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Inappropriate Antibiotic Prescribing for Acute Bronchitis in Children and Impact on Subsequent Episodes of Care and Treatment

Jake R. Morgan, PhD¹, Kathleen M. Carey, PhD^{1,2}, Tamar F. Barlam, MD³, Cindy L. Christiansen, PhD⁴, Mari-Lynn Drainoni, PhD^{1,2,3,5}

¹Department of Health Law, Policy and Management, Boston University School of Public Health Boston, MA, USA

²Center for Healthcare Organization and Implementation Research, Edith Nourse Rogers Memorial Veterans Affairs Hospital, Bedford, MA, USA

³Section of Infectious Diseases, Department of Medicine, Boston University School of Medicine, Boston, MA, USA

⁴Henry M. Goldman School of Dental Medicine, Boston University, Boston, MA, USA

⁵Evans Center for Implementation and Improvement Sciences, Boston University School of Medicine, Boston, MA

Abstract

Background—To examine whether inappropriate antibiotic treatment for an initial bout of acute bronchitis in childhood affects patterns of future healthcare utilization and antibiotic prescribing.

Methods—We conducted a retrospective analysis of children with at least one acute bronchitis episode, defined as the 14-day period following an acute bronchitis visit, born in 2008 and followed through 2015 in a nationally representative commercial claims database. We predicted the likelihood of returning for a subsequent acute bronchitis episode, and being prescribed an antibiotic as part of that episode, as a function of whether or not the child was prescribed an antibiotic as part of the first acute bronchitis episode controlling for patient, provider, and practice characteristics.

Results—Children prescribed an antibiotic as part of their initial acute bronchitis episode were more likely both to have a subsequent acute bronchitis episode (HR=1.23, 95% CI 1.17-1.30) and to be prescribed an antibiotic as part of that second episode (HR=2.13, 95% CI 1.99-2.28) compared to children who were not prescribed as part of their first episode. Children diagnosed with asthma were more likely to experience a second visit for acute bronchitis, but less likely to receive an antibiotic as part of that second episode.

Conclusions—Inappropriate antibiotic prescribing for a child's initial acute bronchitis episode of care predicted likelihood of subsequent acute bronchitis episodes and antibiotic prescriptions.

Providers should consider the downstream effect of inappropriate antibiotic prescribing for acute bronchitis in childhood.

Keywords

antibiotics; acute bronchitis; pediatric prescribing

Introduction

In the United States, antibiotics are inappropriately prescribed to children with viral respiratory tract infections (RTIs) contributing to approximately ten million prescriptions per year.¹ Unnecessary antibiotics contribute to antibiotic resistance and can result in drug-related adverse events such as *Clostridium difficile*.^{2,3} Early antibiotic exposure has been linked to later development of asthma and obesity.^{4,5} Prior research has demonstrated that a variety of patient, provider, and practice characteristics affect antibiotic prescribing for viral RTIs⁶⁻⁸ including patient/parent expectations that antibiotics will be prescribed.⁹⁻¹¹ However, little is known about why patients and/or parents expect antibiotics for acute bronchitis and whether early childhood medical visits may be formative in this expectation. If a child is given antibiotics for bronchitis the initial time he or she is diagnosed, the parent may expect the same treatment at subsequent visits. Such expectation may suggest that targeted interventions during early medical interactions could have substantial downstream implications for antibiotic exposure. In this study, we assessed the long-term consequences of inappropriate prescribing for acute bronchitis by examining how a provider's decision to prescribe antibiotics as part of a child's initial encounter for acute bronchitis affects the likelihood of a subsequent bronchitis encounter and antibiotic prescription.

Methods

Overview

We constructed an analytic sample using data from the Truven Health Analytics MarketScan Commercial Claims and Encounters databases (MarketScan) of 2008-2015. MarketScan consists of medical claims data from approximately 350 payers covering insured employees and their dependents for active employees, early retirees, and Consolidated Omnibus Budget Reconciliation Act (COBRA) enrollees across the United States. Patients are aged 0 to 64 and are followed longitudinally for as long as they are enrolled in a participating health care plan. To examine long-term outcomes, we created a cohort of children born in 2008 who had a visit with a primary diagnosis of acute bronchitis (ICD-9 codes 466.x, 490) at some point during their enrollment, had prescription drug coverage, and were enrolled continuously from birth through 2015. We excluded visits with a secondary diagnosis warranting an antibiotic and excluded children with complex chronic conditions,¹² as this can obscure the prescribing decision.¹³ The Boston University Institutional Review board deemed this study not human subjects' research.

Each child had at least one visit for acute bronchitis between 2008 and 2015; we considered this visit the start of the initial episode of care. We defined the initial episode of care as the 14-day period following the first acute bronchitis visit.¹⁴ An antibiotic prescription filled

within four days of an acute bronchitis visit was considered to have been prescribed during that episode of care.⁶

Our primary question was whether the prescribing behaviors as part of the initial episode were associated with a subsequent acute bronchitis episode occurring and whether antibiotics were prescribed as part of that subsequent episode. We defined a subsequent episode as the 14-day period following the first visit for a new diagnosis of acute bronchitis that occurred after the initial episode. An antibiotic prescription filled within four days of the acute bronchitis visit was considered to have been prescribed during that episode of care. We evaluated patient, provider, and practice characteristics identified in prior studies as associated with inappropriate prescribing.^{6,15} These variables included sex, age, whether the child had been diagnosed with asthma before the episode of care,¹⁶ geographic region where the child received care (Northeastern, Midwestern, Southern, or Western United States), whether the child received care in an urban, suburban or rural area (identified by Metropolitan Statistical Area - MSA), and type of insurance including health maintenance organization (HMO), preferred provider organization (PPO), point-of-service (POS) or other. Provider characteristics included the specialty of the provider (pediatrician, family medicine, emergency room (ER)/urgent care, or other).⁶ Practice characteristics included the site of care (physician's office, outpatient hospital, ER/urgent care, inpatient, or other). We measured these characteristics at the initial and subsequent episode of care.

Analysis

We examined the effect of early prescribing on both the occurrence of a subsequent acute bronchitis episode and on antibiotic prescribing as part of that subsequent episode in two steps. First, we tested the association between prescribing as part of the initial episode of care and whether a child returned for a subsequent acute bronchitis episode. Second, among children with a subsequent acute bronchitis episode, we evaluated whether prescribing as part of the initial episode predicted prescribing in the subsequent episode.

To evaluate the likelihood of returning for a future episode of care for acute bronchitis, we calculated the person-time follow-up contributed by each child from their initial episode until either the next episode or the end of the study on December 31, 2015, whichever was earlier. We used this information to develop a Cox proportional hazards model of the time to a subsequent acute bronchitis episode as a function of whether or not an antibiotic was prescribed as part of the initial episode. We controlled for the characteristics discussed above at the time of the initial episode.

Next, we used a Cox proportional hazards model to test the association between antibiotic prescribing for the initial episode of acute bronchitis and prescribing as part of the subsequent acute bronchitis episode to reflect the differential follow-up time after the initial episode of care. Using the subsample of children with a subsequent episode, the hazard of receiving an antibiotic as part of the subsequent episode was a function of the prescribing behavior as part of the initial episode. We controlled for relevant characteristics at the time of the subsequent episode of acute bronchitis.

Results

We identified 14,683 unique children born in 2008 who were enrolled in the dataset through December 31st, 2015, and had at least one acute bronchitis episode of care. Table 1 provides an overview of the two outcomes (returning for a subsequent episode and being prescribed as part of that episode), stratified by whether or not an antibiotic was prescribed during the initial episode. Forty-five percent of children overall returned for a subsequent acute bronchitis visit, and this was similar in those who were (44%) and were not (45%) prescribed an antibiotic as part of the first episode. Seventy-one percent of those prescribed as part of the first episode were also prescribed during the second compared to 43% of those not prescribed as part of the first episode.

Children who were prescribed an antibiotic at their initial episode of care were more often female (48% vs. 44%) and from the Midwest (24% vs. 21%), were about a year older on average (2.2 vs. 1.2), less often covered by an HMO (18% vs. 22%), and slightly less likely to have had an asthma diagnosis prior to the first episode (9.3% vs. 10.7%) or be treated by a pediatric provider at the first visit (64% vs. 69%). We found that those receiving an antibiotic as part of their initial episode of care were more likely to return for a subsequent episode of care (hazard ratio (HR) = 1.24, 95% confidence interval (CI) 1.18-1.31) (Table 2). Multiple patient, provider, and practice characteristics also were significantly associated with experiencing a subsequent acute bronchitis episode. Children at lower risk of experiencing a subsequent episode were older (HR=0.77 for each year of age), female (HR=0.93), lived in an urban area (HR=0.84), were covered by an HMO (HR=0.92 compared to a PPO), or were seen at an outpatient clinic (HR=0.87) or ER/urgent care (HR=0.80). Those with a diagnosis of asthma before the initial episode of care had a higher risk of a subsequent episode (HR=1.33) as did those living in the south (HR = 1.26 relative to living in the Northeast) (Table 2).

Next, we tested the association between prescribing as part of the initial episode of care and prescription of an antibiotic during the subsequent episode (Table 3). Children who had been prescribed as part of the initial episode had more than double the hazard of being prescribed in the subsequent episode (HR=2.13, 95% CI 1.99-2.28) compared to those who were not prescribed as part of the initial episode. Children who were older at the time of the subsequent episode were less likely to be prescribed (HR=0.47), as were children with a diagnosis of asthma by the time of the second acute bronchitis episode (HR = 0.86).

Discussion

We found that a child's initial interaction with the health care system for acute bronchitis predicted whether that child returns for a subsequent acute bronchitis episode and whether he or she is prescribed an antibiotic at that time. Children prescribed an antibiotic as part of their initial episode were more likely to return for a subsequent episode of care for acute bronchitis compared to children who were not. Children not prescribed were less likely to have a subsequent episode. A survey at 36 day care centers in Massachusetts found that greater parent knowledge about RTIs was associated with a lower rate of antibiotic seeking.¹⁷ Providers withholding antibiotics for a diagnosis of acute bronchitis may be educating

parents about the appropriateness of antibiotics for viral infections, potentially making them less likely to seek care for a similar set of symptoms in the future.

We observed a similar pattern for the prescription of an antibiotic as part of the subsequent acute bronchitis episode. Those children who were prescribed as part of the initial episode were more likely to be prescribed as part of the second episode. Qualitative research has suggested that some providers who inappropriately prescribe blame patient/parent demand as a major driver of those prescriptions, suggesting that patient satisfaction with care will worsen if they don't provide an antibiotic.¹⁸ However, studies suggest that the strongest driver of satisfaction with healthcare encounters is education during the visit, not the receipt of an antibiotic.¹⁹ In conjunction with our findings that experience with physicians who do not prescribe antibiotics for the initial episode of acute bronchitis reduced the likelihood of subsequent acute bronchitis visits and prescribing, these studies provide evidence that appropriate use of antibiotics can promote future proper use.

This study has several limitations. First, while MarketScan represents a large cohort and allows for longitudinal observation, only children covered by private insurance are included in the dataset. Although previous research has found that inappropriate prescribing does not vary between public and private insurance,^{6,15} early prescribing patterns may be different based on insurance type. Also, while MarketScan includes data from over 350 payers, we do not know who these payers are, and whether excluded payers are systematically different than those included. However, while the sample may not be representative of the entire population, research has shown MarketScan to be a good representation of the U.S. privately insured population.²⁰ Second, administrative claims do not allow us to know exactly why the provider was prescribing the antibiotic. We only included visits where acute bronchitis was the primary diagnosis and excluded visits with secondary diagnoses that could warrant an antibiotic to reduce this bias, but it is possible that the provider was considering some factor not documented in the claims. Third, because we only examined the initial and a single subsequent episode, we are unable to comment on high utilizers and prescribing patterns for this group of children. Fourth, the dataset does not identify unique providers longitudinally, so we were unable to account for differences in outcomes associated with an ongoing relationship to a single provider. Fifth, we cannot assess the accuracy of diagnostic coding in a claims database, and it is possible that some diagnoses of bronchitis were actually a different infection such as bronchiolitis. However, antibiotics are not warranted for bronchiolitis or acute bronchitis, so our results and conclusions would be unchanged. Finally, we only included children continuously enrolled from birth through the end of 2015. Outcomes for children who were not enrolled during the entire period may differ if change of insurance affects the relationship with the medical system and prescribing.

Inappropriate prescribing of antibiotics for viral RTIs is an important public health issue, and there has been little research into how prescribing for an initial episode of acute bronchitis can affect a patient's antibiotic trajectory. We found that antibiotic prescribing for the initial bronchitis episode was significantly associated with patients seeking care for subsequent episodes of acute bronchitis and for prescribing for those episodes. Future research should investigate these questions for adults to determine whether future utilization is also predicted by prior utilization in that population. This novel study improves our

understanding of antibiotic prescribing and should caution potential prescribers that a single antibiotic prescription can have long-term consequences.

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Table 1.

Overview of acute bronchitis episodes of care and antibiotic prescribing

Initial episode	Returned for subsequent episode			Prescribed subsequent episode	
	<i>n</i>	<i>n</i>	% (of total)	<i>n</i>	% (of returned)
Prescribed	7,309	3,237	44%	2,285	71%
Not prescribed	7,374	3,322	45%	1,434	43%
<i>Total</i>	<i>14,683</i>	<i>6,559</i>	<i>45%</i>	<i>3,719</i>	<i>57%</i>

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Table 2.

Multivariable model predicting occurrence of an acute bronchitis subsequent episode

	Hazard Ratio	95% Confidence Interval	p-value
Patient characteristics			
Prescribing types			
Prescribed first episode	1.24	(1.18 - 1.31)	<0.001
Not prescribed first episode		<i>Reference</i>	
Age at visit, years	0.77	(0.75 - 0.79)	<0.001
Sex			
Male		<i>Reference</i>	
Female	0.93	(0.89 - 0.98)	0.004
Asthma diagnosis before initial episode	1.33	(1.23 - 1.44)	<0.001
Health plan types			
PPO		<i>Reference</i>	
HMO	0.92	(0.87 - 0.99)	0.02
POS	1.02	(0.95 - 1.10)	0.55
Other	1.02	(0.94 - 1.10)	0.72
Regions			
Northeast		<i>Reference</i>	
Midwest	1.06	(0.97 - 1.16)	0.22
South	1.26	(1.16 - 1.36)	<0.001
West	0.99	(0.89 - 1.10)	0.86
Unknown	1.10	(0.78 - 1.55)	0.60
Urban area (MSA)	0.84	(0.79 - 0.90)	<0.001
Provider characteristics*			
Provider specialty at first bronchitis visit			
Pediatrician	1.00	(0.88 - 1.15)	0.95
Family medicine	1.14	(0.98 - 1.32)	0.09
ER/Urgent care	1.01	(0.83 - 1.23)	0.94
Other	1.01	(0.88 - 1.15)	0.91
Practice characteristics*			
Location of first bronchitis visit			
Physician office	0.94	(0.81 - 1.08)	0.34
Outpatient hospital	0.87	(0.76 - 0.99)	0.04
ER/Urgent care	0.80	(0.68 - 0.93)	0.004
Inpatient	1.00	(0.89 - 1.13)	0.96
Other	1.00	(0.88 - 1.15)	0.95

* Overlapping, some fall into more than one category

Table 3.

Multivariable model predicting antibiotic prescribing as part of the subsequent episode

	Hazard Ratio	95% Confidence Interval	p-value
Patient characteristics			
Prescribing types			
Prescribed first episode	2.13	(1.99 - 2.28)	<0.001
Not prescribed first episode		<i>Reference</i>	
Age at visit	0.47	(0.45 - 0.48)	<0.001
Sex			
Male		<i>Reference</i>	
Female	1.01	(0.95 - 1.08)	0.80
Asthma diagnosis before subsequent episode	0.86	(0.79 - 0.94)	<0.001
Health plan types			
PPO		<i>Reference</i>	
HMO	0.99	(0.90 - 1.08)	0.75
POS	1.06	(0.96 - 1.18)	0.25
Other	1.04	(0.95 - 1.14)	0.44
Regions			
Northeast		<i>Reference</i>	
Midwest	0.98	(0.87 - 1.11)	0.76
South	0.93	(0.84 - 1.04)	0.20
West	0.95	(0.83 - 1.10)	0.50
Unknown	1.10	(0.59 - 2.07)	0.77
Urban area (MSA)	0.96	(0.88 - 1.05)	0.34
Provider characteristics *			
Provider specialty at first bronchitis visit			
Pediatrician	0.90	(0.71 - 1.14)	0.38
Family medicine	0.91	(0.71 - 1.17)	0.45
ER/Urgent care	0.96	(0.72 - 1.27)	0.77
Other	0.92	(0.73 - 1.16)	0.48
Practice characteristics *			
Location of first bronchitis visit			
Physician office	1.18	(0.93 - 1.51)	0.18
Outpatient hospital	0.95	(0.76 - 1.18)	0.62
ER/Urgent care	0.94	(0.73 - 1.21)	0.65
Inpatient	0.87	(0.68 - 1.10)	0.24
Other	0.90	(0.71 - 1.14)	0.38

* Overlapping, some fall into more than one category