

# Impact of Diagnostic Testing on Pediatric Patients With Pharyngitis: Evidence From a Large Health Plan

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**Objective:** The recommended treatment for children and adolescents under 18 years of age who have a positive test for group A *Streptococcus* (GAS) are antibiotics using the “test and treat” strategy to detect and treat GAS for pediatric pharyngitis. This study used paid claims data to document the extent to which real-world treatment patterns are consistent with these recommendations. We document the factors correlated with testing and treatment, then examine the effects of receiving a GAS test and being treated with an antibiotic impact the likelihood of a revisit for an acute respiratory tract infection within 28 days.

**Methods:** This retrospective cohort study used Optum Insight Clinformatics data for medical and pharmacy claims from 2011-2013 to identify episodes of care for children and adolescents with pharyngitis around their index visit ( $\pm$  6 months). The sample population included children and adolescents under 18 years of age with a diagnosis of pharyngitis. Multivariable logistic regression analyses

were used to document factors associated with receipt of GAS test and antibiotic treatment. Next, we used logistic regression models to estimate the impact of test and treat recommendation on revisit risk.

**Results:** There were 24 685 treatment episodes for children and adolescents diagnosed with pharyngitis. Nearly 47% of these episodes included a GAS test and 48% of tested patients were prescribed an antibiotic prescription. Failing to perform a GAS test increased the risk of a revisit within 28 days by 44%. The use of antibiotics by tested and untested patients had no impact on revisit risk.

**Conclusion:** While the judicious use of antibiotics is important in managing pharyngitis infections and managing complications, the use of rapid diagnostic tools was found to be the determining factor in reducing revisits for pediatric patients with pharyngitis.

**Keywords:** pediatrics; pharyngitis; respiratory infections; acute infections; diagnostic tests; group A *Streptococcus*; antibiotics; revisits.

Acute pharyngitis is a common acute respiratory tract infection (ARTI) in children. Group A  $\beta$ -hemolytic streptococci (GABHS) is the most common bacterial etiology for pediatric pharyngitis, accounting for 15% to 30% of cases.<sup>1</sup>

Beyond clinical assessment, laboratory diagnostic testing generally plays a limited role in guiding appropriate antibiotic prescribing for patients with an ARTI.<sup>2,3</sup> Most diagnostic tests require 2 or 3 days to result, incur additional costs, and may delay treatment.<sup>4</sup> While these tests do not provide clear and timely guidance on which specific antibiotic is appropriate for ARTI patients, this is not the case for patients with pharyngitis.<sup>5,6,7</sup> A rapid diagnostic test exists to identify pharyngitis patients with GABHS which accounts for 1 in 4 children with acute sore throat.<sup>1,4,6</sup> Both

the American Academy of Pediatrics and the Infectious Diseases Society of America recommend antibiotic treatment for children and adolescents under 18 years of age who have a positive test for group A *Streptococcus* (GAS).<sup>8,9</sup> This “test and treat” protocol has been consistently included in the Healthcare Effectiveness Data and Information Set (HEDIS) standards over time for pediatric

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pharyngitis patients aged 3 to 18 years before dispensing an antibiotic.<sup>10</sup>

Sinusitis, pneumonia, and acute otitis media are considered ARTIs where antibiotic treatment is justified. Therefore, pharyngitis of unclear etiology seen with these comorbid infections may not always undergo GAS testing but move directly to the patient being prescribed antibiotics. This analysis enumerates ARTI-related comorbidities present together with the initial coded pharyngitis diagnosis to evaluate their impact on the provider's decision to test and treat, and on revisit risk.

Antibiotic treatment for GAS patients is likely to eradicate the acute GABHS infection within 10 days. Penicillin and amoxicillin are commonly recommended because of their narrow spectrum of activity, few adverse effects, established efficacy, and modest cost. Alternative antibiotics for patients with penicillin allergy, or with polymicrobial infection seen on culture results, include a first-generation cephalosporin, clindamycin, clarithromycin (Biaxin), or azithromycin (Zithromax).<sup>1,8,11</sup> However, while compliance with these HEDIS guidelines has been evaluated, the outcome effects of following the HEDIS "test and treat" recommendations for children with pharyngitis have not been adequately evaluated.

These outcome evaluations have increasing importance as the latest HEDIS survey has shown testing rates in commercial Preferred Provider Organizations (PPO) falling from 86.4% in 2018 to 75.9% in 2019, the lowest rate of testing since 2009, with similar reductions under 80% for Health Maintenance Organizations (HMO).<sup>10</sup> While health plans may execute cost-benefit analyses and algorithms to forge best practices for GAS testing in children and adolescents presenting with symptoms of pharyngitis, it is important to regard the wasteful resource utilization and additional cost of revisits that may offset any gains accrued by more focused GAS testing outside the existing clinical guidelines and HEDIS measures. This may be of particular importance in documenting infection and sparing antibiotic therapy in toddlers and younger.

The objective of this study was to investigate the correlation between testing and antibiotic use on the likelihood of a revisit for an acute respiratory tract infection within 28 days. To achieve this objective, this investigation consists of 3 sequential analyses. First, we document the

factors associated with the decision to test the patient for a GABHS infection using the GAS test. Next, we document the factors associated with the decision to use an antibiotic to treat the patient as a function of having tested the patient. Finally, we investigate the impact of the testing and treatment decisions on the likelihood of a revisit within 28 days.

## Methods

### Study design

This was a retrospective cohort study of episodes of treatment for pediatric patients with pharyngitis. Episodes were identified using data derived from the Optum Insight Clinformatics claims database provided to the University of Southern California to facilitate the training of graduate students. These data cover commercially insured patients with both medical and pharmacy benefits. Data were retrieved from the 3-year period spanning 2011-2013. An episode of care was identified based on date of the first (index) outpatient visit for a pharyngitis diagnosis (*International Classification of Diseases, Ninth Revision* [ICD-9]: 462, 463, 034.0). Outpatient visits were defined by visit setting: ambulatory clinics, physician offices, emergency rooms, and urgent care facilities. Each pharyngitis treatment episode was then screened for at least a 6-month enrollment in a health insurance plan prior and subsequent to the index visit using Optum enrollment data. Finally, eligible treatment episodes were restricted to children and adolescents under 18 years of age, who had an index outpatient visit for a primary diagnosis of acute pharyngitis.

A diagnostic profile was created for each episode using the diagnoses recorded for the index visit. Up to 3 diagnoses may be recorded for any outpatient visit and the first recorded diagnosis was assumed to be the primary diagnosis for that episode. Any secondary diagnoses recorded on the index visit were used to define comorbidities present at the index visit. ARTI-related comorbidities included: acute otitis media (AOM), bronchitis, sinusitis, pneumonia, and upper respiratory infection (URI). Other comorbid medical diagnoses were documented using diagnostic data from the pre-index period. Dichotomous variables for the following categories were created: mental disorders, nervous system

disorders, respiratory symptoms, fever, injury and poisoning, other, or no diseases.

Prior visits for other respiratory infections in the previous 90 days were also identified for patients based on their index visit for pharyngitis. Similarly, any subsequent visits, within 28 days of the index visit, were also recorded to measure the health outcome for analysis. Practice settings include physician offices and federally qualified health centers, state and local health clinics, outpatient hospitals facilities, emergency departments, and other outpatient settings such as walk-in retail health clinic or ambulatory centers. Providers include primary care physicians (family practice, pediatricians, internal medicine), specialty care physicians (emergency medicine, preventive medicine), nonphysician providers (nurse practitioners, physician assistants) and other providers (urgent care, acute outpatient care, ambulatory care centers). Seasons of the year were determined based on the index date of the episode to account for possible seasonality in pharyngitis treatment. Lastly, a previous visits variable was created to identify whether the child had nonpharyngitis ARTI visits in the 3 months prior to the index visit.

Demographic variables were created based on enrollment and the socioeconomic data available in the Optum socioeconomic status file. These variables include patient age, race, sex, household income, geographic location, practice setting type, provider specialty, and type of insurance. An estimate of patient household income was based on algorithms using census block groups. Income categories were informed by the federal guidelines for a family of 4. A low-income family was defined as earning less than \$50 000; a middle-income family earned between \$50 000 and \$75 000, and a high-income family earned \$75 000 and above.<sup>12</sup> Patient insurance type was categorized as HMO, Exclusive Provider Organization (EPO), Point of Service (POS), and PPO. Race was identified as White, Black, Hispanic, and Asian. Patient location was defined according to national census regions.

### Outcomes

#### **GAS test**

The HEDIS measures for pharyngitis recommend using the GAS test to identify the bacterial etiology of the pharyngitis infection. Patients who received the test were iden-

tified based on Current Procedural Terminology (CPT) codes 87070-71, 87081, 87430, 87650-52, and 87880.<sup>10</sup>

#### **Antibiotic treatment**

The pharmacy administrative claims dataset was used to identify study patients who filled a prescription for an antibiotic during their pharyngitis treatment episode. Optum pharmacy data identify the medications received, specifies the date of prescription filling, National Drug Codes, and American Hospital Formulary Service (AHFS) Classification System codes for each medication. We used the AHFS Pharmacologic-Therapeutic classification of antibiotics to create dichotomous variables documenting the antibacterial used by each patient.<sup>13</sup> These are categorized under antibacterial including penicillins, cephalosporins (first, second, third, fourth generation cephalosporins), macrolides (first generation and others), tetracyclines, sulfonamides, fluoroquinolones (ciprofloxacin, levofloxacin, moxifloxacin), cephamycin, carbapenems, and  $\beta$ -lactam antibiotics (amoxicillin, amoxicillin/clavulanate, cephalexin, cefuroxime, cefdinir).

#### **Revisits to physician or other provider**

Revisits within 28 days were used as the measure of patient outcomes related to testing and filling of an antibiotic prescription for acute pharyngitis. Revisits may also be due to a patient returning for a follow-up, alternative treatment, worsening pharyngitis, or for another ARTI. An ARTI-related revisit also increases total resources used to treat pediatric pharyngitis patients.

#### **Statistical analysis**

Logistic regression was used for all 3 analyses conducted in this study. First, we determined the patient and treating physician characteristics that impact the decision to use GAS testing for pharyngitis. Second, we identified those factors that impact the decision to use antibiotic prescriptions among children who were diagnosed with pharyngitis adding in the dichotomous variable indicating if the patient had received a GAS test. Third, we used a logit regression analysis to document if receiving a GAS test and/or an antibiotic impacted the likelihood of a revisit by comparing revisit risk. To estimate the effect of testing and/or antibiotic use, we

divided patients into 4 groups based on whether the patient received a GAS test and/or an antibiotic prescription. This specification of the analysis of revisits as an outcome focuses on adherence to HEDIS “test and treat” guidelines<sup>10</sup>:

1. Patients who were not tested yet filled an antibiotic prescription. This decision was likely based on the clinician’s judgment of the patient’s signs and symptoms, and confirmational testing not performed.
2. Patients who were not tested and did not fill an antibiotic prescription. Apparently, in the clinician’s judgment the patient’s signs and symptoms were such that the infection did not warrant treatment and the clinical presentation did not necessitate the GAS test to confirm the recorded diagnosis of pharyngitis.
3. Patients who were tested and received antibiotic prescription, likely because the test was positive for GABHS.
4. Patients who were tested and did not receive antibiotic prescription.

We tested for statistically significant differences in baseline characteristics across these 4 patient groups using *t* tests for continuous variables and  $\chi^2$  tests for categorical variables. Odds ratios (OR) and CI were computed for the influential variables included the regression analyses.

We conducted a sensitivity analysis using a model specification which included the dichotomous variables for testing and for treatment, and the interaction term between these variables to assess if treatment effects varied in tested and untested patients. We also estimated this model of revisit risk using revisits within 7 days as the outcome variable.

All analyses were completed using STATA/IC 13 (StataCorp, College Station, TX).

## Results

There were 24685 treatment episodes for children diagnosed with pharyngitis. Nearly 47% of these episodes included GAS testing and 47% of the tested patients filled an antibiotic prescription. Similarly, 53% of patients were not tested and 49% of untested patients filled an antibiotic prescription. As a result, the 4 groups identified for analysis were evenly distributed: untested and no prescrip-

tion (26.9%), untested and prescription (26.3%), tested and prescription (21.9%), and tested and no prescription (24.9%) (Figure).

**Table 1** presents the descriptive statistics for these 4 patient groups. Note first that the rate of revisits within 28 days is under 5% across all groups. Second, the 2 tested groups have a lower revisit rate than the untested groups: the tested and treated have a revisit rate of 3.3%, and the tested and untreated have a revisit rate of 2.4%, while both the untested groups have a revisit rate of nearly 5%. These small absolute differences in revisit rates across groups were statistically significant.

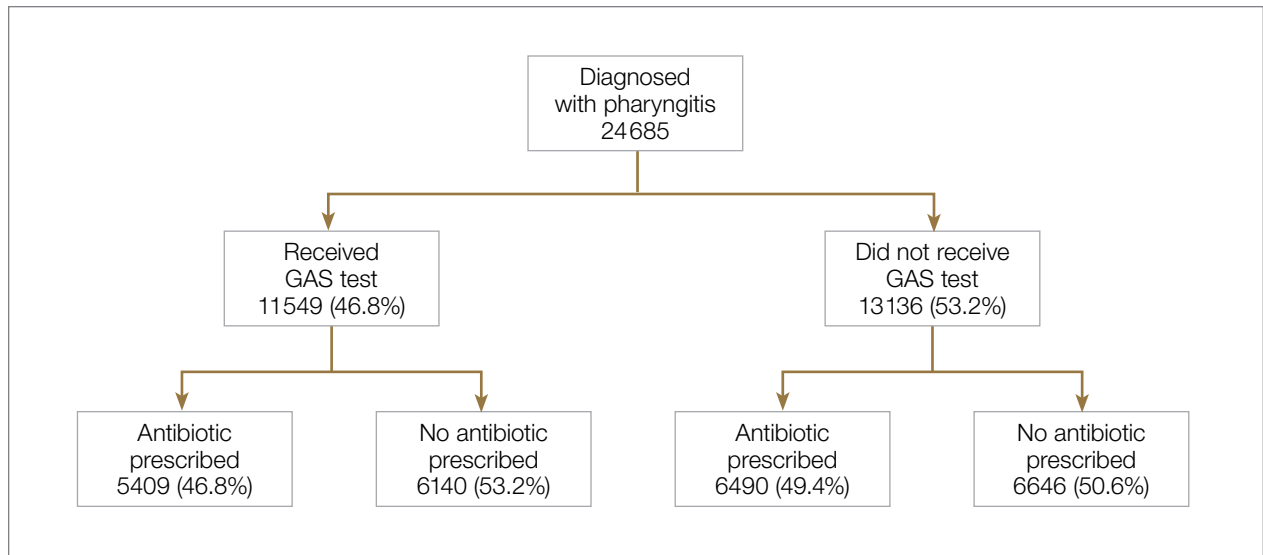
### Factors associated with receiving GAS test

Several factors were found to impact the decision to test (Table 2). Only 9.7% of children were reported to have any ARTI coinfection. As expected, these comorbidities resulted in a significantly lower likelihood of receiving the GAS test: AOM, bronchitis, sinusitis, pneumonia, and URI as comorbid infections had a 48%, 41%, 37%, 63%, and 13% lower likelihood of receiving the GAS test, respectively, than those with no comorbidities. Similarly, children with fever and respiratory symptoms were 35% and 45% less likely to receiving the GAS test, respectively. This is consistent with our expectation that comorbid ARTI infections will lead many providers to forgo testing.

Provider type and patient age also plays a role in receipt of the GAS test. Relative to outpatient facility providers, primary care physicians were 24% more likely and specialty physicians were 38% less likely of employing the GAS test. The child’s age played a significant role in receipt of the GAS test. Children aged 1 to 5 years and 5 to 12 years were 15% and 14% more likely to receive the test compared to children older than 12 years.

Pharyngitis patients have disproportionately higher odds of receiving a GAS test in most regions of the country compared to the Pacific region. For instance, children in the Mid-Atlantic region have 51% higher odds of receiving a GAS test while children in New England have 80% higher odds of receiving the same test.

Black children have 11% lower odds of receiving the GAS test compared to White children. Both



**Figure.** Four patient groups.  
GAS, group A *Streptococcus*.

middle-income and high-income children have 12% and 32% higher odds of receiving the test compared to low-income children. Compared to office-based visits, children visiting a clinic were twice as likely to receive a GAS test while those seen in the emergency room have 43% lower odds of receiving a GAS test. Hospital outpatient departments, which account for less than 1% of all visits, rarely used a GAS test which could be a statistical artifact due to small sample size. Lastly, insurance and season of the year had no significant impact of receipt of a GAS test.

### **Factors associated with receiving antibiotic prescription**

Surprisingly, receiving the GAS test has a small but insignificant impact on the likelihood that the patient will receive an antibiotic prescription (**Table 3**) (Adjusted OR = 1.055,  $P = .07$ ). After controlling for receipt of a GAS test, children with AOM and sinusitis comorbidities have an increased likelihood of being prescribed an antibiotic. Children with URI have a lower likelihood of being prescribed an antibiotic. Additionally, relative to primary care physicians, children visiting nonphysician providers for pharyngitis were more likely to be prescribed an antibiotic.

Children under 12 years of age were more likely to use an antibiotic compared to children 12 years and older. Geographically, there is some evidence of regional varia-

tion in antibiotic use as well. Children in the south Atlantic, west-south central, and southeast central regions had a significantly lower odds of being prescribed an antibiotic respectively than pharyngitis patients in the Pacific region. Black children had a 10% lower likelihood of being prescribed an antibiotic compared to White children, possibly related to their lower rate of GAS testing. Compared to office-based visits, children visiting a clinic were less likely to use an antibiotic. Household income, insurance type, and season had no significant impact on revisit risk.

### **Effects of GAS test and antibiotic prescriptions on likelihood of revisits**

The multivariate analysis of the risk of a revisit within 28 days is presented in **Table 4**. Children with pharyngitis who tested and did not receive an antibiotic serve as the reference comparison group for this analysis to illustrate the impact of using the GAS test and treatment with an antibiotic. The results in Table 4 are quite clear: patients who receive the GAS test were significantly less likely to have a revisit within 28 days. Moreover, within the group of patients who were tested, those not receiving an antibiotic, presumably because their GAS test was negative, experienced the lowest risk of a revisit. This result is consistent with the data in Table 1. Moreover,

Table 1. Descriptive Statistics

<b>N = 24685</b>	<b>Tested; treated (N = 5409)</b>	<b>Tested; no treatment (N = 6140)</b>	<b>No test; treated (N = 6490)</b>	<b>No test; no treatment (N = 6646)</b>	<b>P value</b>
<b>Rate of revisit within 28 days, n (%)</b>	179 (3.3)	151 (2.4)	325 (5)	326 (5)	<.001
<b>Sex, n (%)</b>					
Male	2451 (45)	2967 (48)	3085 (47)	3204 (48)	.004
Female	2958 (55)	3173 (52)	3405 (53)	3442 (52)	.004
<b>Age, y</b>					<.001
< 1	5 (0.09)	14 (0.22)	20 (0.30)	22 (0.33)	
1 to ≤5	721 (13)	706 (11)	848 (13)	764 (11)	
5 to ≤12	3057 (56)	2762 (45)	3493 (53)	2933 (44)	
12 to ≤18	1626 (30)	2658 (43)	2139 (33)	2927 (44)	
<b>Household income, n (%)</b>					<.001
Low	489 (9)	549 (9)	839 (13)	854 (13)	
Middle	678 (12)	699 (11)	879 (13)	959 (14)	
High	3447 (64)	4025 (65)	3735 (57)	3711 (56)	
Unknown	795 (14)	867 (14)	1037 (16)	1122 (17)	
<b>Season of the visit, n (%)</b>					<.001
Winter (December-February)	2410 (44)	2810 (46)	2824 (43)	2965 (44)	
Spring (March-May)	1389 (26)	1656 (27)	1665 (26)	1654 (25)	
Summer (June-August)	262 (4.8)	313 (5)	366 (5.6)	376 (5.6)	
Fall (September-November)	1348 (25)	1361 (22)	1635 (25)	1651 (25)	
<b>Provider type, n (%)</b>					<.001
Primary physician	3023 (56)	3098 (50)	4347 (67)	4333 (65)	
Specialty physician	124 (2)	143 (2)	266 (4)	283 (4)	
Nonphysician provider	280 (5)	251 (4)	416 (6)	381 (6)	
Other providers	1982 (37)	2647 (43)	1459 (22)	1648 (25)	
<b>Setting, n (%)</b>					<.001
Office	1783 (33)	2413 (39)	175 (3)	233 (3.5)	
Clinic	3550 (65)	3635 (59)	5328 (82)	5304 (80)	
Outpatient hospital	24 (0.44)	38 (0.61)	23 (0.37)	24 (0.36)	
ER	18 (0.33)	21 (0.34)	892 (14)	1001 (15)	
Other	34 (0.62)	33 (0.53)	72 (1)	84 (1)	
<b>ARTI-related diagnosis, n (%)</b>					<.001
AOM	83 (1.5)	62 (1)	208 (3.2)	168 (2.5)	
Bronchitis	19 (0.35)	19 (3.4)	45 (0.69)	42 (0.63)	
Sinusitis	54 (1)	60 (1)	146 (2.2)	99 (1.49)	
Pneumonia	1 (0.02)	5 (0.08)	10 (0.15)	9 (0.14)	
URI	241 (4.5)	320 (5.2)	360 (5.5)	458 (6.8)	
<b>Other comorbid diagnosis, n (%)</b>					<.001
Mental disorders	7 (0.13)	18 (0.29)	8 (0.12)	17 (0.26)	
Nervous system diagnosis	55 (1)	61 (1)	91 (1.4)	118 (1.8)	
Respiratory symptoms	81 (1.5)	110 (1.8)	217 (3.3)	264 (4)	
Fever	189 (3.5)	212 (3.5)	468 (7.2)	455 (7)	
Injury and poisoning	19 (0.35)	17 (0.28)	16 (0.25)	37 (0.5)	
Other	4388 (86)	5044 (85)	4206 (74)	4288 (74)	

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## Diagnostic Testing on Pediatric Patients With Pharyngitis

Table 1. continued

<b>N = 24685</b>	<b>Tested; treated (N = 5409)</b>	<b>Tested; no treatment (N = 6140)</b>	<b>No test; treated (N = 6490)</b>	<b>No test; no treatment (N = 6646)</b>	<b>P value</b>
<b>AHFS antibiotic classes<sup>a</sup>, n (%)</b>					.13
Penicillins	3059 (56)	0 (0.0)	3618 (56)	0 (0.0)	
1st line cephalosporins	365 (6.7)	0 (0.0)	405 (6.2)	0 (0.0)	
Sulfonamides	135 (2.5)	0 (0.0)	154 (2.3)	0 (0.0)	
Other macrolides	1069 (20)	0 (0.0)	1391 (21)	0 (0.0)	
2nd-4th line cephalosporins	662 (12)	0 (0.0)	754 (11.6)	0 (0.0)	
Other	119 (2)	0 (0.0)	168 (2.5)	0 (0.0)	
<b>Insurance type, n (%)</b>					<.001
EPO	672 (12)	825 (13.4)	760 (12)	870 (13)	
HMO	554 (10)	609 (9.9)	484 (7.8)	420 (6)	
POS	4076 (75)	4582 (75)	5099 (78)	5207 (78)	
PPO	107 (2.0)	124 (1.28)	147 (2.18)	149 (2.14)	
<b>Race, n (%)</b>					.001
Black	271 (5)	322 (5)	294 (4.5)	290 (4.3)	
White	4057 (75)	4508 (73)	4777 (74)	4854 (73)	
Hispanic	377 (7)	513 (8)	539 (8.3)	621 (9)	
Asian	492 (9)	588 (9.5)	648 (10)	650 (9.8)	
Unknown	212 (4)	209 (3.4)	232 (3.5)	231 (3.5)	
<b>Region, n (%)</b>					<.001
East North Central	784 (14)	796 (13)	1203 (18)	1097 (16)	
East South Central	170 (3)	202 (3)	272 (4)	291 (4)	
Mid-Atlantic	486 (9)	524 (8.5)	500 (7.7)	479 (7)	
Mountain	591 (11)	638 (10)	626 (10)	602 (9)	
New England	170 (3)	177 (3)	212 (3)	222 (3)	
Pacific	192 (3.5)	188 (3)	269 (4)	269 (4)	
South Atlantic	1448 (27)	1927 (31)	1461 (22)	1759 (26)	
West North Central	787 (15)	764 (12)	850 (13)	755 (11)	
West South Central	781 (14)	924 (15)	1097 (17)	1172 (18)	

<sup>a</sup>AHFS classifications include penicillins, cephalosporins (1st-4th generation), macrolides (1st line and others), sulfonamides, and Other (including tetracyclines, fluoroquinolones, cephamycin, carbapenems, and  $\beta$ -lactam antibiotics).

AOM, acute otitis media; AHFS, American Hospital Formulary Service; ARTI, acute respiratory tract infection; EPO, exclusive provider organization; ER, emergency room; HMO, health maintenance organization; POS, point of service; PPO, preferred provider organization; URI, upper respiratory infection.

using an antibiotic had no impact on the likelihood of a revisit in patients not receiving the GAS test. This result is also consistent with Table 1.

Other results from the analysis of revisit risk may be of interest to clinicians. Pharyngitis patients with a prior episode of treatment within 90 days for an acute respiratory tract infection were more than 7 times more likely to experience a revisit within 28 days of the pharyngitis

diagnosis than patients without a history of recent ARTI infections. Age is also a risk factor in likelihood of initiating a revisit. Children under 1 year and children aged 1 to 5 years were more likely to have a revisit than children aged more than 12 years. Compared to White children, Black children were 25% ( $P=.04$ ) less likely to have a revisit. The care setting also has a significant impact on revisit risk. Children visiting outpatient hospital and

Table 2. **Multivariable Model of Factors Associated With Receiving a GAS Test (n = 11 549)**

	<b>OR</b>	<b>P value</b>	<b>95% CI</b>
<b>Secondary ARTI diagnoses</b>			
AOM	0.52	<.001	0.42-0.63
Bronchitis	0.59	.01	0.40-0.88
Sinusitis	0.63	<.001	0.50-0.80
Pneumonia	0.37	.04	0.14-0.96
URI	0.87	.02	0.77-0.98
<b>Comorbid medical diagnoses</b>			
Mental disorders	1.37	.30	0.76-2.47
Nervous system disorders	0.75	.02	0.59-0.95
Respiratory symptoms	0.55	<.001	0.46-0.66
Fever	0.65	<.001	0.57-0.75
Injury and poisoning	0.91	.69	0.58-1.43
Other		Reference	
<b>Had previous ARTI visit within 90 days</b>	1.01	.92	0.92-1.10
<b>Season of the visit</b>			
Winter (December-February)	1.02	.78	0.89-1.16
Spring (March-May)	1.04	.53	0.91-1.20
Summer (June-August)		Reference	
Fall (September-November)	0.92	.24	0.80-1.06
<b>Provider</b>			
Primary physician	1.24	<.001	1.10-1.39
Specialty physician	0.62	<.001	0.50-0.77
Nonphysician provider	1.13	.13	0.97-1.33
Outpatient facility provider		Reference	
Other facility provider	0.05	.008	0.01-0.45
<b>Sex</b>			
Female	1.01	.69	0.96-1.07
<b>Age, y</b>			
< 1	0.77	.42	0.40-1.46
1 to ≤5	1.15	.006	1.04-1.26
5 to ≤12	1.14	<.001	1.07-1.21
12 to ≤18		Reference	
<b>Insurance type</b>			
EPO	0.61	.11	0.33-1.12
HMO	0.81	.50	0.45-1.48
POS		Reference	
PPO	0.62	.14	0.33-1.16
<b>Region</b>			
East North Central	1.38	<.001	1.16-1.64
East South Central	1.19	.10	0.96-1.48
Mid-Atlantic	1.51	<.001	1.26-1.82
Mountain	1.34	.002	1.11-1.60
New England	1.80	<.001	1.42-2.27
Pacific		Reference	
South Atlantic	1.44	<.001	1.22-1.70
West North Central	1.66	<.001	1.39-1.99
West South Central	1.15	.10	0.97-1.37

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## Diagnostic Testing on Pediatric Patients With Pharyngitis

Table 2. continued

GAS test (n = 11 549)	OR	P value	95% CI
<b>Race</b>			
White		Reference	
Black	0.89	.05	0.80-1.00
Hispanic	0.94	.22	0.85-1.04
Asian	0.92	.30	0.79-1.08
Unknown	1.10	.18	0.96-1.26
<b>Household income</b>			
Low		Reference	
Middle	1.13	.05	1.00-1.27
High	1.32	<.001	1.20-1.45
Unknown	1.11	.09	0.99-1.24
<b>Setting</b>			
Office		Reference	
Clinic	2.02	.002	1.30-3.13
Outpatient hospital	0.04	<.001	0.03-0.05
ER	0.57	<.001	0.42-0.78
Other	17.08	<.001	14.69-19.86

AOM, acute otitis media; ARTI, acute respiratory tract infection; CI, confidence interval; EPO, exclusive provider organization; ER, emergency room; GAS, group A *Streptococcus*; HMO, health maintenance organization; OR, odds ratio; POS, point of service; PPO, preferred provider organization; URI, upper respiratory infection.

other care settings had a significantly higher revisit risk than those visiting a physician's office. Lastly, household income, geographic region, season, medical comorbidities, gender, and insurance type have no significant impact on revisit risk.

### Sensitivity analysis

The results from the analysis of 7-day and 28-day revisit risk are summarized in **Table 5**. These results indicate that patients who were tested had a more significant decrease in revisit risk at 7 days (72%) than was evident at 28 days (47% reduction). Receiving an antibiotic, with or without the test, had no impact on revisit risk.

### Discussion

Published data on revisits for pharyngitis are lacking with the concentration of prior research focused more on systemic complications of undertreated GABHS disease or on identifying carrier status. Our study results suggest that GAS testing is the most important factor in reducing revisit risk. Being prescribed an antibiotic, on its own, does not have a significant impact on the

risk of a revisit. However, once the GAS test is used, the decision not to use an antibiotic was correlated with the lowest revisit rate, likely because the source of the pharyngitis infection was viral and more likely to resolve without a revisit. Prior studies have reported variable rates of testing among children with pharyngitis prescribed an antibiotic, ranging from 23% to 91%,<sup>14,15</sup> with testing important toward more appropriate antibiotic use.<sup>16</sup> More recently, among more than 67 000 patients aged 3 to 21 years presenting with sore throat and receiving a GAS test, 32.6% were positive.<sup>17</sup>

Our analysis found that more than 46% of pediatric pharyngitis patients were given the rapid GAS test. While this testing rate is substantially lower than HEDIS recommendations and lower than testing rates achieved by several health maintenance organizations,<sup>10</sup> it is similar to the 53% of children receiving such testing in a recent National Ambulatory Medical Care Survey.<sup>18</sup> Furthermore, we found that when antibiotics are prescribed following a GAS test, the revisit risk is not significantly reduced, possibly because antibiotics lower revisit risk when informed by diagnostic testing tools that determine the infectious

Table 3. **Multivariable Model of Factors Associated With Receiving Antibiotic Prescription (n = 11899)**

	<b>OR</b>	<b>P value</b>	<b>95% CI</b>
<b>Not receiving GAS test</b>	1.06	.07	1.00-1.12
<b>Secondary ARTI diagnoses</b>			
AOM	1.26	.01	1.05-.50
Bronchitis	1.11	.56	0.78-1.59
Sinusitis	1.47	<.001	1.19-1.82
Pneumonia	0.88	.75	0.40-1.95
URI	0.82	.001	0.74-0.92
<b>Comorbid medical diagnoses</b>			
Mental disorders	0.47	.02	0.25-0.86
Nervous system disorders	0.85	.15	0.68-1.06
Respiratory symptoms	0.86	.05	0.73-1.00
Fever	1.01	.82	0.90-1.14
Injury and poisoning	0.69	.10	0.45-1.07
Other		Reference	
<b>Had previous ARTI within 90 days</b>	1.07	.10	0.99-1.16
<b>Season of the visit</b>			
Winter (December-February)	0.99	.88	0.88-1.11
Spring (March-May)	1.01	.84	0.90-1.14
Summer (June-August)		Reference	
Fall (September-November)	1.06	.39	0.93-1.19
<b>Provider</b>			
Primary physician		Reference	
Specialty physician	1.00	.96	0.85-1.16
Nonphysician provider	1.13	.04	1.00-1.26
Other facility provider	0.97	.63	0.87-1.09
<b>Sex</b>			
Female	1.08	.003	1.03-1.14
<b>Age, y</b>			
<1	0.61	.11	0.33-1.11
1 to ≤5	1.57	<.001	1.45-1.71
5 to ≤12	1.69	<.001	1.60-1.78
12 to ≤18		Reference	
<b>Insurance type</b>			
EPO	0.80	.44	0.45-1.41
HMO	0.96	.88	0.54-1.68
POS		Reference	
PPO	0.75	.35	0.42-1.36
<b>Region</b>			
East North Central	1.01	.86	0.87-1.17
East South Central	0.83	.05	0.69-1.00
Mid-Atlantic	0.94	.47	0.80-1.11
Mountain	0.96	.58	0.82-1.11
New England	0.94	.57	0.78-1.15
Pacific		Reference	
South Atlantic	0.77	<.001	0.67-0.89
West North Central	1.00	.96	0.85-1.16
West South Central	0.86	.05	0.74-1.00

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## Diagnostic Testing on Pediatric Patients With Pharyngitis

Table 3. continued

Received antibiotic (n = 11899)	OR	P value	95% CI
<b>Race</b>			
White		Reference	
Black	0.90	.04	0.82-0.99
Hispanic	0.99	.76	0.90-1.08
Asian	1.02	.73	0.89-1.18
Unknown	0.97	.64	0.86-1.10
<b>Household income</b>			
Low		Reference	
Middle	0.98	.77	0.89-1.09
High	0.98	.61	0.90-1.06
Unknown	0.96	.44	0.87-1.06
<b>Setting</b>			
Office		Reference	
Clinic	0.62	.03	0.41-0.95
Outpatient hospital	0.90	.13	0.78-1.03
ER	0.82	.16	0.62-1.08
Other	0.82	.001	0.72-0.92

AOM, acute otitis media; ARTI, acute respiratory tract infection; CI, confidence interval; EPO, exclusive provider organization; ER, emergency room; GAS, group A *Streptococcus*; HMO, health maintenance organization; OR, odds ratio; POS, point of service; PPO, preferred provider organization; URI, upper respiratory infection.

organism. This is supported by a similar population analysis in which we observed reduced revisit rates in children with AOM managed with antibiotics within 3 days of index diagnosis.<sup>19</sup>

Several other factors also affect the likelihood of a child receiving the GAS test. Children aged 1 to 12 years were significantly more likely to receive the GAS test than children over the age of 12. This included children in the 1 to 5 years old bracket who had a 15% higher likelihood of undergoing a GAS test, despite children less than 3 years of age as not recommended targets for GAS testing.<sup>20</sup> As expected, children with reported ARTI-associated comorbidities were also less likely to receive a GAS test. Additionally, specialty care physicians were less inclined to implement the GAS test, possibly because of diagnostic confidence without testing or referral after GAS was ruled out. Black and low-income children had statistically lower odds of receiving the test, even after controlling for other factors, and yet were less likely to consume a revisit. As the overall data suggested more revisits in those not tested, further study is needed to examine if race or income discrepancies are equity based. Finally, children in the Pacific

region, compared to the rest of the nation, were the least likely to receive a GAS test and yet there were no significant differences in revisit rates by region. Regional differences in antibiotic use were also observed in our study, as has been seen by others.<sup>21</sup>

After statistically controlling for having received the diagnostic GAS test and filled a prescription for an antibiotic, there are multitude of factors that independently affect the revisit risk, the most important of which if which was a history of an ARTI infection in the prior 90 days. While prior visit history had no impact on the likelihood of being tested or filling an antibiotic, patients with prior visits were more than 7 times more likely to consume a revisit. This was not reflected in nor related to comorbid ARTIs as these patients did not have statistically higher revisits than those with pharyngitis as the sole-coded diagnosis. Moreover, speculation for bacterial etiology of primary or superinfection based on a recent history of ARTI accounting for revisits seems unlikely as it did not yield greater antibiotic use in that group. Further analysis is required to determine the clinical and behavioral factors that promote for prior ARTI history as a major factor in revisit risk after an index visit for pharyngitis.

Table 4. **Factors Associated With Revisits After Diagnosis of Acute Pharyngitis (n = 981)**

	<b>OR</b>	<b>P value</b>	<b>95% CI</b>
<b>Group</b>			
Not tested; not treated		Reference	
Tested; treated	0.69	<.001	0.57-0.84
Tested; not treated	0.53	<.001	0.43-0.65
Not tested; treated	1.00	>.99	0.85-1.18
<b>Secondary ARTI diagnoses</b>			
AOM	0.79	.32	0.51-1.25
Bronchitis	0.51	.26	0.16-1.64
Sinusitis	0.87	.60	0.51-1.48
Pneumonia	0.94	.66	0.72-1.23
URI	0.69	.02	0.51-0.95
<b>Comorbid medical diagnoses</b>			
Mental disorders	1.35	.62	0.41-4.50
Nervous system disorders	1.19	.48	0.73-1.94
Respiratory symptoms	0.90	.59	0.61-1.33
Fever	1.03	.84	0.79-1.35
Injury and poisoning	1.34	.54	0.53-3.34
Other		Reference	
<b>Had previous ARTI within 90 days</b>	7.63	<.001	5.64-10.33
<b>Provider</b>			
Primary physician	3.51	<.001	2.45-5.02
Specialty physician	4.26	<.001	2.89-6.29
Nonphysician provider	2.64	<.001	1.67-4.16
Outpatient facility provider		Reference	
Other facility provider	16.07	.02	1.66-166.08
<b>Sex</b>			
Female	0.98	.79	0.86-1.12
<b>Age, y</b>			
1	1.65	.36	0.56-4.83
1 to ≤5	1.39	.001	1.14-1.70
5 to ≤12	1.027	.72	0.89-1.19
12 to ≤18		Reference	
<b>Season of the visit</b>			
Winter (December-February)	1.04	.80	0.78-1.40
Spring (March-May)	1.03	.88	0.76-1.39
Summer (June-August)		Reference	
Fall (September-November)	0.77	.10	0.56-1.05
<b>Insurance type</b>			
EPO	0.41	.11	0.14-1.23
HMO	0.51	.23	0.18-1.51
POS		Reference	
PPO	0.68	.51	0.22-2.13

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## Diagnostic Testing on Pediatric Patients With Pharyngitis

Table 4. continued

Revisit (n = 981)	OR	P value	95% CI
<b>Region</b>			
East North Central	0.71	.07	0.49-1.03
East South Central	0.78	.29	0.49-1.24
Mid-Atlantic	1.13	.53	0.77-1.65
Mountain	0.94	.73	0.64-1.37
New England	1.01	.97	0.63-1.62
Pacific		Reference	
South Atlantic	0.89	.52	0.63-1.26
West North Central	0.79	.22	0.54-1.15
West South Central	0.95	.79	0.67-1.36
<b>Race</b>			
White		Reference	
Black	0.75	.04	0.58-0.98
Hispanic	0.83	.13	0.65-1.06
Asian	0.95	.81	0.68-1.36
Unknown	1.28	.08	0.98-1.69
<b>Household income</b>			
Low		Reference	
Middle	1.06	.64	0.82-1.37
High	0.97	.76	0.78-1.19
Unknown	0.91	.44	0.70-1.17
<b>Setting</b>			
Office		Reference	
Clinic	0.43	.18	0.13-1.47
Outpatient hospital	1.63	.02	1.08-2.47
ER	1.07	.87	0.48-2.38
Other	1.73	.007	1.16-2.57

AOM, acute otitis media; ARTI, acute respiratory tract infection; CI, confidence interval; EPO, exclusive provider organization; ER, emergency room; HMO, health maintenance organization; OR, odds ratio; POS, point of service; PPO, preferred provider organization; URI, upper respiratory infection.

Children aged between 1 and 5 years, though 15% more likely to be tested than those aged 12 through 17 years, were also 39% more likely to initiate a revisit compared to older children when statistically controlling for other covariates. This perhaps suggests longer illness, wrong diagnosis, delay in appropriate treatment, or more caution by parents and providers in this age group. Justification for testing children less than 3 years of age who are outside of the HEDIS suggested age group, when clinical judgement does not point to another infection source, can result in positivity rates between 22% and 30% as previously observed.<sup>22,23</sup> Patients visiting

nonphysician providers and outpatient facility providers were less likely to have a revisit than those visiting primary and specialty care physicians, though slightly higher propensity for antibiotic prescriptions was seen for nonphysician providers. Pediatricians have been noted to be less likely to prescribe antibiotics without GAS testing than nonpediatric providers, and more guidelines-compliant in prescribing.<sup>24</sup>

Recommendations to not test children under 3 years of age are based on the lack of acute rheumatic fever and other complications in this age group together with more frequent viral syndromes. Selectivity in applying

Table 5. **Revisit Model With GAS Test/Antibiotic Interaction Term (N = 24685)**

	Revisit within 28 days (n = 981)		Revisit within 7 days (n = 981)	
	OR	95% CI	OR	95% CI
<b>GAS test</b>	0.53	0.43-0.66	0.28	0.19-0.34
<b>Antibiotic</b>	1.00	0.85-1.18	1.00	0.79-1.26
<b>GAS + antibiotic</b>	1.30	0.99-1.71	1.40	0.88-2.24

CI, confidence interval; GAS, group A *Streptococcus*; OR, odds ratio.

clinical criteria to testing can be attempted to separate bacterial from viral illness. Postnasal drainage/rhinorrhea, hoarse voice, and cough have been used successfully to identify those with viral illness and less need for testing, with greater certainty of low risk for GABHS in those over 11 years of age without tonsillar exudates, cervical adenopathy, or fever.<sup>17</sup> However, the marginal benefits of those who have all 3 features of viral illness versus none in identifying GAS positivity was 23.3% vs 37.6% - helpful, but certainly not diminishing the need for testing. These constitutional findings of viral URI also do not exclude the GAS carrier state that features these symptoms.<sup>25</sup> Others have reinforced the doubt of pharyngeal exudates as the premier diagnostic finding for test-positive GAS.<sup>26</sup>

This study had several limitations. The Optum claims dataset only contains ICD-9 codes for diagnoses. It does not include data on infection severity and clinical findings related to symptoms, thus empiric treatment warranted based in clinical severity is not assessed. Antibiotics are commonly available as generics and very inexpensive. Patients may fill and pay for these prescriptions directly, in which case, a claim for payment may not be filed with Optum. This could result in an undercount of treated patients in our study.

There is no corresponding problem of missing medical claims for GAS testing which were obtained from the CPT codes within the Optum claims data set. However, we elected not to verify the test results due to these data being missing for 75% of the study population. Nevertheless, this study's focus was less about justifying antibiotic treatment, but dealt with the outcomes generated by testing and treatment. Toward that end, we used CPT codes to identify a revisit, and while those can at times be affected by financial reimbursement incentives,

differences related to revisits in the 4 patient groups should not be subject to bias.

## Conclusion

This study used data from real world practices to document the patterns of GAS testing and antibiotic use in pediatric pharyngitis patients. Revisit rates were under 5% for all patient groups and the use of rapid diagnostic tools were found to be the determining factor in further reducing the risk of revisits. This supports the need for compliance with the HEDIS quality metric for pharyngitis to the recommended levels of rapid testing which have been falling in recent years. Use of more accurate antigen and newer molecular detection testing methods may help further delineate important factors in determining pediatric pharyngitis treatment and need for revisits.<sup>27</sup>

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