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Provider Variation in Antibiotic Prescribing and Outcomes of Respiratory Tract Infections

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Abstract

Objectives: Inappropriate antibiotic use for respiratory tract infection (RTI) is an ongoing problem linked to the emergence of drug resistance and other adverse effects. Less is known about the prescribing practices of individual physicians or the impact of physician prescribing habits on patient outcomes. We studied the prescribing practices of providers for acute RTIs in an integrated health system, identified patient factors associated with receipt of an antibiotic and assessed the relation between providers' adjusted prescribing rates and a number of patient outcomes.

Methods: This was a retrospective analysis of adults with an RTI visit to any primary care providers across the Cleveland Clinic Health System in 2011–2012. Patients with a history of chronic obstructive pulmonary disease or immunocompromised status were excluded. Logistic regression was used to examine patient factors associated with receipt of an antibiotic.

Results: Of 31,416 patients with an RTI, 54.8% received an antibiotic. Patient factors associated with antibiotic prescribing included white race (odds ratio [OR] 1.35, $P < 0.001$), presence of fever (OR 1.66, $P < 0.001$), and a diagnosis of bronchitis (OR 10.98, $P < 0.001$) or sinusitis (OR 33.85, $P < 0.001$). Among 290 providers with 10 RTI visits, adjusted antibiotic prescribing rates ranged from 0% to 100% (mean 49%). Antibiotics were prescribed more often for sinusitis (OR 33.85, $P < 0.001$), bronchitis (OR 10.98, $P < 0.001$), or pharyngitis (OR 1.76, $P < 0.001$) compared with upper respiratory tract infection. Patients who were prescribed antibiotics at the index visit were more likely to return for RTI within 1 year (adjusted OR 1.26, $P < 0.001$). Emergency department visits for respiratory complications were rare and not associated with antibiotic receipt.

Conclusions: Antibiotic prescribing for RTI varies widely among physicians and cannot be explained by patient factors. Patients prescribed antibiotics for RTI were more likely to return for RTI.

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Keywords

antibiotic usage; primary care provider; provider variation; respiratory tract infection

Antibiotic overuse is a contributor to the emergence of drug-resistant pathogens and is a major public health concern globally.¹ In the ambulatory setting, antibiotics are prescribed most commonly for respiratory tract infections (RTIs), often inappropriately.^{2,3} Up to 50% of all antibiotics prescribed for acute RTI in the ambulatory setting are not indicated²⁻⁴ and this practice has been discouraged by guidelines for decades.^{2,5}

In addition to drug resistance, inappropriate antibiotic prescribing may contribute to increased medical costs⁶ and “medicalization,”^{7,8} encouraging people to seek medical care for future respiratory illnesses. For example, patients who are prescribed antibiotics for a sore throat tend to return to the office seeking care.⁸ This increased utilization adds to unnecessary healthcare spending. In 2009, direct antibiotic prescription costs totaled \$6.5 billion in the community setting.⁸

Attempts to reduce antibiotic prescribing have been only modestly successful. One reason may be that prescribing rates vary widely among physicians in ways that cannot be explained by patient factors alone.⁹⁻¹³ High-prescribing physicians see more patients with RTIs, work in proximity to one another, and are more likely to practice family medicine.^{10,13} The impact of individual prescribing on patient outcomes has not been assessed, however.

We aimed to study the prescribing practices of providers for acute RTIs in an integrated health system during a period of 2 years. In addition, we identified patient factors associated with receipt of an antibiotic and then assessed the relation between providers’ adjusted prescribing rates and the following patient outcomes: subsequent healthcare utilization, complications, visit billing, and patient satisfaction.

Methods

Setting and Patients

We conducted a retrospective cohort study of all patients aged 18 years and older who had an ambulatory visit for an RTI to any internal medicine or family practice provider at the Cleveland Clinic Health System in northeast Ohio from January 1, 2011 to December 31, 2012. The Cleveland Clinic Health System comprises a tertiary medical center with 18 family health centers and 18 additional practice sites. The study was approved by the Cleveland Clinic institutional review board. Visits for RTI were identified based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* codes 381 through 382 and 460 through 466. The RTI diagnoses were then categorized into acute upper respiratory tract infection (URI), sinusitis, pharyngitis, and bronchitis. We excluded otitis media cases because there were too few (N = 115).

For the purposes of comparing rates of antibiotic prescribing, we combined all of the RTI diagnoses to avoid biases related to individual physicians’ coding patterns. We also excluded patients with a history of chronic obstructive pulmonary disease, a

history of immunocompromised status (history of organ transplant, leukemia, lymphoma, human immunodeficiency virus/acquired immunodeficiency syndrome), current use of immunosuppressant medications, or hospitalization within 14 days before their first visit during the study period, which we refer to as the index visit. Subsequent visits were considered outcomes. For the analyses of physician-prescribing patterns, physicians with fewer than 10 RTI visits in the study period were excluded.

Data

All of the data were extracted from the electronic medical record. We collected the following patient characteristics: age, sex, race, smoking status, asthma diagnosis, and listed primary care provider (PCP). For the index visit we also extracted PCP, vital signs, and RTI diagnosis. Our primary outcome was any antibiotic prescription associated with that RTI diagnosis. We considered the following antibiotics to be intended to treat RTI: penicillins, cephalosporins, tetracyclines, macrolides, trimethoprim-sulfamethoxazole, and fluoroquinolones. We included a variety of secondary outcomes that could result from antibiotic prescribing. First, we assessed whether antibiotic prescribing was associated with all-cause office visits within 30 days, which could result from worsening of the infection or adverse effects of the antibiotic prescription. To assess for serious complications of the initial infection, we measured emergency department (ED) visits or hospitalization related to RTI within 7 days. Lastly, to determine whether offering prescriptions encouraged patients to seek future care, we measured office visits for an RTI beyond 30 days but within 1 year. To determine whether prescribing medication increased visit complexity, we measured the evaluation and management services level of the index visit. Finally, to assess whether receipt of an antibiotic improved patient satisfaction, we compared scores on the medical practice survey and the Clinician & Group Consumer Assessment of Healthcare Providers and Systems administered following the index visit. We included only those domains related to satisfaction with the provider.

Statistical Analysis

Descriptive statistics were used to summarize continuous variables as means and standard deviations or medians and inter-quartile ranges (IQRs) and categorical variables as frequencies and percentages. The frequency of antibiotic prescribing was summarized at the provider level, PCP panel level, and the RTI diagnosis level. Adjusted prescribing rates were computed for healthcare providers and PCPs by controlling for patient characteristics in logistic regression models. The mixed-effects logistic regression model also was used to examine predictors for prescribing antibiotics, which included a random intercept at the provider level. Outcomes were compared between patients with and without antibiotics and those treated by low and high prescribers, divided at the median prescribing rate, after adjusting for patient factors. Statistical significance was considered as a two-sided $P < 0.05$.

Results

Our final cohort contained 31,416 patients, 17,203 (54.8%) of whom received an antibiotic for an RTI. Patient characteristics stratified by receipt of antibiotics appear in Table 1. The majority of the study population was women (63.5%) and white race (85.9%), with

a mean age of 45.6 years; 61% of patients never smoked, 10% had diabetes mellitus, and few (1.3%) had end-stage renal disease or congestive heart failure. Only 40% of visits were with the patient's PCP. The most commonly prescribed antibiotics were macrolides (40.9%), penicillins (38%), and tetracyclines (8.1%). When compared with a diagnosis of URI, antibiotics were more likely to be prescribed for sinusitis (odds ratio [OR] 33.85, 95% confidence interval [CI] 31.65–36.21), bronchitis (OR 10.98, 95% CI 10.35–11.64), or pharyngitis (OR 1.76, 95% CI 1.70–1.85).

Table 2 shows the patient factors that were independently associated with antibiotic prescribing. The strongest predictors for receipt of antibiotic were white race (OR 1.35, 95% CI 1.26–1.44), presence of fever (OR 1.66, 95% CI 1.46–1.89), body mass index ≥ 30 (OR 1.20, 95% CI 1.15–1.25), and being a current smoker (OR 1.14, 95% CI 1.09–1.20).

Provider Variation

Among the 290 providers with at least 10 RTI visits, adjusted antibiotic prescribing rates ranged from 0% to 100% (median 49.0%, IQR 29.1%–70.5%; Fig. 1). Overall, 96 (33.1%) providers had adjusted rates that were significantly higher and 86 (29.3%) were significantly lower than the mean. Moreover, 29 providers (10%) had adjusted antibiotic prescribing rates $>80\%$ and 2 providers (0.7%) did not prescribe any antibiotics for RTI. Among the 248 PCPs with at least 10 RTI visits, the adjusted percentage of patients in their panel who received an antibiotic when visiting any provider for an RTI ranged from 12.9% to 90.3%. There was less variation of antibiotic prescribing at the PCP panel level compared with the provider level (Appendix Fig. 1, <http://links.lww.com/SMJ/A87>).

Diagnoses for which antibiotics always are inappropriate (URI and bronchitis) accounted for 40.9% of total cases (range 0%–92.3%, IQR 23.3%–54.1% for providers). The rest included diagnoses for which antibiotics are sometimes appropriate. The specific RTI diagnoses as a proportion of the total varied by provider. Low prescribers (quartile 1) were least likely to diagnose sinusitis and bronchitis and most likely to diagnose URI, whereas the opposite was true for the highest quartile of prescribers (Fig. 2A). Rates of antibiotic prescribing within diagnoses also demonstrated wide variation among providers (Fig. 2B). Providers in the lowest quartile prescribed antibiotics least often for all of the diagnoses. The gradient from the lowest to highest quartile was steepest for bronchitis and URI and relatively flat for sinusitis.

Outcomes

After adjustment for patient characteristics, patients who were prescribed antibiotics were no more likely to return to office within 30 days for any cause (adjusted OR [AOR] 1.00, 95% CI 0.87–1.16; Table 3), but they were more likely to return after 30 days but within 1 year for an RTI (AOR 1.26, 95% CI 1.16–1.37). Few patients (0.3%) visited the ED for a respiratory complaint within 7 days. Adjusted rates of ED visits for complaints related to RTI did not differ significantly between patients given antibiotics and those not given them (AOR 0.82, 95% CI 0.49–1.40; Table 3). Results were similar when we compared patients of providers whose prescribing was above the median with patients of those below the median, regardless of what they received (Appendix Table 1, <http://links.lww.com/SMJ/A88>).

For established patients, visits including antibiotics were billed at a slightly higher rate (1.10 vs 1.08 relative value units [RVUs], $P < 0.001$), whereas for new patients, visits including antibiotics were billed slightly at a lower rate (1.27 vs 1.34 RVUs, $P < 0.001$). Overall, there was no significant difference in billed RVUs (1.113 vs 1.107, $P = 0.07$). Patient satisfaction ratings were available for only a minority of the visits ($N = 241$). For most of the measures, patient satisfaction was slightly higher for providers who prescribed antibiotics, but the differences reached statistical significance only for “Did the provider explain things in a way that was easy to understand?” (3.9 vs 3.7, $P = 0.01$) and “Did the provider spend enough time with you?” (3.8 vs 3.6, $P = 0.045$).

Discussion

In this study of 290 providers treating >31,000 patients with RTIs in a single health system during a 2-year period, we found extreme variation in antibiotic prescribing rates that could not be explained by patient factors, which had generally weak associations with receipt of an antibiotic. Although the mean prescribing rate was almost 50%, individual prescribing rates ranged from 0% to 100% of cases, and one-third of physicians were statistically higher or lower than the mean. High prescribers were not only more likely to prescribe antibiotics for every diagnosis but they also were more likely than low prescribers to diagnose sinusitis and bronchitis. Patient outcomes were similar or better for patients who did not receive antibiotics. They were less likely to return within the next year for an RTI and they were no more likely to visit an ED for infectious complications. Complications such as pneumonia were extremely rare, regardless of treatment. Finally, patients were equally satisfied with high and low prescribers.

Two studies have described variation in prescribing among physicians in a large health system. Barlam et al¹⁰ studied adult patients with uncomplicated RTI (excluding sinusitis and pneumonia) during a 3-year period and found a mean prescribing rate similar to ours, which was lower than the national rate.¹⁴ The variation was extreme, from 21% in the lowest quartile to 65% in the highest (total range 5%–85%). In addition, there were important differences in diagnosis coding. High prescribers diagnosed pharyngitis and acute bronchitis more often and “acute URIs of unspecified site” less often compared with low prescribers, similar to what we observed. Jones and colleagues¹¹ studied antibiotic prescribing for acute respiratory infection in the Veterans Affairs health system during an 8-year period. Antibiotics were prescribed in 68.4% of visits, but again, there was considerable variation at the provider level with the top 10% of providers prescribing antibiotics at 95% of visits and the lowest 10% prescribing to 40% of their patients. As in the study by Barlam et al,¹⁰ patient- and system-level factors had little influence on the prescribing rate, which was almost entirely dependent on the physician. We, too, found that patient factors had little impact on the rates of prescribing. We did note that patients were less likely to receive an antibiotic from their PCP, which appears to be a novel finding.

Our study has several strengths compared with other studies. It was conducted at a single academic center that controlled for geographic variation in prescribing. Our study also had a large number of visits and 290 providers, as well as clinical data from the electronic health record, which allowed us to identify novel predictors of antibiotic prescribing and then avoid

confounding through rigorous adjustment. Finally, we included a large number of outcomes, including ED visits and hospitalizations related to RTI and the effects of “medicalization” (ie, encouraging people to seek medical care for future respiratory illnesses and the impact of antibiotic prescribing on visit complexity and patient satisfaction).

Our study has several important implications. It establishes what is possible. Some physicians prescribed antibiotics to almost none of their patients, with no obvious detrimental effects. Patients of low prescribers had similar outcomes but fewer return visits than patients of high prescribers, regardless of what they received. At the same time, because there is such a wide range in practice, a single intervention to reduce antibiotic prescribing is unlikely to be the most effective method.⁹ Single-intervention studies targeting one aspect of this complex problem have shown variable results.⁹ Educational material mailed to physicians,^{15–17} provider audit and feedback,^{18–21} paper-based physician reminders and checklists,²² and point-of-care reminders²³ did not reduce prescribing frequency. Academic detailing has produced mixed results.^{16,17,24,25} Delayed antibiotic prescribing, in which patients are given a prescription but asked not to fill it immediately, also reduces the number of filled antibiotic prescriptions.^{26–28} Multifaceted interventions involving a combination of provider, patient, and community education appear to be most effective.^{29–33} Communication skills training, as well as laboratory testing with procalcitonin, rapid antigen test, polymerase chain reaction assay, and C-reactive protein, can decrease antibiotic prescribing,³⁴ and behavioral interventions aimed at clinicians, including accountable justification and peer comparison, also appear to be effective.³⁵ We observed that prescribing also mirrors diagnosis; as such programs will need to report prescribing for all respiratory infections or they may note a diagnosis shift in which physicians more frequently code sinusitis to avoid appearing as outliers.

In general, changes in prescribing have not adversely affected patient outcomes or drug costs, although these outcomes are not reported universally.³⁴ More research is needed to understand why some physicians prescribe antibiotics to almost all of their patients, whereas others prescribe to few or none. In one qualitative study by Dempsey et al, clinicians cited patient demand as the main reason for antibiotic prescribing for acute bronchitis.³⁶ Others also have suggested that patient expectations play a role in physician prescribing^{37,38}; however, studies have shown that for patients who expected antibiotics, receiving antibiotics and receiving information/reassurance were equally important determinants of satisfaction.³⁹ We found that patients were slightly more satisfied with visits during which they received an antibiotic, but the differences were small and generally not statistically significant. We also found that physician behavior may shape patient expectations, with patients who receive antibiotics more likely to return seeking antibiotics for uncomplicated RTIs. Our finding parallels those in the study by Little and colleagues, which showed that patients who received antibiotics for sore throat were more likely to seek them in the future.⁸

For physicians who worry about respiratory complications from untreated bacterial infections, our results are reassuring because few patients from either group went to the ED within 1 week. The reduction in respiratory complications such as pneumonia among patients receiving antibiotics was similar to that observed in a British study,⁴⁰ although the difference in our study did not reach statistical significance. Even if it had, the number

needed to treat to prevent one case of pneumonia would exceed 500. Finally, we did not find evidence for higher physician fees associated with antibiotic prescribing. Although prescription medication management often would justify a moderate-complexity visit (level 4), we found that both visits with and without antibiotic prescribing tended to be billed as low complexity (level 3). Because our physicians worked on a straight salary model, these findings may not apply to private practice, in which there remains a financial incentive to prescribe antibiotics.

Our study has several limitations. Our study data were obtained from 2011 to 2012 and current prescribing patterns may differ. We also excluded patients with immunocompromised status and chronic obstructive pulmonary disease, so our results apply only to uncomplicated RTIs. The data were collected electronically, and we could not document specific clinical symptoms, duration of symptoms, or physical examination findings other than vital signs. These may have explained some of the observed variation; however, given the large sample size and tremendous variation seen, it is unlikely that patient symptoms are responsible for the patterns observed. In addition, the inclusion of diagnostic codes somewhat mitigates the lack of symptoms and clinical findings because antibiotics are never indicated for URI. Our outcomes also were limited. We used ED visits and hospitalizations as a proxy for severe complications; however, some patients may have sought care outside our system. We also had relatively few visits in which the patients provided/completed a satisfaction survey; this pertains to the way patient satisfaction is assessed in clinical care. Although scores may be affected by response bias, such bias may have been expected to affect visits with and without antibiotics equally. Finally, we did not have access to claims data and cannot say which prescriptions were actually filled, let alone taken. Without doubt, some physicians gave patients prescriptions with directions not to fill them immediately. Again, this is unlikely to explain the degree of variation seen, including the variation in diagnosis.

Conclusions

In one large health system, we found extreme variation in antibiotic prescribing for respiratory infections at the provider level, which could not be explained by patient factors. Patients who received antibiotics were no less likely to present to the ED within 7 days and were generally not more satisfied with their care, but they were more likely to return for an RTI at least 1 month later. Better understanding of why some physicians prescribe so many antibiotics and others so few may lead to more effective interventions to decrease unnecessary antibiotic prescribing.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Key Points

- We found extreme variation in prescribing rates (from 0%–100%), despite adjusting for patient factors.
- Patient outcomes did not differ between high and low prescribers, but patients of high prescribers had higher future utilization.
- Patients who received antibiotics were no less likely to present to the emergency department within 7 days and were generally not more satisfied with their care, but they were more likely to return for a respiratory infection at least 1 month later.
- A better understanding of why some physicians prescribe so many antibiotics and others so few may lead to more effective interventions to decrease unnecessary antibiotic prescribing.

Fig. 1.

Variation among providers in adjusted rates of antibiotic prescribing for respiratory tract infection. Rates were adjusted by age, sex, race, temperature, systolic and diastolic blood pressure, pulse rate, body mass index, oxygen saturation, smoking status, history of diabetes mellitus, asthma diagnosis, congestive heart failure, end-stage renal disease, income, and insurance. Each line represents the confidence interval for a single provider. Red lines are significantly different from the mean.

Fig. 2.

(A) Distribution of diagnosis by provider quartile (Q). (B) Antibiotic prescribing rate for each diagnosis by overall prescribing quartile. Quartile 1: lowest prescribers, quartile 4: highest prescribers. URI, upper respiratory tract infection.

Table 1.

Baseline characteristics between patients with and without antibiotic prescription

Characteristic	All (N = 31,416) N (%)	No antibiotic (N = 14,213) N (%)	Antibiotic (N = 17,203) N (%)	P
Sex				
Female	19,951 (63.5)	9073 (63.8)	10,878 (63.2)	0.27
Male	11,465 (36.5)	5140 (36.2)	6325 (36.8)	
Race				
Black	2777 (8.8)	1522 (10.7)	1255 (7.3)	<0.001*
Other	1660 (5.3)	856 (6)	804 (4.7)	
White	26,979 (85.9)	11,835 (83.3)	15,144 (88)	
Age, y, mean (SD)	45.56 (16.7)	45.08 (17.15)	45.96 (16.31)	<0.001*
< 65	26,859 (85.5)	12,083 (85)	14,776 (85.9)	
65	4557 (14.5)	2130 (15)	2427 (14.1)	0.03*
Fever ^a	477 (1.8)	153 (1.3)	324 (2.1)	<0.001*
SBP, mm Hg				
< 100	2157 (4.7)	1084 (5)	1073 (4.5)	
100	29,259 (95.3)	13,129 (95)	16,130 (95.5)	0.05
Pulse, bpm				
< 100	24,095 (91.2)	10,609 (91.8)	13,486 (90.7)	<0.001*
100	2331 (8.8)	943 (8.2)	1388 (9.3)	
BMI				
< 25.0	9142 (31.8)	4396 (33.8)	4746 (30.2)	<0.001
25.0–29.9	9323 (32.5)	4190 (32.2)	5133 (32.7)	
30.0	10,249 (35.7)	4417 (34.0)	5832 (37.1)	
Smoking status ^b				
Never	18,527 (60.9)	8628 (62.7)	9899 (59.4)	<0.001*
Quit	7630 (25.1)	3375 (24.5)	4255 (25.5)	
Yes	3855 (12.7)	1563 (11.4)	2292 (13.8)	
Asthma	3207 (10.2)	1374 (9.7)	1833 (10.7)	0.004*

Characteristic	All (N = 31,416) N (%)	No antibiotic (N = 14,213) N (%)	Antibiotic (N = 17,203) N (%)	P
PCP visit ^c	12,518 (39.8)	5893 (41.5)	6625 (38.5)	<0.001 *
Medical residents ^d	792 (2.5)	417 (2.9)	375 (2.2)	<0.001 *
Income, thousands of dollars, mean (SD)	59.32 (17.95)	58.93 (18.67)	59.64 (17.32)	<0.001 *
Diagnosis				
Bronchitis	3718 (11.8)	603 (4.2)	3115 (18.1)	<0.001 *
Pharyngitis	8542 (27.2)	4662 (32.8)	3880 (22.6)	
Sinusitis	6699 (21.3)	414 (2.9)	6285 (36.5)	
URI	12,457 (39.7)	8534 (60)	3923 (22.8)	
Insurance				
Commercial	26,864 (85.5)	12,133 (85.4)	14,731 (85.6)	0.004 *
Medicaid	220 (0.7)	124 (0.9)	96 (0.6)	
Medicare	4332 (13.8)	1956 (13.8)	2376 (13.8)	

Asterisk means statistically significant P < 0.05.

^aFever is defined as temperature 100.4 °F (38 °C).

^bDid not include smoking status if not asked or passive.

^cPCP was the provider at the visit.

^dResident was the provider at the visit.

BMI, body mass index; PCP, primary care provider; SBP, systolic blood pressure; SD, standard deviation; URI, upper respiratory tract infection.

Table 2.

Patient characteristics for predicting antibiotic prescription (multivariate analysis)

	OR (95% CI)	P
Race		
Black	1.000	
White	1.347 (1.260–1.440)	<0.001
Other	1.108 (1.007–1.219)	0.285
Age, y		
< 65	1.000	
65	0.831 (0.779–0.887)	0.004
Temperature, °F		
< 100.4	1.000	
100.4	1.663 (1.463–1.889)	<0.001
SBP, mm Hg		
100	1.000	
< 100	0.983 (0.910–1.060)	0.817
Pulse, bpm		
< 100	1.000	
100	1.128 (1.066–1.194)	0.033
BMI		
< 25.0	1.000	
25.0–29.9	1.130 (1.086–1.176)	0.002
30.0	1.200 (1.153–1.249)	<0.001
Smoking		
Never	1.000	
Quit	1.071 (1.030–1.113)	0.076
Yes	1.143 (1.089–1.200)	0.006
Asthma	1.121 (1.063–1.181)	0.031
PCP visit	0.862 (0.829–0.895)	<0.001
Insurance		
Private	1.000	
Medicaid	0.575 (0.480–0.688)	0.002
Medicare	1.098 (1.028–1.173)	0.156

BMI, body mass index; CI, confidence interval; OR, odds ratio; PCP, primary care provider; SBP, systolic blood pressure.

Table 3.

Comparison of healthcare utilization between patients prescribed with and without antibiotics

	No antibiotic (N = 14,213) N (%)	Antibiotic (N = 17,203) N (%)	AOR (95% CI) ^a	P
Return to office within 30 d	672 (4.7)	926 (5.4)	1.00 (0.87–1.16)	0.99
Return for RTI in 30–365 d	2360 (16.6)	3712 (21.6)	1.26 (1.16–1.37)	<0.001
RTI-related ED visits or hospitalization within 7 d	57 (0.4)	41 (0.2)	0.82 (0.49–1.40)	0.48

^a Adjusted for sex, age, race, temperature, systolic and diastolic blood pressure, pulse rate, body mass index, smoking status, diagnosis, history of asthma, PCP visit, income, and insurance.

AOR, adjusted odds ratio; CI, confidence interval; ED, emergency department; PCP, primary care provider; RTI, respiratory tract infection.