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Considerations for Designing EHR-Embedded Clinical Decision Support Systems for Antimicrobial Stewardship in Pediatric Emergency Departments

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Abstract

Objective This study was aimed to explore the intersection between organizational environment, workflow, and technology in pediatric emergency departments (EDs) and how these factors impact antibiotic prescribing decisions.

Methods Semistructured interviews with 17 providers (1 fellow and 16 attending faculty), and observations of 21 providers (1 physician assistant, 5 residents, 3 fellows, and 12 attendings) were conducted at three EDs in the United States. We analyzed interview transcripts and observation notes using thematic analysis.

Results Seven themes relating to antibiotic prescribing decisions emerged as follows: (1) professional judgement, (2) cognition as a critical individual resource, (3) decision support as a critical organizational resource, (4) patient management with imperfect information, (5) information-seeking as a primary task, (6) time management, and (7) broad process boundaries of antibiotic prescribing.

Discussion The emerging interrelated themes identified in this study can be used as a blueprint to design, implement, and evaluate clinical decision support (CDS) systems that support antibiotic prescribing in EDs. The process boundaries of antibiotic prescribing are broader than the current boundaries covered by existing CDS systems. Incongruities between process boundaries and CDS can under-support clinicians and lead to suboptimal decisions. We identified two incongruities: (1) the lack of acknowledgment that the process boundaries go beyond the physical boundaries of the ED and (2) the lack of integration of information sources (e.g., accessibility to prior cultures on an individual patient outside of the organization).

Keywords
- clinical decision support
- antimicrobial stewardship
- process boundaries

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Conclusion Significant opportunities exist to improve appropriateness of antibiotic prescribing by considering process boundaries in the design, implementation, and evaluation of CDS systems.

Background and Significance

Antimicrobial resistance is a threat to effective clinical care and a major public health concern.[1–3] Resistant bacteria account for 2.8 million infections and 35,000 deaths annually.[4] Resistant organisms have evolved from selective pressure exerted by decades of excessive and inappropriate antibiotic prescribing.[2,5] Approximately 10 million emergency department (ED) outpatient antibiotic prescriptions are written annually in the United States, with up to 50% being inappropriate or unnecessary.[6–8] Consequently, multiple organizations and societies have emphasized the need for antimicrobial stewardship programs (ASP) in the ED.[9] In the inpatient settings, ASPs have reduced unnecessary antibiotic use by as much as 36%,[10–13] and produced institutional cost savings of up to $900,000 per year.[14] Failure to implement ASPs in EDs has been, in large part, the result of challenges unique to this setting and failure to consider clinical context during implementation.[2,15,16] ED clinicians often need to make rapid decisions and are frequently interrupted during the decision-making process.[2,16] In addition, guidelines are rarely tailored to the context of the ED environment and end-user needs. To successfully implement ED-based ASPs and produce the desired behavior change of improved antibiotic prescribing, it is necessary to account for both the clinical environment and end-user needs.[2,17–19]

Use of health information technology (HIT), specifically the electronic health record (EHR) and clinical decision support (CDS), is a potentially effective method for successful implementation of ASPs in the ED.[20–24] In fact, ED providers prefer to use EHR-based CDS for ASP implementation.[25,26] Use of the EHR for ASP implementation permits incorporation of the Centers for Disease Control and Prevention "core elements" of outpatient antibiotic stewardship: (1) accountable justification for antibiotic choice, (2) CDS to promote guideline-adherent prescribing practice, (3) monitoring of outpatient antibiotic prescribing, and (4) delivering provider feedback.[27] These core elements must intertwine with CDS design and implementation practices that also promote ED uptake of ASP, namely, by provision of CDS within the clinical workflow and at the point of care, to be most effective.[28,29] Additionally, emerging standards for EHR-agnostic implementation of CDS will support future dissemination efforts across multiple EDs.[30] Success of CDS systems, however, depends on various individual and organizational sociotechnical factors such as acceptability, usability, appropriate task allocation between people and computers, and incentives for appropriate use. Failure to methodically develop HIT interventions has contributed to the variable success of EHR–CDS in affecting clinical care.[31–36]

The purpose of this study was to gain design-oriented insights by examining the intersection of organizational environment, ED workflow, and technology related to decision making on antibiotic prescribing. Examining such interactions helps define the process boundaries that should be considered in decision making in EDs and identify the needs of ED clinicians to support appropriate decisions. Process boundaries separate the activities included in a process at hand (i.e., antibiotic prescribing) from other (excluded) activities. In other words, activities within the process boundaries are considered in relevant decisions. Pinpointing imprecise process boundaries can lead to poor HIT design.[37–40]

Methods

We conducted a cross-sectional qualitative descriptive study that utilized direct observations and semistructured interviews. Qualitative methods were utilized because of the exploratory nature of the study.[41,42] The combination of semistructured interviews and direct field observations is used in qualitative research to understand the reasons of clinicians' actions by exploring their perceptions, experiences, and attitudes. Semistructured interviews also give clinicians the opportunity to generate ideas to improve the practice.[43]

Settings

This study was conducted within the Pediatric Emergency Care Applied Research Network (PECARN). We collected data from three high-volume PECARN EDs in the United States. One ED was in the Mountain region, one in the Midwest, and one on the West coast (►Table 1).

Sample

Using a convenience sampling method,[44] lead investigators at each site recruited providers for interviews or direct observation (or both) during a regularly scheduled shift. Probability sampling was not practical, considering the fact that the sample pool is relatively homogenous and consisted of available clinicians who served as rich data sources. For ED workflow observations, we included providers with various levels of training, including physician

Table 1 Study locations, number of beds, and annual patient visits

Emergency department (ED)	Location	Hospital bed capacity	Number of ED beds	ED annual census
ED-1	Mountain region	444	48	73,000
ED-2	Midwest	616	62	84,000
ED-3	West coast	132	16	20,000

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assistants (PAs), nurse practitioners (NPs), fellows, and attending faculty physicians (pediatric and general emergency medicine). For the interviews, we included ED physicians (pediatric and general emergency medicine).

Data Collection

Two data collection methods were employed for this study: observations and semistructured interviews.[41,42] Observation tools, procedures, and interview guide questions were piloted at ED-1 in October 2018. Data were then collected at ED-1 between November 2018 and February 2019, at ED-2 in October 2018, and at ED-3 in December 2018.

We conducted direct field observations to capture ED workflow, providers' usage of HIT, providers' antibiotic decision-making processes, and barriers and facilitators to antibiotic prescribing. Two observers (M.O. and N.M.) were introduced to providers in the ED at the beginning of each observation period and shadowed them at least 4 hours during the day shifts, documenting pertinent information. Providers solicited verbal consent for observations from patients and/or patient families when visiting patient rooms. Clarifying questions were asked of the provider when necessary, but the investigator was primarily a silent observer (i.e., with no patient interactions). Two observers shadowed the same provider the majority of the time unless only one observer was requested by the provider. When the one observer was requested, the other observer shadowed the resident working with the attending, if the resident granted consent. Both trained observers digitally transcribed their handwritten notes at the conclusion of each observation session. Both sets of notes were reviewed by the principal investigator (R.D.M.), who sought clarification on any differences in observations.

The semistructured interviews in this study were directed by a 14-question interview guide developed and pilot tested by the research team prior to data collection (►Supplementary Material S1, available in the online version). The open-ended questions focused on understanding provider antibiotic prescribing practices, factors that might impact decision making, and current usage of tools and resources to facilitate/enhance clinical decisions on antibiotic prescribing in the ED. Two trained study investigators interviewed clinicians in conference rooms adjacent to the hospital, outside of their clinical time. Prior to each interview, clinicians provided written informed consent. Interviews were then captured with participant's permission using digital audio recorders and transcribed verbatim.

At the conclusion of each day, study investigators independently documented thoughts and impressions for later coding and analysis. Regular debriefing by the research team occurred as soon as possible, but within 48 hours of the visit. Debriefing allowed for research team members to discuss their perspectives on data collection and the quality of the data collected.

Data Analysis

Qualitative analysis was based on a theory-driven approach.[45] Prior to coding and thematic analysis, all verbatim interview transcripts and observation notes were aggregated in Dedoose, a qualitative data management application that facilitates qualitative coding and data analysis.

Coding was accomplished in two cycles. In the first cycle, study investigators focused on data immersion, memoing, reflecting on the literature and emerging stories, and developing a draft codebook. Initial codes were based on literatures on workflow, technology, and organizational research. Then, two study investigators (M.O. and N.M.) independently reviewed a subset of interview transcripts. As the data were reviewed, the initial codes were revised and new codes were identified. Codes were reconciled to develop a draft codebook that consisted of 52 codes across 17 categories in a hierarchal structure.

In the second cycle, investigators used the codebook to apply the codes to all interview transcripts, observation notes, and memos. Existing codes were revised as needed and new codes were added using an inductive coding method. Once coding was completed, codes were pulled to create links in the data and identify emerging themes. The relationship between the themes, in terms of which theme affected the other, was determined by concurrent coding of the same data. Additionally, we had open discussions among team members to arrive at consensus regarding the relationship between themes.

Results

Twenty-one providers were observed (1 physician assistant, 5 residents, 3 fellows, and 12 attendings). A total of 34 hours of observation was conducted, 13.3 hours in ED-1; 10.3 hours in ED-2; and 10.5 hours in ED-3. A total of 17 providers (1 fellow and 16 attending faculty physicians) consented to be interviewed. No participant declined to participate. Total interview duration was approximately 12 hours, with each interview ranging in length from 20 to 38 minutes. The mean number of years providers had been at ED-1 was 9.8 years, ED-2 was 8.5 years, and ED-3 was 7.3 years. Three interviewees were also shadowed, one in each study setting. All were attending level physicians. Our analysis revealed seven themes.

1. Professional judgement: professional (clinical) judgement, which is a result of experience, has an important role in antibiotic prescribing decision making. As summarized by one participant: "most of the time I do what I think is right"—provider at ED-2 (Midwest ED). Decisions based on professional judgement may vary individually for similar situations. Providers may have different opinions whether antibiotics should be initiated in ED or by a subsequent provider (e.g., primary care and inpatient provider). Clinical variables, as well as social determinants of health (SDoH), are considered in prescribing decisions. Maximizing clinician use of professional judgement and avoiding potential biases depends on cognitive resources (e.g., attention and memory). A majority of providers either explicitly or implicitly mentioned professional judgement as a way of closing the gap between time constraints and imperfect information. However, interruptions, fatigue, and the busyness of the ED may impact clinician's judgement. One provider stated that

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"clinical judgement decreases the more fatigued you are. In all respects."—provider at ED-1. Another clinician explained:

"The more exhausted or disinterested you are, the less you're going to look into details and the more you're just going to do things by rote memorization or practiced patterns or inertia."—provider at ED-3.

2. Cognition as a critical individual resource: clinical decision making, especially as it pertains to antibiotic prescribing, requires considerable cognitive functioning (reasoning, remembering, problem solving, decision making, and attention). Clinician's fatigue can affect cognitive capacity. One of the providers detailed the effects of fatigue as follows:

"(fatigue) just affects things in the way that it affects everything. Quality of care and the speed of decision making goes down. The more likely that you say "oh I'm going to treat that person with these antibiotics" and then forget to write the order because I'm so fatigued. Or more likely to write the order on the wrong patient because I'm so fatigued. We know these things about physicians in general, and I certainly know that about myself. When I'm fatigued it's more likely to happen."—provider from ED-1 (Mountain region ED).

Busyness is another factor that affect cognitive workload and may lead to suboptimal antibiotic prescribing practices as exemplified below:

"When I am very busy… I'm more afraid of missing something. I have less time to think really carefully and so maybe if I looked very closely at that urinalysis, I would go that's actually a contaminated sample or I would have time to plug it into a UTI [urinary tract infection] like calculator that will actually give you a true risk based-off of the UA [urine analysis] and the symptoms. And I might do that but if I'm very busy I might just go (with) what was good enough let's just prescribe some antibiotics and be done."—provider ED-3 (West Cost ED).

Patient complexity, staffing, organizational culture, and other factors can work together to either increase or decrease the cognitive load on a provider. If activities on the unit become hectic, a provider's cognitive resources can be depleted sooner, resulting in poor judgement and vulnerability to errors that affect antibiotic prescribing. Reducing workload on memory is the method to prevent interruptions and distractions from affecting the task of antibiotic prescribing.

3. Decision support systems as a critical organizational resource: we found a commonality among providers which included (1) the majority used one or more decision support tools regularly in their practice, particularly to make antibiotic choices and (2) a desire for assistance in antibiotic prescribing. The most common tools used among all participants were order sets/smart sets, particularly at discharge. While the actual design in the EHR varied from site to site, providers repeatedly mentioned using and liking order sets. The perceived value of order sets was explained this way:

"The discharge set helps you decide. It has diagnosis and explains like what each diagnosis is …. So in order to pick the right International Classification of Disease-9th revision (ICD-9), ICD-10 code guides you to do that. It also gives you discharge instructions you can click right in there and do the discharge instructions and it's based on what you're diagnosing them with. And then again, it gives you antibiotic choices …. And then all of those are pre checked so that when I click on the box it automatically pulls in the patient's weight and then it automatically pulls and how many days and all that stuff which is nice …. So I like that."—provider at ED-2.

Additional resources used by ED providers included paper-based documentation, the best practice advisories within the EHR, and consultation with other clinicians. Providers preferred and were more comfortable with CDS resources that they sought out rather, than those that were being dictated to them. While resources were used to varying degrees, there was a clear indication that resources and ease of access could be improved.

4. Patient management with imperfect information: Many decisions related to antibiotic prescribing were made with imperfect (e.g., incomplete, limited, or inadequate) information. Lack of reliable or incomplete history from patients or their families/caregivers, imperfect diagnostic tools and tests, incorrect information, or incomplete information in patient charts (regarding historical or current encounters) contribute to a knowledge gap. For example, "(clinicians) assume sensitivity at the time of prescribing the antibiotics without having that information. Because you send up a culture and it's about 24 or 48 hours before that comes back …."—provider at ED-3.

Imperfect information can also lead to heuristic biases as highlighted by one of the participants: "the last patient you saw is the measuring stick for the patient you're currently seeing"—provider at ED-1.

Providers seek to fill that gap and compensate for imperfect information through the process of information seeking, resulting in less time for other aspects of patient care.

5. Information seeking as a primary task: to decide which antibiotics to use, providers often perform the following information-seeking tasks during clinical decision making: gathering information from patients or other clinicians and consulting guidelines, examining bacterial sensitivities, awaiting laboratory/culture results, and finally ranking and prioritizing this information. This complex, lengthy process consumes cognitive resources and time. Coupled with the repeated interruptions inherent in ED work, this information-seeking process creates opportunity for error that can impact the use of professional judgement.

Information-seeking is also affected by the physical layout of the ED. The three EDs had different physical layouts for workstations. Provider workstations, patient rooms, and nurse workstations were not always in direct proximity. Physical layout plays a role in communication between nurses and providers, which is an important component of information seeking. The "den model" was employed in two EDs. Den model refers to a configuration with providers located in the same room but separated from other clinicians with walls, and bulletin boards communicate relevant information related to antibiotic prescribing guidelines.

6. Time management: prescribing antibiotics appear to have a temporal component. Time of day, workload in the ED, the likelihood of an inpatient bed becoming available for admission, can all impact a provider's prescribing practice. Clinicians will often employ different waiting strategies

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during which they seek more information to make the correct diagnoses. Waiting strategies include closely watching symptoms and signs in the ED, and parent observation at home to assess the progress of the patient's health condition. Some participants reported that patient education and shared decision making can increase the efficiency of waiting strategies; however, these discussions are often rushed, or even not performed, due to the time required to conduct them appropriately. Time management comprised several clinical, patient-related, and contextual factors. The contextual factors include busyness of ED, whether being at the end of the shift, time of the day and fatigue level of the clinicians. These factors affect time management and, ultimately, decision making.

"The time of day for example affects antibiotic prescriptions that we're much more likely to make quick decisions and not want to really talk to patients about appropriate prescribing, as the day goes on. Sort of decision fatigue as the day goes on and I think that busyness of the ED does also impact that. And then also something that's a little bit less tangible or not as easily found is, what's the case mix? What else is going on? Like the acuity, you know whether or not you have a difficult or challenging patient that you're dealing with. I think all these things make people sort of depleted intellectually and emotionally and then they may be more likely to make different decisions than if they, which may be just the easiest decision. But means that reverting back to whatever they learned or giving into that antibiotic that isn't really necessary."—provider at ED-1.

"I think in general the fallback would be to treat when you're tired at the end of a shift and you're just trying to … clean up and get out of there."—provider at ED-3.

"Busyness can affect decision-making …. I'm not convinced it has a significant impact on what you choose. It may impact when you chose. Might make your move a little faster. Per patient though, you might get to each patient a little bit slower."—provider at ED-2.

7. Broad process boundaries of antibiotic prescribing: the process boundaries (where and when relevant activities occur) are not limited to the time spent with patients while in the ED. Ultimately, providers' inclusion of factors outside the immediate process boundaries of an ED visit may affect antibiotic prescribing decisions. Lack of a primary care provider, perceived low probability of follow-up, fear of missing an infection, and other SDoH often trump professional judgement and waiting strategies. In fact, antibiotic prescribing practice may ultimately be determined by the patient's environment after they leave the ED, as reported by two participants: "time of day. SDoH. Like, this is a family with really poor access to care. I might be more likely to give certain types of … either antibiotics that don't need to be refrigerated if they're out on the street or antibiotics that are longer lasting."—provider at ED-1 and "Like my prescribing habits may have more to do with the fact that I can't get the right antibiotic to the patient …. I don't know which ones are covered by whose insurance, and that really changes my prescribing pattern with urinary tract infections in particular."—provider at ED-3.

►Fig. 1 shows the relationship between the seven themes that emerged from the data related to antibiotic prescribing decisions. "(2) cognition as a critical individual resource" factors heavily into a clinician's appropriate use of "(1) professional judgement," which contributing to "(4) patient management with imperfect information." "(5) Information seeking" impacted both of these factors, with "(3) decision support as a critical organizational resource" driving much of the information seeking. "(5) Information seeking" also affects "(6) time management." Cognition also affects information seeking. "(4) Patient management with imperfect information" and "(6) time management" emerged as the two main themes impacting the temporal and geographical scope of a provider's prescribing habits, which we labeled "(7) broad process boundaries of antibiotic prescribing."

Discussion

In this study, we focused on the intersection of organizational environment, workflow, and technology to gain insights into meaningful designs of CDS for implementation of antibiotic stewardship in the ED. We noted that decisions regarding prescribing antibiotics required appropriate time management, information-seeking using professional judgement, use of imperfect information, intensive use of cognitive resources, the use of decision support tools, and the consideration of broader scope than the ED environment. As identified in prior studies, we found that antibiotic prescribing in EDs is complex,[2,46] with continuous interactions and interplay among multiple individuals, organizational factors, and competing tasks. Although implementation of CDS systems are promising for antimicrobial stewardship in the ED, their success depends on the extent to which these interactions are adequately considered during design and implementation.[18,47,48] In general, CDS is expected to encourage providers to use antibiotics only when they are needed, select appropriate antibiotics, choose only sufficient durations of therapy, and improve medication compliance of patients. Technology plays an important role, but it should be supported by other elements (e.g., policies, patient education, staff education, and mechanisms to better link patients to primary care) of the health system for an ideal ASP. The findings of this study highlight this and could be used to inform the development of effective EHR-embedded CDS in EDs, by pushing the processes boundaries of antibiotic prescribing and making CDS context sensitive.

The main contribution of this study to the existing literature is the detail provided about the process boundaries that should be considered in designing CDS. The process boundaries of antibiotic prescribing are broader than those covered by existing CDS systems. Incongruities between process boundaries and CDS design can under-support clinicians, and potentially lead to suboptimal decision making. We identified two incongruities in this study: (1) the lack of acknowledgment that the process boundaries go beyond the physical boundaries of the ED, and (2) the lack of integration of information sources.

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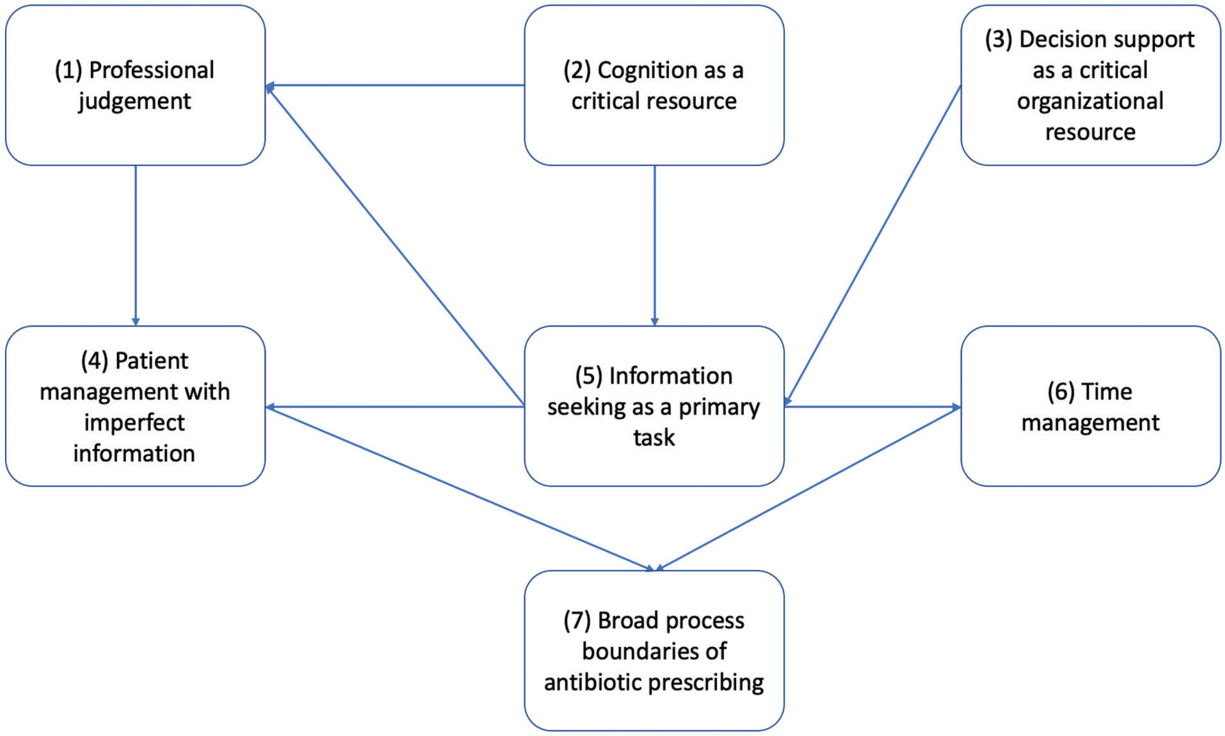

Fig. 1 Emerging themes and their relationship.

Process boundaries that should be accounted for in CDS design include (1) supporting collaboration of ED clinicians with patients and clinicians in other settings (e.g., primary care settings and daily living settings), and (2) facilitating ED clinicians' access to the information that is available outside of the ED. Close collaboration and engagement with patients and their families (and other proxies) is essential in appropriate antibiotic prescribing. However, it may be difficult to accurately communicate the subtleties of each clinical situation to patients and their proxies.[49] Visualizations or probability-based results (provided by CDS) are easier to convey to patients and families (e.g., an infection is bacterial versus viral).[50] Having visual representations for patients to explain clinicians' decisions may increase the patient's likelihood of medication compliance and extend the influence outside ED settings (e.g., primary care settings and daily living settings). Suggested mechanisms to enhance the effectiveness of ED CDS systems could include directly populating discharge instructions. This could include patient-friendly guidance on antibiotic use and indications for returning the ED or seeking care at primary care settings. A health system that facilitates close follow-up (with primary care physicians) would potentially make ED clinicians more confident with prescribing decisions even with "imperfect information," as there will be a safety net and potential opportunity to start or change the antibiotic, if necessary. CDS can help clinicians assess the likelihood for close follow-up, by reviewing information such as insurance status or other SDoH.

Facilitation of outside information is an additional process boundary to be overcome by CDS. Given that information seeking is a primary task, CDS systems that link various resources would make access to needed information more efficiently.[51,52] Critical data, such as patient information (including medical history and allergies), and microbiologic data, such as bacterial epidemiology and antibiotic susceptibility testing, should be easy to find and searchable through simple queries that require minimal effort. Full connectedness of local clinical practice guidelines and third-party clinical pathway services to the EHR could increase a clinician's efficiency and potentially improve antibiotic prescribing. Another suggested mechanism to aid clinicians in antibiotic prescribing, is the development of easy to use and safe mechanisms to remove or inactivate allergies from the EHR.[53] Misattribution of penicillin allergy, for example, is very common and often results in inappropriate choice of broader-spectrum antibiotics.[54]

Our data clearly identified the important role professional judgement plays in antibiotic prescribing decision making. CDS can complement professional judgement by including relevant and contextual data.[55–59] Moreover, trust in the output from CDS is a critical determinant of its use.[60]

Our data suggest that context-sensitive CDS can potentially improve efficiency in decision making related to prescribing antibiotics and provide individualized decision support. These context variables include patient-related (e.g., SDoH), provider-related (e.g., fatigue), and organizational (e.g., busyness, interruptions) factors. SDoH, such as insurance coverage, homelessness, and number and complexity of medications appeared to affect a clinician's decision regarding antibiotic prescribing. CDS could, for example, provide suggestions about when to administer the first dose of an antibiotic prescription by considering patient access to pharmacies or health insurance. Incorporation of provider and organizational factors would also be ideal for CDS design. For example, a CDS that is adaptive to the busyness of the ED (i.e., increases and slows

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down according to the pace of work) by adjusting the number of alerts fired would be ideal. The design of CDS should consider interruptions and distractions, with the minimum possible memory to perform decision making successfully.[61,62] Clearly, however, the complete array of interventions to minimize the negative effects of patient, provider, and organizational factors are beyond CDS design and requires taking a complex sociotechnical systems approach.[63,64]

Limitations

There are limitations to our findings. First, the convenience sample of volunteer participants in the three EDs. Second, we evaluated antibiotic prescribing practices in pediatric academic EDs. The responses of the participants and workflows in these setting may not be fully generalizable to other settings. Third, qualitative studies are inherently susceptible to the assumptions and biases of the study investigators. We utilized analyst triangulation, presentation of direct quotes, written study protocol, and audit trail (of study instruments and data collection, reduction, and analysis) to establish trustworthiness.

Conclusion

Significant opportunities exist to improve CDS systems for appropriate antibiotic prescribing by considering appropriate process boundaries in their design, implementation, and evaluation.

Understanding the interplay of interrelated components in the design and implementation of these systems is critical to achieve the best possible decision making on antibiotic prescribing and improved patient care.

Clinical Relevance Statement

Antibiotic prescribing in the ED is a challenging task. CDS can assist providers in clinical decision making. Significant opportunities exist to improve appropriateness of antibiotic prescribing by considering process boundaries in the design, implementation, and evaluation of CDS systems in EDs; because the information needs of decision-making clinicians go beyond the ED and the patient's time in the ED.

Multiple Choice Questions

1. Which of the following contributes the least to decision making on antibiotic prescribing in EDs?

a. Clinical judgement
b. Patients' current diet
c. Patient history
d. Clinical decision support tools

Correct Answer: As data analysis revealed in this study, many factors contributes to decision making on antibiotic prescribing in EDs. These include clinical judgement, patient history and decision support tools. There is no evidence that patients' current diet is a factor in such decision.

2. Which of the following factors does not make antibiotic prescribing in EDs more challenging?

a. Fatigue
b. Business in ED
c. Age of the patient
d. Imperfect patient information

Correct Answer: This study revealed that, fatigue, business in ED, and imperfect patient information make decision making on antibiotic prescribing in EDs more challenging. There is no evidence that patients' age makes decision making on antibiotic prescribing in EDs more challenging.

Protection of Human and Animal Subjects

The study protocol was approved by the Colorado Multiple Institutional Review Board.

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Conflict of Interest

None declared.

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