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Running Title: Uncertainty and antibiotics in asthma

Uncertainty as a critical determinant of antibiotic prescribing in patients with an asthma exacerbation: a qualitative study

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Abstract

Objective: To identify factors that influence providers' decisions to prescribe antibiotics in patients presenting to the hospital with an asthma exacerbation.

Methods: We performed semi-structured interviews with a purposive sample of providers including sixteen hospitalists, emergency room providers, or pulmonologists, and one focus group with internal medicine residents recruited from one large, urban, teaching hospital and one small, rural, community hospital. Questions were informed by the Theoretical Domains Framework to determine factors that may influence behaviors. Directed content analysis was used to code and analyze transcripts of the interviews.

Results: Uncertainty regarding the diagnostic (asthma vs. COPD) and the cause of exacerbation (bacterial vs. viral infection) emerged as the main driver for prescribing behavior. Provider response to uncertainty included: "watchful

waiting” or immediate antibiotic prescribing. The following factors played important roles in providers’ prescribing decision: 1) awareness/agreement with existing guidelines 2) confidence in their ability to apply the guidelines in challenging cases; 3) perceived risk of patient deterioration without antibiotics; 4) fear of litigation; 5) habit and clinical inertia 6) prescribing within the group 7) lack of information of antibiotic prescribing rates and 8) lack of time and/or resources.

Conclusions: We identified diagnostic uncertainty as the primary determinant of antibiotic prescribing in asthma exacerbations and developed a conceptual model to explain provider responses and factors that influenced their responses. These results enhance our understanding of the factors that can contribute to low-value and wasteful practices like superfluous antibiotic prescribing and will support the development of interventions to de-implement such practices.

Key Words: Uncertainty, antibiotics, asthma, exacerbation, qualitative, interviews, semi-structured, behavior, de-implement, guidelines, model

Introduction:

Asthma exacerbations are responsible for 1.7 million emergency department (ED) visits, 440,000 adult hospitalizations and over 50 billion dollars in healthcare expenditures each year in the US.¹ Among the various triggers for asthma exacerbations, bacterial infections play a minor role; consequently, professional guidelines do not recommend routine use of antibiotics.^{2,3} Nonetheless, prior research has shown that antibiotic prescribing in the setting of asthma exacerbation is common, with rates among hospitalized patients ranging from 30% to 70% in the absence of a clear indication.⁴⁻⁷ The Centers for Disease Control and Prevention (CDC) has estimated that as much as 50% of all antibiotic use in hospitals may be inappropriate and that antibiotic overuse contributes to adverse drug events, hospital acquired infections (e.g. *Clostridioides difficile* colitis), antibiotic resistance, and unnecessary health care costs.⁸⁻¹⁰ For these reasons, reducing unnecessary antibiotic prescribing is an urgent national priority.¹¹

To maximize their chances of success, interventions aimed at decreasing inappropriate prescribing of antibiotics should be based on an empirical understanding of the factors that determine prescribing behaviors. Such factors might be associated with the patient, physician, care setting or larger organizational context. Examples of determinants of practice for antibiotic prescribing identified in prior studies focused on upper respiratory infection (URI) include: patient expectations, patient symptoms, uncertainty in diagnosis and in differentiating viral from bacterial infections, availability and awareness of evidence, inertia, peer practice, perceived autonomy, presence and/or enforcement of hospital policies, fear of missing a bacterial infection, and beliefs about antibiotic resistance.¹²⁻¹⁶

To date, no research has examined determinants of antibiotic prescribing in the setting of asthma exacerbation. This step is critical because the design and choice of strategies deployed to optimize antimicrobial prescribing should be informed by research into prescribing behavior intention.^{15,17,18} In this study, we focused on patients presenting with asthma to the ED or admitted with a diagnosis of an asthma, and explored ED physicians and hospitalists attitudes toward antibiotic prescribing. The majority of published studies exploring the issue of inappropriate antibiotic prescribing included patients with URI in an outpatient setting, who are generally in a stable condition. We hypothesized that given the more acute condition of those who are coming to the ED, some of the drivers could be different, such as fear of deterioration. Even in the broad category of URI, inappropriate prescribing rates vary by condition, suggesting unique factors at play. Based on a qualitative analysis of interviews with clinicians involved in the care of patients hospitalized for asthma, we identified factors that influence antibiotic prescribing across one large healthcare system. We used the knowledge gained from these interviews to create a conceptual model that can guide the development of future strategies to decrease inappropriate prescribing of antibiotics in asthma exacerbations.

Methods

Study setting and recruitment

We recruited a purposive sample of physicians and advanced practice providers (APPs) responsible for prescribing decisions in patients with acute asthma exacerbations at one large academic medical center and one small rural hospital in Western Massachusetts that are part of a single integrated health delivery system. To represent diverse perspectives, we recruited these physicians and APPs from different departments, including emergency medicine, hospital medicine, and pulmonary medicine, and attempted to balance the sample according to gender and career stage. One-on-one semi-structured interviews with the attending physicians and APPs were conducted. We also conducted one focus group with 8 internal medicine residents in the outpatient clinic. We contacted potential participants via email and invited them to complete an interview about antibiotic prescribing in asthma and sent follow-up email reminders two-weeks later. Those who expressed interest were contacted by telephone for scheduling; for their convenience, participants could complete the interview either in person or over the telephone. The sample size was not fixed; we anticipated enrolling 14 to 20 providers for interviews. Interviews continued until we reached thematic saturation.

Interview development

Interview guides explored provider perceptions and motivations regarding antibiotic prescribing. To create the interview questions, we used the Theoretical Domains Framework (TDF) and findings reported in other prior qualitative studies of antibiotic prescribing.^{12-16,19} The TDF consists of 14 domains (groups of constructs from theories of behavior change) and provides a method for eliciting and categorizing barriers and facilitators to implementation as well as individual behaviors. Interviews began by asking providers to describe their typical approach for treating patients with exacerbation of asthma, and to recall a case when they prescribed antibiotics. Subsequent questions focused on: reasons for prescribing antibiotics; awareness of and confidence in guidelines and other evidence-based recommendations (TDF: knowledge); possible patient harms related to antibiotics; prescribing as a contributor to antibiotic resistance (TDF: beliefs about consequences); attitudes regarding decisions to stop antibiotics prescribed by other providers (TDF: professional role and identity); the role of culture and influence of others; organizational context or constraints (TDF: organizational context); and possible strategies to decrease ineffective prescribing. (See Appendix for full interview guide). We piloted the interview guide with three providers and refined questions based on the feedback we received.

Data collection

A team of three women researchers (MS, KS, SZ) conducted the interviews and the focus group. One interviewer is a hospitalist-researcher with formal training in qualitative research (MS), one is a PhD researcher with extensive experience in qualitative research (KS), and one is a resident in the internal medicine program who was trained by the other two researchers on semi-structured interview methodology (SZ). To achieve concordance, the interviewers conducted the first two interviews together. The one-on-one interviews were on average approximately 30 minutes long. The focus-group took 60 minutes, covered the same themes as the individual interviews, and was done in the outpatient clinic during their lunch break.

Data analysis

Verbatim transcripts for each interview session were created from the audio recordings. Qualitative data management and analysis software (NVivo) was used to organize and code the data. Demographic data on the participants, their professional role and clinical practice setting was summarized. We used both deductive and inductive coding. Domains and constructs from the TDF as well as from prior qualitative studies of antibiotic prescribing served as the initial basis for the codebook. Coding occurred concurrently with the interviews to ensure that the interview guide was eliciting data related to the domains of interest. Four research team members (MS, BH, SZ, KS) were responsible for coding. Each researcher read the first four interviews and came to agreement on the use of the domains and constructs as codes, as well as corresponding code definitions and examples. The codebook was refined and used for all interviews going forward, with the team meeting periodically to discuss the emergence of any new codes or to clarify the relevance of domains and constructs. The coding procedures for the focus group were identical. After initial coding of the dataset, the researchers again reviewed the interviews as a team in order to generate foundational themes regarding clinical treatment decision making that were, by extension, considered the core of an explanatory model. Given the fact that drivers for antibiotic prescribing could vary depending on clinical scenarios and settings, we also reviewed the main themes of the interviews to evaluate if there were differences between ED providers and hospitalists.

When we piloted the interview questions, we found that clinicians questioned the generalizability of the results of the large studies which showed a high rate of inappropriate antibiotic prescribing and wanted to know the rate of prescribing in their own institution. As such, we calculated the rate of antibiotic prescribing in patients hospitalized with diagnosis of asthma and no secondary diagnosis of an infection in our hospital.

The study was approved by the University of Massachusetts- Baystate IRB committee.

Results

Participants' characteristics

We reached thematic saturation after 17 interviews and one focus group. Seventeen providers including 7 emergency physicians, one ED APP, one pulmonologist, and 8 hospitalists were interviewed. Table 1 shows the demographic and professional characteristics of the interviewed providers. Sixty-five percent of the interviewees were male, 47% were from the ED, 70% worked with residents and 30% were from the rural community hospital. There was substantial variation in years of professional experience (range: 0 – 37). The focus group included 11 residents from internal medicine.

Interview themes

Table 2 contains the main themes that emerged from the qualitative analysis mapped to the TDF domains. The themes that were identified as influencing antibiotic prescribing decisions and quotes from the interviews (*in italics*) are described below.

Diagnostic uncertainty as the main driver for prescribing antibiotics

All respondents initially stated that they don't prescribe antibiotics in asthma unless there is a clear cause of infection (i.e. pneumonia). Most clinicians challenged the results of earlier studies that reported high antibiotic prescribing rates among hospitalized asthma patients and were surprised to find that the prescribing rate was 35% in their own healthcare system. Further discussions revealed that when clinicians indicated that they do not prescribe antibiotics, they were picturing a classic

presentation of asthma exacerbation (e.g. a 30-year-old, otherwise healthy, non-smoker with asthma from childhood presenting with typical symptoms of an exacerbation). Upon reflection, several interviewees recognized that they are more likely to prescribe antibiotics when faced with uncertainty of diagnosis of asthma versus chronic obstructive pulmonary disease (COPD), such as in an older patient or one with smoking history, especially in the absence of pulmonary function tests. *"It's tough when you're seeing patients who have never been in the hospital, they don't have pulmonary function tests and they just tell you. You know, I have COPD or have asthma and you just have to go sometimes for that and then, of course, that creates the problem there."*

(Interview 11, late-career hospitalist)

Even when providers felt confident that the patient had asthma, another area of uncertainty was related to whether the exacerbation was triggered by a bacterial versus a viral infection. Fever, even in the absence of sputum production, high white cell count, or a potential infiltrate on CXR also influenced heavily their decision. *We're paid to make judgment calls, and there's a lot of grey, right? And putting everyone into a black and white of 'you've got asthma, [you're] given antibiotics.' This is bad."* (Focus Group, internal medicine resident) *"Maybe they really have bronchitis or sinusitis, or maybe some touch of pneumonia because, you know, in chest x-ray, you cannot see all the infiltrate. You see them only on CT scan and you do not want to do all those CT scans."* (Interview 14, late-career hospitalist)

When asked how they proceed when faced with diagnostic uncertainty, providers responded in three main ways: a) prescribe an antibiotic "just in case" there is a bacterial infection; 2) withhold antibiotics and attempt to decrease uncertainty by ordering additional testing or obtaining more history c) withhold antibiotics and observe clinical course (directly or by scheduling a follow-up with a primary care physician). A provider's choice among these alternative approaches was greatly influenced by specific factors which we categorized using the TDF main domains.

Knowledge

Awareness of and trust in guidelines and evidence-based recommendations: Most providers were aware of the existence of guidelines for asthma treatment but did not know which organization published them; the majority referenced Up-to-Date as their main source of 'truth' because of its accessibility. Some of the interviewees expressed the view that asthma is straightforward and that not much has changed over time; as such there was no need to check guidelines. A small number believed that asthma and COPD are very similar diseases and should be treated the same, including the use of antibiotics.

Beliefs about capabilities

Provider tolerance for uncertainty was influenced by their perceived self-efficacy (i.e., their belief that they can follow guidelines recommendations for complex patients); *"And I've convinced myself that [lobar pneumonia] is a viral syndrome for the most part, and antibiotics have no role."* (Interview 02, late-career hospitalist) For physicians-in-training, the decision was less related to their beliefs about capabilities because the attendings influenced those decisions most of the time. *"If [you're] from a hospital where your pulmonologists have always been giving [antibiotics], you'll be like, 'Okay, this is what we do, this is how I was trained, 'cause I had that like someone.'"* (Focus Group, internal medicine resident)

Beliefs about consequences/regret

Fear of deterioration or readmission: This factor resulted in a ‘better safe than sorry’ approach among some providers and tended to favor prescribing. *“I don’t want to miss him getting sicker, and it’s coming back to me. So I’m just gonna give this.”* (Focus Group, internal medicine resident) The perceived risk of non-treatment was heavily influenced by the severity of the presentation and complexity of the patient (comorbidities). *“The different category of patient who have other comorbid conditions, who have like renal failure or diabetes and back and forth, outside being treated for Medrol pack, nebulizers – now you are doubting yourself also because it might not be viral only. And now, the picture is a little changed, a mixed picture going with bronchitis that can lead to pneumonia in [patients. At least] those patients I definitely want to cover because they are in a bad shape right now.”* (Interview 01, late-career hospitalist)

Concerns about antibiotic side effects: Although providers were aware of the problem of antibiotic resistance, they rarely seemed to consider it when prescribing antibiotic. *“So a potential harm is more resistant bacteria. It is both the case for the person and also the general public; but if someone needs it, you just give it.”* (Interview 06, late-career hospitalist) They acknowledged more concern about patient-related adverse events such as *C. difficile* infection, especially if someone had a history of *C. difficile*.

Emotion

Fear of litigation: The threat posed by possible legal implications elicited an emotional reaction for some of the participating physicians, and fear of litigation if a bad outcome could be considered preventable had antibiotics been prescribed. *“We practice very defensive medicine in this country, I think. A lot of what we do is we don’t want to get called up. We don’t wanna get sued.”* (Focus Group, internal medicine resident)

Group norms and group conformity

Providers acknowledged that when the patient has already been started on antibiotics by another colleague they were hesitant to stop them because they were concerned that the initial provider may have had a reason that had not been communicated or just out of courtesy. *“Sometime it’s a professional collegiality issue rather than a medical issue.”* (Interview 04, late-career emergency medicine physician) Noteworthy, most hospitalists were comfortable stopping antibiotics if they were started by an emergency physician, but were less likely to discontinue them if started by another hospitalist.

Behavioral regulation

Habit, inertia or failure to update practice: There was a general belief among young clinicians and resident physicians that those who are further away from residency are more reluctant to update their practice and they are less open to change. *“This happens in medicine all the time where evidence gets ignored...[There is] unwillingness to change habits even in the face of evidence.”* (Interview 02, late-career hospitalist) *“I’ve seen providers who are like, this is the way I’ve always done it. I don’t care what the literature says, this is the way I’m gonna do it.”* (Interview 08, late-career emergency medicine physician) One physician stated that *“I think guidelines are only for residency. I think now you have to modify based on what you see.”* (Interview 01, late-career hospitalist)

Environmental context and resources

Resources: Lack of availability of rapid diagnostic testing such as procalcitonin (PCT) assays or accessibility of data (e.g. laboratory and imaging results) from primary care offices in the EMR and

time pressure were important factors impacting provider decisions for prescribing. *“So the question is, is really less of antibiotics or not, it's can you afford to wait? ...you want to start something, have an idea in your mind, have a pretty expansive workup with things that you think need to be started soon, and move on to the next patient, and then come back and reassess.”* (Focus Group, internal medicine resident)

Patient pressure: A small number of providers thought that the prevalence of prescribing might be patient- driven and reflect the pressure for high patient satisfaction among clinicians. *“And they might tell you whenever I have this, my pulmonologist gives antibiotics. And I just see them for one time, so I'd rather treat them as they're usually being treated.”* (Interview 06, late-career hospitalist)

Pressure for the organization to meet Center for Medicare and Medicaid (CMS) sepsis reporting measures: The emergency physicians indicated that antibiotic overprescribing is the unintended consequence of the hospital emphasis on the CMS sepsis reporting measures:²⁰ *“It's one of those low-risk, high-reward type of things, and...I'd rather just get a dose of antibiotics in because with the sepsis campaign and the reimbursement and everything along those lines, if you don't get the antibiotics in within the hour, you don't get reimbursed for everything else you do afterwards.”* (Interview 17, early-career emergency medicine physician)

The concerns from the residents were largely similar. Naturally, the residents stated that their decisions are influenced by the attending they work with.

When we reviewed the main themes of the interviews to evaluate if there were differences between the ED and hospitalists providers, we found the following: 1) while ED providers were more worried of deterioration or readmissions for patients sent home, hospitalists worried about those admitted with severe exacerbation; 2) ED providers will continue antibiotics started by the primary care provider (PCP) so that they do not undermine the patient's relationship with their PCP; when they made the decision for starting antibiotics, they thought that it will be easy for the hospitalists to stop it when all the tests are known 3) ED providers discussed how the sepsis campaign and the requirements for starting antibiotics within a time frame influenced their decision; 4) ED providers did not think that Procalcitonin would be useful for making decisions on antibiotic use unless the results were quick, while hospitalists were more likely to consider it useful. (Supplemental Table)

Figure 1 shows our conceptual model that integrates the main themes and subthemes uncovered in the interviews and demonstrates how they are interrelated in influencing the decision to prescribe antibiotics. As shown, a provider may encounter patients who present to the emergency room with wheezing symptoms and a history of asthma. They may then take a history from the patient and complete a physical exam and then treat the patient with bronhodilators and steroids, the typical therapy for a patient with asthma. For many patients with asthma, especially if they fit the typical picture for asthma exacerbation, this will be the main therapy. For other patients and particularly in case of diagnostic uncertainty providers could consider prescribing antibiotics despite the guidelines recommendations. The decision for prescribing is influenced by several factors which were described above. We have grouped these factors in two boxes, based on the possible effect as inhibitors or promoters on antibiotic prescribing.

Possible strategies to decrease inappropriate antibiotic prescribing in asthma exacerbations

We asked providers to suggest interventions or to weigh-in on some we proposed. The findings are presented in Table 3. The most frequent suggestion concerned traditional education including talks from pulmonary consultants. Clinicians were surprised by the rates of antibiotic prescribing and they were receptive to the idea of audit and feedback. Providers believed that lack of knowledge about

their group or individual rates of antibiotic prescribing was an important barrier for appropriate prescribing. However, many mentioned that it is important to give feedback in such a way that it is not perceived as judgmental. Order sets were considered useful especially by the emergency physicians ED providers. Respondents recommended the use of a clinical decision- support (CDS) tool that would provide clinical guidance in a form that permits and supports professional judgement when there is a conflict between the providers' intentions and practice guidelines. Biomarkers such as to differentiate between bacterial and viral infection were viewed as a possible solution, especially by the hospitalists. The ED providers believed that in order for biomarkers to be useful, they would need the results during the ED encounter.

Discussion

Uncertainty has been described as a “cognitive state which commonly causes affective symptoms of anxiety and lack of confidence”²¹ and it is a source of variability in decision making in medicine. In this study, we identified diagnostic uncertainty (asthma vs COPD; bacterial vs viral infection) as the primary driver for antibiotic prescribing decisions in patients hospitalized for asthma exacerbations. When faced with diagnostic uncertainty, several providers valued the reassurance that comes with prescribing antibiotics. Uncertainty-related prescribing was moderated by patient characteristics (age, comorbidities) and clinical presentation severity. The analysis of the interviews uncovered several other factors that lead towards inappropriate prescribing of antibiotics, including lack of awareness and familiarity of relevant guidelines, providers not applying recommendations for complex cases, an emphasis on risk of not-treating over concern for adverse antibiotic effects, risk avoidance and fear of litigation, clinical inertia/therapeutic momentum (keep going with what is already done) and unavailable resources.

We discovered that the gap between recommendations found in current guidelines and actual practice may stem from the fact that guideline recommendations typically presume that a patient has already been identified as having an asthma exacerbation; however, in routine care, providers often encounter cases where the clinical presentation is less certain.¹⁴ Along these lines, clinicians were confident that they refrain from prescribing antibiotics for patients with asthma exacerbations; however, further discussions revealed that they were only referring to the ‘classic’ patient with asthma that they might have learned about in medical school (i.e. young, pre-existing diagnosis from childhood, non-smoker).

Providers who were knowledgeable about current guidelines and were confident that they could apply the recommendations for any asthma patient (i.e., not only for the typical patient but also for patients who were older, or had multiple comorbidities, or had a severe asthma attack) were less likely to inappropriately prescribe antibiotics. Those who followed the ‘better safe than sorry’ approach, and for whom uncertainty triggered an emotional reaction and fear of bad outcomes, were more likely to prescribe antibiotics even when an infection was not confirmed. In another qualitative study of inpatient physicians in two teaching hospitals, the authors found that over-prescribing of antibiotics in general, was largely driven by anxiety about missing an infection while potential adverse effects of antibiotics did not strongly influence decision-making.²² Altering one’s clinical practice in the face of uncertainty is a complex process. A systematic review showed that point-of-care testing for C-reactive protein was one of the most effective interventions to reduce antibiotic prescriptions for acute respiratory tract infections in primary care.²³ This point-of-care testing served to decrease diagnostic uncertainty and fear of bad outcomes and regret in complex clinical situations, and to support clinicians when there was a need for rapid decision making. This approach may lend itself to the care of patients presenting to the hospital with asthma exacerbation.^{24,25}

Our findings that awareness and agreement with guidelines determine antibiotic prescribing decisions are consistent with previous studies. Only a few clinicians incorrectly believed that the

treatment for asthma and COPD is essentially the same, and that antibiotics are indicated for asthma. Many recognized that there is greater emphasis and education about the management of COPD exacerbation, while the treatment of asthma receives disproportionately less attention. As such, educational strategies that emphasize the low-value care and possibility of harm related to prescribing antibiotics in asthma when no infection is apparent should be tested as part of a multicomponent de-implementation strategy in the hospital setting.²⁶ To that end, our results increase understanding of the factors that contribute to low-value and wasteful practices (as they are different from implementation)^{27,28} and can inform how best to employ evidence-based interventions to de- implement such practices.

We found that prescribing decisions were influenced by a host of cultural determinants in addition to the clinical factors already discussed. Our results are consistent with those from a qualitative study by Charani *et al.* in the UK that found antibiotic prescribing in the hospital is governed by a culture of ‘noninterference’ in the prescribing practice of peers.¹⁷ These findings have significant implications; providing feedback about rates of prescribing might make clinicians aware and create incentives to avoid antibiotics unless necessary, by changing cultural norms; antibiotic review and calls from a pharmacist in case of inappropriate prescribing could help with inertia. Our findings contrast with those reported in upper respiratory infections in the outpatient setting regarding patient and family influence on antibiotic prescribing decisions.^{13,15} Hospital-based physicians reported that they were rarely influenced by a patient’s wishes to receive antibiotics.

Our study has several limitations. First, it was conducted in two hospitals within a single healthcare system. While they represent very different practice settings, our results may not reflect the experiences of providers at other sites. Second, no assumption can be made regarding the relative importance of each factor we identified and the extent of influence it exerts on prescribing decisions. Third, two of the interviewers were professional peers to some of the participants which could have influenced the interview dialogue and information shared during the interview sessions. Lastly, although the goal of our study was to identify determinants of antibiotic prescribing, we did not imply that prescribing antibiotics is always inappropriate in patients with asthma. Macrolide antibiotics could be of benefit on asthma symptom and exacerbation in patients with uncontrolled persistent asthma.

Conclusions/key findings

Antibiotics are some of the most effective drugs in medicine, and have dramatically changed the prognoses of patients with bacterial infections over the past 50 years. Awareness of the therapeutic benefits of antibiotics underpins antibiotic prescription. Nevertheless, there is strong evidence of inappropriate prescribing of antibiotics for conditions where guidelines do not recommend their use, such as in upper respiratory infections or in asthma exacerbation.¹¹ The challenge in improving antimicrobial stewardship lies in building a strategy that is based on the careful assessment of the determinants of prescribing, grounded by theory.¹⁵ We identified diagnostic uncertainty as the primary determinant of antibiotic prescribing in asthma exacerbations. This knowledge can be used to guide future development of interventions and implementation strategies to reduce inappropriate antibiotic prescribing for patients with asthma exacerbations in the ED and inpatient setting.

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Conflicts of Interest Summary

The authors report no conflict of interest.

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Appendix. Interview Guide

A qualitative study to determine physicians' attitudes toward antibiotic prescribing and effectiveness in the treatment of asthma exacerbation

Mihaela Stefan, Kerry Spitzer, Peter Lindenauer

Introduction: *The aim of this interview is to help us understand how you manage care for patients presenting with an asthma exacerbation. Prior research by our team has found that nationally*

roughly 60% of patients admitted with an asthma exacerbation receive antibiotics in the hospital. At Baystate the number is roughly 40%. A national study of Emergency Rooms found that 20% of patients presenting with an asthma exacerbation leave with a prescription for antibiotics. We are trying to understand how different clinicians, including hospitalists and ED doctors, approach the use of antibiotics for patients with an asthma exacerbation. Throughout the interview, when we refer to patients, we would like you to think about patients presenting with or admitted for an asthma exacerbation.

1) I'd like to start with some basic questions about your practice:

a) How many years have you practiced since completing your residency?

b) At which hospital site do you spend most of your time practicing?

c) Do you practice or work closely with residents?

d) How long have you been at Baystate?

2) Thinking back over the past 1 (or 3) months [hospitalists]/2-3 shifts [ER], about how many adult patients did you care for who were admitted/presenting with an asthma exacerbation?

3) Could you briefly describe your approach to managing care for a patient presenting/admitted with an asthma exacerbation? (*Probes: What medications would you prescribe?*)

4) When you prescribe antibiotics for a patient presenting with an asthma exacerbation, what are the factors that inform your decision? [If interviewee discusses a case where there is no suspicion of COPD, probe and ask about a harder to differentiate case. If interviewee discusses a difficult case to differentiate, probe and ask about a case where COPD is not suspected.]

a) Possible probes: treating underlying infectious disorders that could trigger an asthma exacerbation; patients' desires or concerns; do you worry that the patient may deteriorate; time constraints?

b) Are there specific antibiotics or classes of antibiotics that you prescribe?

c) Why?

5) What evidence informs your approach to caring for patients presenting with an asthma exacerbation?

a) Are you aware of any guidelines for treatment Asthma?

b) Do you consider other evidence, such as randomized control trials, regarding effectiveness of antibiotics in Asthma?

c) How does this evidence influence your decisions about prescribing antibiotics?

6) To what extent do you rely on tools like pocket cards, apps, or order sets when making decisions about the management of care for patients presenting with asthma exacerbation?

7) How do you balance the potential harms with the potential benefits of antibiotics when managing the care of patients presenting with an asthma exacerbation?

a) C. Diff?

b) Do you ever worry about antibiotic resistance?

8) If you were to assume the care of a patient with asthma who has been prescribed antibiotics by (another hospitalist/in the ED/by their primary care physician/the attending) do you ever question the decision? How easy or difficult is it for you to discontinue antibiotics?

9) How might the views or opinions of others affect your prescribing decisions for a patient with an asthma exacerbation?

10) Do you think your colleagues at Baystate generally follow the same approach to using antibiotics for patients presenting with asthma exacerbation? How do they differ? How are they similar?

a) How about your colleagues at conferences or in your professional associations?

11) Our decisions are often informed by past experience, are there any past experiences, either personal or professional, that have shaped how you think about prescribing antibiotics for patients who present with an asthma exacerbation? (Probe: for example was there a patient with asthma who deteriorated and you looking back you worry that AB may have helped?)

12) Do you believe that there are opportunities to improve antibiotic prescribing by physicians (including yourself)?

a) Can you give examples of such opportunities?

b) Do you believe physicians are open to such opportunities?

c) Are there enough resources to implement these changes?

d) What are some strategies that might be useful in reducing unnecessary antibiotics?

13) What are your thoughts on the benefits and downsides of some potential interventions to reduce the use of antibiotics in asthma:

a) Sharing rates (i.e. audit and feedback)?

b) Requiring an indication for antibiotics orders?

c) Order sets?

d) Pharmacist review and call?

e) Education to motivate patients to advocate for treatment without antibiotics?

f) Can you envision any other potential interventions to reduce the use of antibiotics in the management of care for patients presenting with asthma exacerbation?

14) Is there anything else you would like to share with us about the use of antibiotics in patients with asthma exacerbation?

Table 1: Demographic and professional characteristics of the interviewed providers

	N=16
Specialty	
Emergency Department	8
Hospitalist	7
Pulmonologist	1
Gender	
Female	6
Years of professional experience	
Median (IQR)	6 (4-10)
Facility location	
Community, rural	5
Teaching, urban	11
Working with residents	12

Table 2: Main themes that influenced antibiotic decision making, mapped to the main TDF domains

TDF domain(s)	Themes
Knowledge	Awareness/ confidence in existing prescribing guidelines
Beliefs about capabilities	Self-confidence: provider believes that she/he can apply the guidelines recommendations even in complex or severe case
Beliefs about consequences	Fear about bad outcomes if AB not given; Anticipated regret ‘better safe than sorry’ approach for complex cases or uncertainty in diagnosis
Regret	Integrating the risk of AB resistance/AB side effects in the decision for AB prescribing
Emotions	Risk of litigation Diagnostic uncertainty (e.g. COPD vs asthma, presence of bacterial trigger)
Group norms and group conformity	Others as a source of over-prescribing AB – driven by another specialty or provider Prescribing within the group
Behavioral regulation	Habit/Clinical inertia/ Lack of motivation to change behavior
Environmental context and resources	Lack of tools for rapid diagnosis High volume of patients/time constrains Limited access to information to prior testing CMS sepsis reporting measures

Table 3: Possible strategies to decrease inappropriate antibiotic prescribing in asthma exacerbations

Name of the strategy	Illustrative quote
Education	<i>"I think there are certainly opportunities. It might be as simple as education. We get much more education on COPD than asthma." (Interview 07, early-career hospitalist)</i> <i>"[Residents] are going to get inconsistent teaching if you're not regularly reminding everybody of what the standard of care is." (Interview 05, early-career emergency medicine physician)</i>
Audit and feedback regarding the rates of antibiotic prescribing	<i>"And in our group, we're very open to getting things right. So if there's something we can do better, our docs are not kind of those docs that are just going to say, 'No, I'm doing it my way.'" (Interview 15, late-career emergency medicine physician)</i> <i>"I think it's really important how you word it exactly, because it could be taken as punitive." (Focus Group, internal medicine resident)</i>
Order sets and Clinical decision support tools	<i>We've relied on order sets a ton. Sometimes they're a pain to click through and stuff like that, but I think that's the number one way we get through things." (Interview 03, early-career emergency medicine physician)</i> <i>Yeah. So if you put something on anything, asthma is absolutely recommended for that. I think it could really—just by one simple thing, you could probably change a lot of the numbers." (Interview 16, early-career emergency medicine physician)</i>
Biomarkers such as procalcitonin	<i>"We don't use [PCT] in the ED... [it] doesn't change our managements fast enough...PCT takes too long...so we don't order [that test]." (Interview 17, early-career emergency medicine physician)</i>

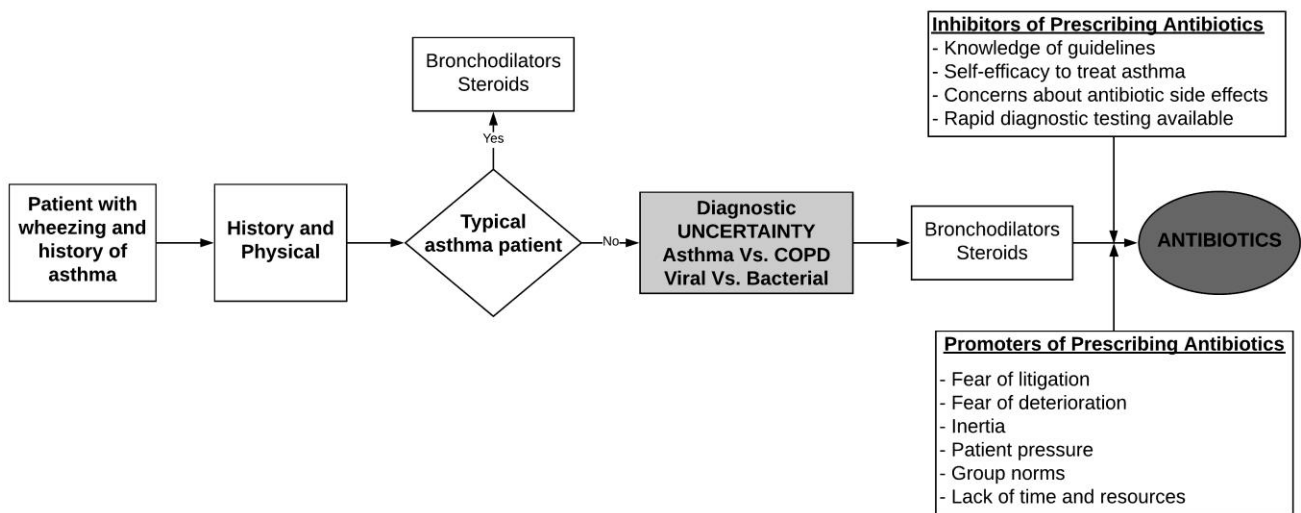


Figure 1. Step-by-step decision-making process and determinants for antibiotic prescribing