Antibiotic Use for Viral Acute Respiratory Tract Infections Remains Common

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ABSTRACT

Objectives: To determine the type and number of antibiotic prescriptions filled in the 28 days following an index visit for acute respiratory tract infections (ARTIs) generally presumed to be viral.

Study Design: This was a secondary analysis of administrative data.

Methods: We linked administrative data for pharmacy, clinical encounters, and providers to identify all prescriptions for a relevant antibiotic filled within 28 days of an index visit for an ARTI. Data were analyzed descriptively. The primary outcome was whether or not the patient was prescribed an antibiotic or anti-influenza medication for an episode of presumed viral ARTI.

Results: There were 54,656 encounters for presumed viral ARTI. Most visits (84.4%) were to a primary care clinician, with 12% to an urgent care center and 3.6% to the emergency department. Within 28 days of an encounter for a presumed viral upper respiratory tract infection, 49.4% of patients filled an initial antibiotic prescription, 4.8% a prescription for an anti-influenza drug, and 1.2% received both. A second antibiotic prescription was filled after the initial prescription by 8.9% of patients, and a third by 0.7%. Antibiotic use was most common for acute bronchitis (67.8%) and in the urgent care setting (60.2%). Antibiotics were prescribed less often by pediatricians, whereas anti-influenza medications were prescribed most often for patients aged 5 to 17 years by both pediatricians and family physicians. Antibiotic use has increased since 2007, when azithromycin became a generic drug.

Conclusions: Prescribing antibiotics for ARTIs that are likely to be viral in origin remains common, despite extensive public health educational efforts.

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Acute viral (upper) respiratory tract infections (ARTIs) are among the most common reasons for a healthcare encounter in the United States, with over 43 million ambulatory visits per year for cough or sore throat, and tens of millions of days of lost productivity.[1] Most episodes are caused by viruses, and in otherwise healthy adults, these infections are typically self-limited and do not require a physician visit or a prescription medication. Nevertheless, many patients with uncomplicated, self-limited ARTIs seek care in the emergency department (ED) or primary care office, which subsequently increases healthcare costs and often leads to an inappropriate antibiotic or antiviral prescription.[2,3] Medicalization of a self-limited illness makes it more likely that the patient visits a healthcare provider the next time they have an episode of respiratory tract infection (RTI).[4]

Previous studies have shown that over 60% of adults presenting with ARTI receive an antibiotic; these antibiotics are increasingly broad-spectrum.[2,3,5] Episodes of ARTI with cough as the predominant symptom are often labeled "acute bronchitis," but well-designed randomized controlled trials have shown that azithromycin,[6] amoxicillin,[7] and amoxicillin-clavulanate[8] do not improve outcomes for patients with acute bronchitis. Furthermore, inappropriate overuse of antibiotics and antiviral medications leads to important harms, including antibiotic resistance, which has an impact of $20 billion to $55 billion per year on the US economy.[9,10] Patients often experience minor adverse effects such as diarrhea, nausea, urticaria, and rash, which lead to further office visits and time off work. Rarely, they may experience serious complications such as anaphylaxis and clostridium difficile infection.[11]

Previous studies of prescribing patterns for RTIs used data that were at least 8 years old, measured rates of prescriptions written rather than prescriptions actually filled, and did not gather data on the number of antibiotic prescriptions filled in

Take-Away Points

Antibiotic use remains common for viral acute respiratory tract infections.

- Antibiotics were most often prescribed for acute bronchitis, in the urgent care setting, and for older patients.
- Second prescriptions for an antibiotic were given to 9% of patients who received a first prescription.
- Use of azithromycin has increased since the drug became available as a generic.

the month after the initial encounter.[2,3,5] The current study addresses those deficiencies and uses a "real-world" data set from a diverse US community.

METHODS

We used administrative data from a regional health system in the southeastern United States; the vast majority of physicians were in private practice. Although the health system does not track the race of participants, the county in which it is located and from which it draws most of its members is 26.5% African American and 10.4% Hispanic, based on 2010 Census data. No academic medical centers or training programs were part of the system during the study period. We specified a time frame from 2000 to 2012 (the last year for which complete data were available at the time of the data pull) and did not limit by age or sex of the patient. We included any encounter with a primary or secondary diagnosis of an upper RTI that is generally viral in etiology and does not require antibiotic therapy based on evidence-based practice guidelines.[12,13] This included acute nasopharyngitis (*International Classification of Diseases, NinthRevision, Clinical Modification* [*ICD-9-CM*] code 460), laryngitis without obstruction (*ICD-9-CM* code 464.00), unspecified upper RTI (*ICD-9-CM* codes 465.0, 465.8, or 465.9), acute bronchitis (*ICD-9-CM* code 466.0), bronchiolitis (*ICD-9-CM* codes 466.1, 466.11, 466.19), viral pneumonia (*ICD-9-CM* codes 480.0, 480.1, 480.2, 480.3, 480.8, 480.9), and influenza (*ICD-9-CM* codes 487.0, 487.1, 487.8, 488.1).

We excluded any encounters that also had a code for a diagnosis that could reasonably be treated with an antibiotic, including any sinus infection (*ICD-9-CM* codes 461.0, 461.1, 461.2, 461.3, 461.8, or 461.9), pneumonia (*ICD-9-CM* codes 481, 482.x, 483.x, 484.x, 485, or 486), acute tonsillitis (*ICD-9-CM* code 463), streptococcal pharyngitis (*ICD-9-CM* code 034.0 or 034.1), otitis media (*ICD-9-CM* code 382.x), mastoiditis (*ICD-9-CM* code 383.x), orbital cellulitis (*ICD-9-CM* code 376.0x), and urinary tract infection (*ICD-9-CM* codes 590.10, 590.11, 595.0, 595.1, 595.9, or 599.0). In order to restrict the sample to patients without chronic lung disease, we excluded any patient with a previous recorded diagnosis of emphysema, chronic bronchitis, bronchiectasis, or COPD (*ICD-9-CM* codes 491.x, 492.x, 494.x, or 496.x); cystic fibrosis (*ICD-9-CM* code 277.0x); or interstitial pneumonia (*ICD-9-CM* code 516.3x). Our general approach is similar to that of the previous study by Grijalva and colleagues.[3]

For each encounter, we obtained the following administrative data: all diagnostic codes, patient date of birth and gender, date of encounter, clinician specialty, and the site of the encounter. We also recorded the medication name and date for any prescriptions filled within 28 days of the initial encounter.

We combined identical drugs with different trade or generic names. We also calculated the age from the date of birth, and the numbers of days from the initial encounter until each prescription for an antibiotic or anti-influenza drug was filled. We created variables for site of care as primary care office, urgent care, or ED. Due to small numbers of encounters for these specialists, we classified general practitioners as family physicians, and pediatric emergency physicians as emergency physicians. We also created variables for primary care physician (family physician, general internist, or pediatrician) versus other specialty, and for physician assistant or nurse practitioner versus other provider.

The analysis was primarily descriptive. We used the χ^2 tests to compare proportions and the Student's *t* test to compare continuous variables. All analyses used Stata version 13.2 (StataCorp, College Station, Texas). The primary analysis was for the first or initial prescription(s) filled following the index visit, but we also report data for second or third antibiotic or anti-influenza drug prescriptions filled on subsequent days.

RESULTS

We identified a total of 54,656 episodes of care for a suspected viral ARTI that met our inclusion and exclusion criteria. The mean age of participants was 26.5 years, with a range of 0 to 83 years; 55.9% were female. Children aged under 5 years made up 22.1% of the sample; children and adolescents aged 5 to 17 years, 18.9%; adults aged 18 to 64 years, 57.8%; and only 1.1% were aged 65 years or older. The site of care was urgent care for 12.0%, ED for 3.6%, and primary care for 84.4%. Of visits in the primary care setting, 43.5% were to a family physician, 32.1% to a pediatrician, 24.1% to a general internist, and 0.3% to a physician assistant or nurse practitioner. Data on race or socioeconomic status were not available in our adminis-

Table 1. Use of Antibiotics and Anti-Influenza Drugs for Presumed Viral ARTIs by Diagnosis[a]

Drug Class	Acute Bronchitis	Acute Naso-pharyngitis	Bronchiolitis	Influenza	Laryngitis	Unspecified Upper RTI	Viral Pneumonia	Total
Antibiotics								
Cephalosporin 1	268 (1.6%)	110 (2.8%)	10 (0.5%)	27 (0.5%)	6 (1.6%)	449 (1.7%)	0 (0.0%)	870 (1.6%)
Cephalosporin 2	573 (3.5%)	108 (2.7%)	58 (2.9%)	32 (0.5%)	3 (0.8%)	663 (2.5%)	1 (1.9%)	1438 (2.6%)
Cephalosporin 3	610 (3.7%)	128 (3.2%)	97 (4.9%)	59 (1.1%)	12 (3.3%)	670 (2.5%)	4 (7.4%)	1580 (2.9%)
Any cephalosporin	1451 (8.9%)	346 (8.7%)	165 (8.3%)	118 (2.2%)	21 (5.8%)	1782 (6.7%)	5 (9.3%)	3888 (7.1%)
Macrolide or lincosamide	6304 (38.7%)	742 (18.7%)	447 (22.4%)	422 (7.8%)	108 (29.7%)	5964 (22.5%)	13 (24.1%)	14,000 (25.6%)
Penicillin	1199 (7.4%)	538 (13.6%)	224 (11.2%)	158 (2.9%)	29 (8.0%)	3120 (11.8%)	7 (13.0%)	5275 (9.7%)
Quinolone	1280 (7.9%)	19 (0.5%)	12 (0.6%)	57 (1.0%)	15 (4.1%)	729 (2.7%)	1 (1.9%)	2113 (3.9%)
Sulfonamide/ tetracycline	733 (4.5%)	27 (0.7%)	4 (0.2%)	41 (0.8%)	11 (3.0%)	738 (2.8%)	1 (1.9%)	1555 (2.8%)
2 antibiotics	72 (0.4%)	4 (0.1%)	3 (0.2%)	6 (0.1%)	3 (0.8%)	102 (0.4%)	0 (0.0%)	190 (0.3%)
Any antibiotic[b]	11,039 (67.8%)	1676 (42.2%)	855 (42.8%)	802 (14.7%)	187 (51.4%)	12,435 (46.8%)	27 (50.0%)	27,021 (49.4%)
Anti-influenza ± antibiotic								
Anti-influenza	47 (0.3%)	17 (0.4%)	4 (0.2%)	2370 (43.6%)	1 (0.3%)	194 (0.7%)	1 (1.9%)	2634 (4.8%)
Anti-influenza + antibiotic	46 (0.3%)	5 (0.1%)	4 (0.2%)	508 (9.3%)	0 (0.0%)	71 (0.3%)	0 (0.0%)	634 (1.2%)
Anti-influenza or anti-influenza + antibiotic	93 (0.6%)	22 (0.6%)	8 (0.4%)	2878 (52.9%)	1 (0.3%)	265 (1.0%)	1 (1.9%)	3268 (6.0%)
Any antibiotic or anti-influenza	11,132 (68.4%)	1698 (42.8%)	863 (43.2%)	3680 (67.7%)	188 (51.6%)	12,700 (47.8%)	28 (51.9%)	30,289 (55.4%)
Total[c]	16,284	3967	1997	5438	364	26,552	54	54,656

ARTI indicates acute respiratory tract infection; RTI, respitatory tract infection.
[a]Initial prescriptions filled following index visit; if more than 1 antibiotic or anti-influenza plus antibiotic, both were filled on the same day.
[b]Sum of all antibiotic rows, excluding "Any cephalosporin."
[c]Total refers to the total number of patients given the diagnosis specified in the heading. For example, 16,284 patients were diagnosed with acute bronchitis.

trative data set, but the region served by the health program is racially and ethnically diverse and includes urban, suburban, and rural areas.

An initial antibiotic prescription was filled by 49.4% of patients and an anti-influenza drug by 4.8% within 28 days of the encounter, with 1.2% receiving both an antibiotic and an anti-influenza drug and 0.3% receiving 2 antibiotics. The percentage of patients receiving an antibiotic or anti-influenza medicine by diagnosis is shown in Table 1. Use of an antibiotic was most common among those with a diagnosis of acute bronchitis (67.8%), although rates were high for all other suspected viral diagnoses (42.2% to 51.4%) other than influenza (14.7%).

Within 28 days of the initial encounter, a second prescription for an antibiotic or anti-influenza medication was filled on a separate day by 2681 patients (8.9% of those who received an initial prescription) and a third prescription was filled by 225 patients (0.7%). The most common combinations by drug class are shown in Table 2. The timing of second prescriptions filled subsequent to the first, and within 14 days of, the initial prescriptions is shown in Figure 1, by days from when the initial prescription was filled. For patients who filled an initial prescription for an anti-influenza drug (including those who also filled a prescription for an antibiotic), the prescription was filled on the same day as the encounter 93% of the time. However,

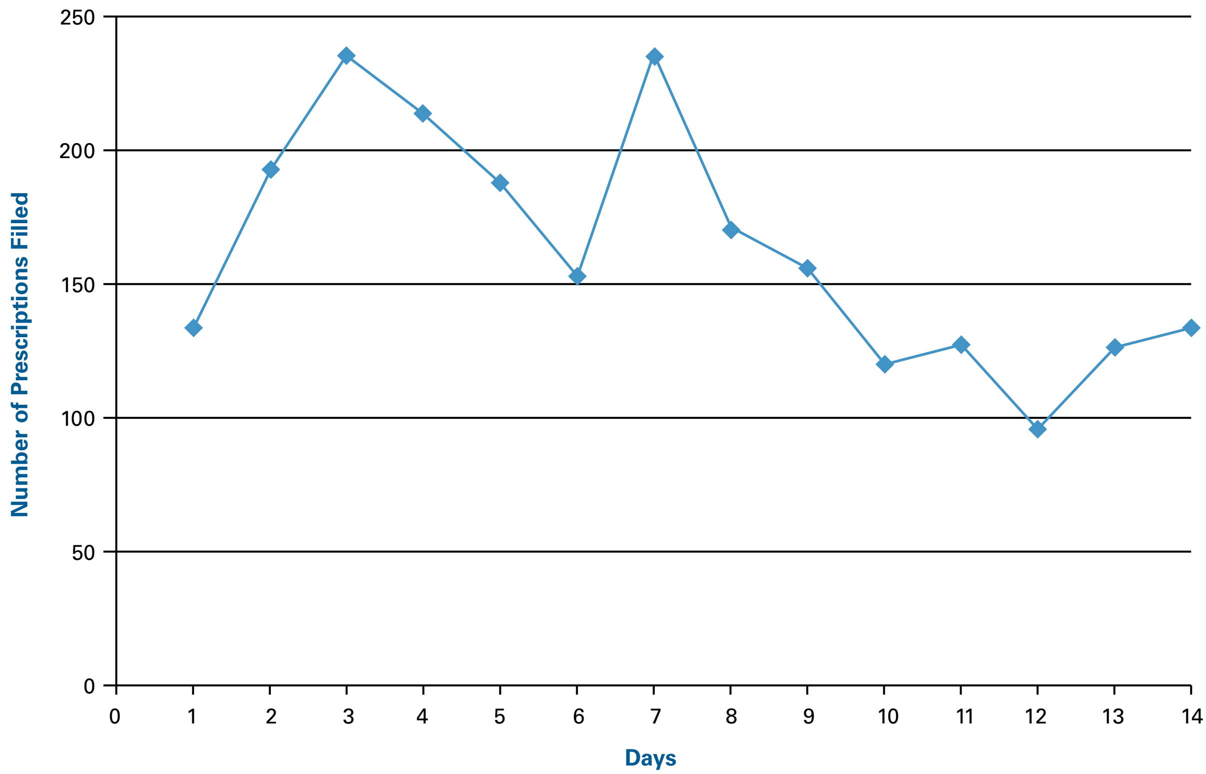
Table 2. The Most Common Combinations of 2 Prescriptions for an Antibiotic or Anti-Influenza Drug on Separate Days Within 28 Days of the Initial Prescription

1st Prescription Filled	2nd Prescription Filled	Number
Macrolide or lincosamide	Penicillin	306
Macrolide or lincosamide	Quinolone	233
Penicillin	Macrolide or lincosamide	187
Anti-influenza	Macrolide	141
Macrolide or lincosamide	Cephalosporin 3	133
Macrolide or lincosamide	Cephalosporin 2	114
Macrolide or lincosamide	Sulfonamide/tetracycline	112
Macrolide or lincosamide	Macrolide or lincosamide	106
Anti-influenza	Penicillin	91
Quinolone	Macrolide or lincosamide	68
Cephalosporin 2	Macrolide or lincosamide	68

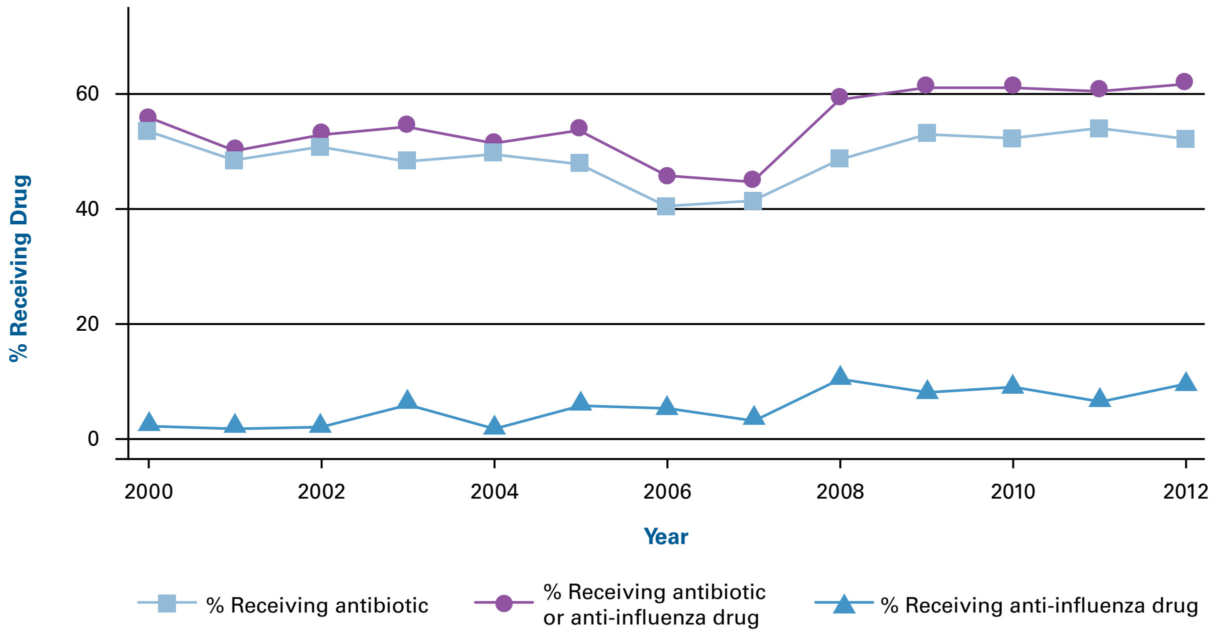
data on the duration of symptoms prior to the clinician encounter were not available.

Time trends of antibiotic and anti-influenza drug use between 2000 and 2012 are shown in Figure 2. Use of any antibiotic decreased from 56% to a low of 45.1% in 2007, but then rose again to a rate of 62% in 2012. Use of anti-influenza medications was more common since 2006 than before for all encounters (6.4% vs 2.7%; P <.001) and for encounters with a diagnosis of influenza (48.3% vs 32.7%; P <.001). Use of specific drug classes by year is shown in Table 3.

Figure 1. Number of Second Prescriptions for an Antibiotic or Anti-Influenza Medication by Days From the Initial Prescription



■ **Figure 2.** Time Trend for Prescribing Antibiotics and Anti-Influenza Drugs From 2000 to 2012



Whereas antibiotic use is more common in older patients, as shown in Table 4, anti-influenza drug use was most common among children and adolescents aged 5 to 17 years (9.6%) but less common in patients under 5 years (2.9%; P <.001) or over 17 years (4%; P <.001). A similar pattern was seen when limiting the analysis to patients with a diagnosis of influenza, with the highest rate again in those aged 5 to 17 years (47.9%) and lower in younger and older patients. There was no clinically important difference between male and female patients in their likelihood of receiving an antibiotic or anti-influenza drug.

Table 5 summarizes antibiotic and anti-influenza drug use by site and physician specialty. The highest rate of prescribing for an antibiotic or anti-influenza drug was seen in the urgent care setting (68.3%). Pediatricians, however, had the lowest rate of prescribing for antibiotics. When limited to patients with influenza aged 5 to 17 years, there was no difference in prescribing rates for anti-influenza drugs between family physicians and pediatricians (49.7% vs 47.9%; P = .163). In dichotomous comparisons, primary care physicians were less likely to prescribe an antibiotic (47.9% vs 57.7%; P <.001), anti-influenza medication (4.5% vs 6.2%; P <.001), or either (53.5% vs 65.5%; P <.001) for a viral ARTI than clinicians in other settings. Emergency physicians were more likely to prescribe an antibiotic (57.7% vs 47.9%; P <.001) or anti-influenza medication (6.2% vs 4.6%; P <.001) than other specialties. Nurse practitioners and physician assistants were also more likely to prescribe an antibiotic (58.3% vs 49.4%; P = .03), but the difference between them and other clinicians regarding anti-influenza drugs was not statistically significant (6.9% vs 4.8%; P = .23).

DISCUSSION

Our primary finding is that clinicians in typical community practice continue to prescribe antibiotics at high levels for ARTIs that are exclusively or predominantly caused by viruses. Rates are especially high when the clinical diagnosis is acute bronchitis, when patients are seen by a clinician in an urgent care setting, or when they are seen by a nurse practitioner or physician assistant. Although antibiotic use is more common in older patients (pediatricians had the lowest rates of prescribing antibiotics), use of anti-influenza drugs is highest among individuals aged 5 to 17 years.

Of particular note is the fact that 8.9% of patients received a second antibiotic and 0.7% received a third during the 28 days following the index encounter. Examination of Figure 1, a graph of when the second prescriptions were filled in relation to the first, reveals that there are 2 peaks around 3 and 7 days. We hypothesize that the first may represent patients who did not tolerate the initial medication, while the second peak around 7 days may represent patients requesting a second prescription because of lack of efficacy with the first.

■ **Table 3.** Prescribing of Different Antibiotic Classes and Anti-Influenza Drugs for Presumed Viral ARTI by Year[a]

Drug Class	2000	2001	2002	2003	2004	2005
Antibiotic						
Cephalosporin 1	52 (1.8%)	75 (2.0%)	71 (1.7%)	69 (1.6%)	61 (1.9%)	70 (1.6%)
Cephalosporin 2	135 (4.6%)	128 (3.3%)	112 (2.7%)	126 (2.9%)	84 (2.6%)	94 (2.1%)
Cephalosporin 3	18 (0.6%)	32 (0.8%)	75 (1.8%)	75 (1.7%)	58 (1.8%)	99 (2.2%)
Macrolide or lincosamide	781 (26.5%)	914 (23.9%)	1128 (26.8%)	1084 (25.0%)	812 (24.7%)	1013 (22.5%)
Penicillins	359 (12.2%)	471 (12.3%)	509 (12.1%)	483 (11.1%)	369 (11.3%)	517 (11.5%)
Quinolone	81 (2.7%)	102 (2.7%)	151 (3.6%)	184 (4.2%)	157 (4.8%)	217 (4.8%)
Sulfonamide/tetrarchy	148 (5.0%)	125 (3.3%)	90 (2.1%)	71 (1.6%)	86 (2.6%)	145 (3.2%)
2 antibiotics	8 (0.3%)	8 (0.1%)	12 (0.3%)	9 (0.2%)	7 (0.2%)	8 (0.2%)
Any antibiotic[b]	1582 (54.0%)	1855 (48.0%)	2148 (51.0%)	2101 (48.5%)	1634 (49.8%)	2163 (48.0%)
Anti-influenza ± antibiotic						
Anti-influenza	49 (1.7%)	53 (1.4%)	57 (1.4%)	207 (4.8%)	47 (1.4%)	215 (4.8%)
Anti-influenza drug + antibiotic	21 (0.7%)	22 (0.6%)	33 (0.8%)	64 (1.5%)	11 (0.3%)	62 (1.4%)
Anti-influenza or anti-influenza + antibiotic	70 (2.4%)	75 (2.0%)	90 (2.1%)	271 (6.3%)	58 (1.7%)	277 (6.2%)
Any antibiotic or anti-influenza	1642 (56.0%)	1930 (50.4%)	2238 (53.2%)	2372 (54.7%)	1692 (51.6%)	2440 (54.1%)
Total[c]	2951 (100%)	3828 (100%)	4209 (100%)	4335 (100%)	3281 (100%)	4509 (100%)

ARTI indicates acute respiratory tract infection.
[a]Initial prescriptions filled following index visit; if more than 1 antibiotic or anti-influenza plus antibiotic, both were filled on the same day.
[b]Sum of all antibiotic rows, excluding "Any cephalosporin."
[c]Total refers to the total number of patients diagnosed with a presumed viral ARTI during that year.

(continued)

Although we used a regional sample, our findings for the years 2000 to 2006 are very similar to those of Grijalva and colleagues, who used the National Ambulatory Medical Care Survey.[3] Their definition of ARTI was similar to ours, although they reported prescriptions written and we reported prescriptions actually filled. From 2000 to 2006, they reported that prescriptions written for antibiotics for an ARTI declined from 63% in 1995/1996 to 54% in 2005/2006, while we found that antibiotic prescriptions filled for an ARTI declined from 54% in 2000 to 40.5% in 2006. This is shown in Figure 2, with use of antibiotics declining until 2007. However, we found that use began to rise again in 2007. This trend was driven largely by an increase in the use of macrolides and coincides with the year that azithromycin became available as a generic medication. Specifically, the use of macrolides declined from 26.5% of prescriptions for presumed viral ARTI in 2000 to only 19.7% in 2007, then jumped to 25.3% in 2008 and is now at 30.2%. This is despite a lack of evidence that macrolides have a clinically meaningful benefit for patients with acute bronchitis or any of the other presumed viral ARTIs studied.[6,12,13]

Strengths and Limitations

This study has several strengths compared with previous studies.[2,3,5] First, it uses a contemporary sample of pa-

■ **Table 3.** Prescribing of Different Antibiotic Classes and Anti-Influenza Drugs for Presumed Viral ARTI by Year[a] ***(continued)***

2006	2007	2008	2009	2010	2011	2012	Total
65 (1.5%)	61 (1.5%)	68 (1.5%)	84 (1.5%)	57 (1.2%)	83 (2.2%)	54 (1.3%)	870 (1.6%)
64 (1.5%)	98 (2.4%)	97 (2.1%)	119 (2.1%)	136 (2.8%)	123 (3.2%)	122 (2.9%)	1438 (2.6%)
119 (2.8%)	162 (4.0%)	201 (4.3%)	218 (3.8%)	184 (3.9%)	152 (4.0%)	187 (4.4%)	1580 (2.9%)
837 (19.8%)	807 (19.7%)	1184 (25.2%)	1729 (30.5%)	1360 (28.5%)	1073 (27.9%)	1278 (30.1%)	14,000 (25.6%)
336 (7.9%)	293 (7.2%)	386 (8.2%)	422 (7.5%)	385 (8.1%)	384 (10.0%)	361 (8.5%)	5275 (9.6%)
178 (4.2%)	164 (4%)	235 (5%)	277 (4.9%)	212 (4.4%)	124 (3.2%)	31 (0.7%)	2113 (3.9%)
105 (2.5%)	111 (2.7%)	116 (2.5%)	142 (2.5%)	140 (2.9%)	116 (3.0%)	160 (3.8%)	1555 (2.8%)
8 (0.2%)	13 (0.3%)	8 (0.2%)	25 (0.4%)	26 (0.5%)	24 (0.6%)	34 (0.8%)	190 (0.4%)
1712 (40.5%)	1709 (41.7%)	2295 (48.9%)	3016 (53.3%)	2500 (52.4%)	2079 (54.1%)	2227 (52.5%)	27,021 (49.4%)
195 (4.6%)	121 (3.0%)	404 (8.6%)	389 (6.9%)	358 (7.5%)	211 (5.5%)	328 (7.7%)	2634 (4.8%)
32 (0.8%)	18 (0.4%)	96 (2.0%)	81 (1.4%)	75 (1.6%)	44 (1.2%)	75 (1.8%)	634 (1.2%)
227 (5.4%)	139 (3.4%)	500 (10.6%)	470 (8.3%)	433 (9.1%)	255 (6.7%)	403 (9.5%)	3268 (6.0%)
1939 (45.8%)	1848 (45.1%)	2795 (59.5%)	3486 (61.6%)	2933 (61.5%)	2334 (60.8%)	2630 (62.0%)	30,289 (55.4%)
4230 (100%)	4099 (100%)	4696 (100%)	5664 (100%)	4772 (100%)	3840 (100%)	4241 (100%)	54656 (100%)

tients in private practice settings and reports prescriptions filled, rather than prescriptions written, by the physician. Thus, it provides a more accurate assessment of the impact of inappropriate antibiotic prescribing in the community. It is also the first study to determine the number of patients with second or third antibiotic prescriptions shortly following the initial encounter, and the first to describe increasing use of antibiotics since azithromycin became available as a generic drug.

Limitations include the small number of patients 65 years or older and the fact that all of the patients had health insurance, largely through an employer. This may make them less price-sensitive than uninsured patients, but should not differ from patients with Medicaid or Medicare Part D, which also provide prescription coverage. Race or socioeconomic status were not directly captured, but the plan's members came from a community that is very diverse based on census data and has a high poverty rate of 33.5%.

The relatively high number of patients receiving a second or third prescription is a novel finding and may be driven by a mismatch between patient expectations and reality. In a previous study, we surveyed residents of Georgia to determine how long they felt that an episode of acute bronchitis typically lasts. The mean was approximately 8 days—much lower than the mean of 17.8 days

Table 4. Use of Antibiotics and Anti-Influenza Drugs for Presumed Viral ARTI by Age Group

Age Group (years)	Antibiotic/ Total (%)	Anti-Influenza Drug/Total (%)		Antibiotic or Anti-Influenza/Total (%)
		Any Diagnosis	Influenza Only	
<5	4391/12,081 (36.4%)	353/12,081 (2.9%)	327/826 (39.6%)	4795/12,081 (39.7%)
5-17	4562/10,321 (44.2%)	988/10,321 (9.6%)	930/1943 (47.9%)	5699/10,321 (55.2%)
18-49	12,768/23,103 (55.3%)	1031/23,103 (4.5%)	901/2140 (42.1%)	14,128/23,103 (61.2%)
50-64	4922/8511 (57.8%)	250/8511 (2.9%)	203/503 (40.4%)	5272/8511 (61.9%)
≥65	378/639 (59.2%)	12/639 (1.9%)	9/26 (34.6%)	395/639 (61.8%)

ARTI indicates acute respiratory tract infection.

that we found in a systematic review of placebo groups in randomized controlled trials.[14]

Implications

Our study has several important implications for medical and public health practice. First, the rise in antibiotic use for largely viral ARTIs from 2007 to 2012 is of great concern. Public health messaging to the community, continuing education for physicians, and patient education by physicians should continue to emphasize that antibiotics are not effective for acute bronchitis and other presumed viral ARTIs. Second, a substantial proportion of patients receive a second prescription for an antibiotic or anti-influenza medication after filling the first prescription, presumably because the first one did not "work." By setting appropriate expectations for the duration of an illness, we may be able to reduce patient demands for a first (or second) antibiotic. Previous research has found that calling the episode a "chest cold" rather than "acute bronchitis" reduces expectations for an antibiotic.[15] Thus, the message to patients should be, "You have a chest cold that is caused by a virus and will probably last about 2 weeks. Antibiotics are unlikely to help and may hurt you." Third, although improvement was seen in antibiotic prescribing rates until 2007, once azithromycin became available as a generic medication (at much lower cost), a significant barrier to its use was removed and prescribing rates increased dramatically. Thus, physicians and patients appear to be at least somewhat sensitive to price, and reducing price may have unintended adverse consequences in terms of inappropriate antibiotic prescribing.

Table 5. Use of Antibiotics and Anti-Influenza Drugs for Presumed Viral ARTI by Physician Specialty and Practice Site

Specialty	Antibiotic/Total (%)	Anti-Influenza Drug/Total (%)		Antibiotic or Anti-Influenza/Total (%)[a]
		Any Diagnosis	Influenza Only	
Primary care physician	21,996/45,951 (47.9%)	2093/45,951 (4.6%)	1868/4256 (43.9%)	24,589/45,951 (53.5%)
General internist	6399/11,131 (57.5%)	407/11,131 (3.7%)	346/826 (41.9%)	6930/11,131 (62.3%)
Family physician (all)	10,603/20,039 (52.9%)	824/20,039 (4.1%)	707/1583 (44.7%)	11,684/20,039 (58.3%)
Patient aged ≥18 years	8890/16,606 (53.5%)	641/16,606 (3.9%)	536/1252 (42.8%)	9760/16,606 (58.8%)
Patient aged <18 years	1713/3433 (49.9%)	183/3433 (5.3%)	171/331 (51.7%)	1924/3433 (56.0%)
Pediatrician	4994/14,781 (33.8%)	862/14,781 (5.8%)	815/1847 (44.1%)	5975/14,781 (40.4%)
Physician assistant or nurse practitioner	84/144 (58.3%)	10/144 (6.9%)	7/17 (41.2%)	95/144 (66.0%)
Emergency physician	977/1978 (49.4%)	106/1978 (5.4%)	94/271 (34.7%)	1106/1978 (55.9%)
Patient aged ≥18 years	656/1246 (52.7%)	64/1246 (5.1%)	60/162 (37.0%)	734/1246 (58.9%)
Patient aged <18 years	321/732 (43.9%)	42/732 (5.7%)	34/109 (31.2%)	372/732 (50.8%)
Urgent care[b]	3964/6583 (60.2%)	425/6583 (6.5%)	401/894 (44.9%)	4499/6583 (68.3%)

ARTI indicates acute respiratory tract infection.
[a]Includes patients who initially received both an antibiotic and anti-influenza drug.
[b]Specialty of the urgent care physician was not reported.

CONCLUSIONS

In terms of future research, there have been relatively few adequately powered studies in US populations comparing treatments for ARTIs such as acute bronchitis. Pelargonium sidoides[16-18] and anti-inflammatory drugs[8,19] have shown promise in previous studies. However, studies of pelargonium have largely been manufacturer-sponsored, with concern about publication bias.[20] Studies of anti-inflammatories have had mixed results and have generally been underpowered or used artificially induced respiratory infections.[8,19] A large, pragmatically designed randomized controlled trial comparing these interventions, including azithromycin because it is so widely prescribed, is badly needed in the United States. Finally, development and validation of clinical decision rules and point-of-care tests such as c-reactive protein could help physicians to better identify patients who are very likely to have a viral cause of their infection.

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