps, lead to perhaps dangerous circumstances for patients if physicians felt like they were being watched and there would be negative repercussions of some sort for the decisions that they make one way or the other. AS15_Resident*	*I think you have to be careful about doing that. You have to be very careful that people aren't feel they're being judged or they're being penalized, or they're being embarrassed in front of trainees, would have to be done carefully. AS22_CTU_Physician*

group pressure towards broader and longer antimicrobial treatment (and away from AS practices). The CTU on the other hand, identified the *norm of noninterference* from the sign-over physician while the peer comparison was more associated with peer judgment (with respondents stating that they were concerned that if there was a poor patient outcome secondary to them narrowing antimicrobials, they would feel their group would consider them to have made a poor judgment and choices and that this negatively impacted their AS choices). Other barriers included *Clinical status of the child, Diagnostic uncertainty, Environmental resources limitations (such as time of day, days of week, and size of team), Fearing consequences, Difficulty accessing guidelines, Feeling inadequately trained in AS* and a *Pejorative monitoring system* (where the prescribers feel put down or judged by the monitoring system). Barriers across the SDAPs are shown in Table 3 below.

Differences in barriers between PICU and CTU

The most notable differences in barriers (noted as shaded in Table 3) were *hierarchy* and *egos* in the PICU (on the side of the PICU attending as well as ID consulting physicians) whereas all the CTU respondents denied that this was a concern. Similarly, 75% of all the PICU respondents expressed pessimism about the group's ability to be good stewards. Residents perceived the CTU as being more committed to appropriate AP. They also noted that there was a positive trend in the PICU with regards to better AS practices as a group over the course of their training. Overall, the resident group felt more *optimistic* about the PICU's AS practices than the PICU physicians as well as the NPs felt about AS practices themselves. All respondents in both the PICU and CTU denied that medico-legal concerns for consequences contributed to their decision-making.

Education needs of the PICU and CTU: The who, where, when, and what of AS education

The educational needs of the PICU and CTU teams were assessed via both the quantitative and qualitative phases of the research. Whereas some education-specific information was gleaned from the TDF domain nodes such as knowledge and skills, respondents were also specifically asked to reflect on previous AS education, and on the practical implementation aspect of AS education for the PICU and CTU teams. This is depicted in Table 4.

Discussion

Using mixed-methods research design with a psychosocial approach, we identified facilitators and barriers affecting AP and

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Table 4. Education needs of the Pediatric Intensive Care Unit (PICU) and Clinical Teaching Unit (CTU): The who, where, when and what of antimicrobial stewardship (AS) education

The "What, When, Where, How and Who" of AS Education		Source
The **"What"** of AS Education	• PICU Antibiotics: Meropenem and Piperacillin-tazobactam Vancomycin and Linezolid	Quantitative phase: Distribution of antimicrobial classes identified as AS concerns by pharmacy over a 6-month period on the PICU and CTU patient-centered rounds.
	• CTU Antibiotics: Meropenem, Piperacillin-tazobactam and Ceftriaxone	
The **"When and Where"** of AS Education	Around cases, at the bedside in a practical fashion (not on rounds)	*Quote: In a way that doesn't slow rounds down, because we already have a lot to discuss and talk through on patients. So in a succinct, constructive way, as we were talking through the antibiotics decisions about the patient. AS19_PICU_Physician*
		Quote: Rounds is a terrible place to make decisions and you don't get great decisions that come out of that environment. It's pressured. AS10_CTU_Physician
The **"How"** of Education	Easy availability of guidelines, direct conversation with AS team	*Quote: I would like to learn about it ideally would be at a time when the information is needed and that's according to adult learning theory, so I have a patient with invasive mastoiditis and it would be nice to have . . . The best way to learn about it would be at the time that the patient is in front of me because then it would be most, I think the information would stick longer. AS12_CTU_ Physician*
The **"Who"** of AS Education in PICU	Audience: entire PICU team with a special focus on the PICU physicians, Education Provider: Pharmacist	*Quote: if you have a pharmacist, you probably get a very rational approach to it because we're . . . Like that's how a pharmacist would approach it. I'm not saying physicians aren't rational, they are very rational, but sometimes there is that gut feeling, or that emotion that's attached to the prescribing as well. It's a hard one because if you want an evidence-based teaching approach, ask a pharmacist to do it, because they'll teach you the criteria and all other stuff, and they'll be very black and white. AS17_PICU_Pharmacist*
The **"Who"** of AS Education in CTU	Audience: entire CTU team, Education Provider: Collaboratively, by various CTU members	*Quote: I think I guess we all have a role as attending physicians. We have a role to teach our residents and our medical students as well as other team members and share any specific knowledge that we have. We also have very knowledgeable team members that can teach as well like the pharmacist. They're part of our team. They can teach as well. AS13_CTU_Physician*

AS practice on PICU and CTU teams and mapped them to SDAPs. We explored the SDAP1: *Relationship between clinicians* and identified facilitators such as *collaboration and trust, shared decision-making*, while the barriers identified were *peer judgment* and *hierarchy*. We identified psychosocial factors that related to SDAP 2: *Risk, identity, uncertainty, fear, and emotion* for AP on PICU and CTU teams (e.g. facilitators included *reliance on guidelines*, *individual and group optimism/pessimism* around AS, being *backed up in AS practices by the ID service and pharmacy* while barriers included: *fear of consequences* in the face of decompensating clinical patients, *diagnostic uncertainty, feeling inadequately trained in AS* and *environmental constraints such as time of day and day of week*). Factors related to SDAP3 were: *(Mis) perception of the problem*, tied closely to AS goals, also emerged out of the data (goals that facilitated AP were: *optimizing care for the patient and feeling empowered as a prescriber*, as well as appreciation of the *accountability* that comes with AS, while barriers included a *pejorative monitoring system*).

The study also generated important factors to consider for the PICU and CTU with respect to their educational needs: *what, when, where, how, and by whom* factors of education. Our findings can be used to help build an education framework for AS for the PICU and CTU, based on behavioral and social determinants of AP. This understanding of the steward-prescriber relationship and psychosocial factors of AP within this setting as well as an assessment of the educational needs, could allow for a grassroots approach to curriculum development.

Strengths and limitations

Our study has many strengths. The study used an established framework, the TDF, to explore the theoretical mechanisms of action and change to understand AP. By using the SDAPs, we combined the social and behavioral constructs in the analysis which allowed for the engagement of broad groups of influencers: the PICU and CTU physicians, NPs, resident physicians, and the pharmacists from PICU and CTU. The broad engagement ensured the voices of the prescribers were heard, while also engaging them to allow for the "buy-in" aspect, boosting the feasibility and implementation of future interventions. Our study also looked at education for the entire PICU and CTU teams, which represents a more real-life and pragmatic approach to prescriber education. Often AS education is targeted towards a certain group, and few have directed education towards pharmacists and other members of the prescribing team.[12,14,21–23] In reality, the AP decision is a very social decision that requires consideration of team dynamics and multiple team members, especially in institutions that have patient-centered clinical rounds.

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Our study is not without limitations. Our study utilized an opportunistic (convenience) sampling strategy and relied on self-reporting of data which may have recall bias. It is possible that the respondents were more motivated towards AS and biased in their views on this topic. However, we included a varied sample of clinicians with multiple perspectives. The observational component, in the quantitative phase of the study further improved the integration of the data while also allowing for triangulation of the data. Having the quantitative data available enhanced the granularity of the qualitative interview guide as well as added depth to the data, improving the validity of the findings.

Gender bias might also have influenced the results. All the NPs identified as women and there was a predominance of women CTU respondents as well. This does reflect the pediatric hospital context, as our site only has women NPs in the CTU and PICU. This gender difference might be impacting the qualitative results. Previous work that applied a gender lens to AP has shown that concordance (woman physician-woman patient) may have a lower overall AP in the community.[24] Whereas we do not have evidence of this in the pediatric inpatient setting, the gender imbalance is a limitation, as gender plays a role in team collaboration and hierarchy, which were issues identified as salient for AP in our work.[25]

Implications for future research

Future research needs to examine experiential learning, especially around institutional and ASP-related goals such as intervention buy-in and uptake, antimicrobial utilization patterns, patient-centered outcomes, and ultimately antimicrobial resistance patterns. Barriers identified in the PICU such as hierarchy and ego, group pressure, and pessimism around the group AS practices, indicate a need for cultural change in this setting. Ultimately, a culture of AS practice will foster a better culture of collaboration and shared decision-making, which are facilitators identified by the PICU team for better AP. Overcoming hierarchy and group pressure contributes to PICU team education goals of feeling empowered as prescribers and optimizing patient care, which are at the heart of safe, patient-centered pediatric care.

Conclusions

This work identifies barriers and facilitators to AS among PICU and CTU teams as well as gaps in psychosocial-based AS education. The work presented here broadens the scope of research on understanding how teams in a tertiary pediatric care center make AP decisions.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/ash.2024.8.

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Competing interests. The authors have no conflicts of interest to declare.

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