

Factors associated with antibiotic prescriptions for the viral origin diseases in office-based practices, 2006–2012

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Summary

Objective: To test the potential association between time spent with a doctor and antibiotic overprescriptions in case of the common cold, runny nose, bronchitis, chest colds, flu, sore throats, and fluid in the middle ear.

Design: Cross-sectional study

Setting: Office-based physicians in the US.

Participants: A total of 261,623 patient visits recorded to office-based physicians in the US.

Main outcome measures: The interest outcome was unnecessary antibiotic prescription.

Results: The analysis revealed five significant predictors of antibiotic prescriptions for suspected viral infections: length of doctor–patient encounter time, patient gender, spending time with a family medicine doctor, type of insurance, and the rate of antibiotic prescriptions per physician. For every additional minute a patient spent with a physician during a visit, the mean predicted probability of receiving unnecessary antibiotics decreased by 2.4%.

Conclusions: This study provided evidence that physicians continue to prescribe antibiotics in avoidable cases. Policies that would monitor antibiotic prescription in office-based settings should be considered in order to control spreading of antibiotic resistance and eventually improve population health.

Keywords

Antibiotic, overprescription, physicians

Introduction

Prescribing unnecessary antibiotics will lead to spread of antibiotic resistance and eventually death or disability of millions of people. In the United States, every year, approximately two million people acquire serious infections with bacteria that are resistant to one or more of the antibiotics designed to treat those infections. The Centers for Disease Control's report (2013) shows that at least 23,000 people die each year as a direct result of antibiotic-resistant infections. Antibiotic resistance is a natural phenomenon in

which bacteria gain the ability to withstand the effect of an antibiotic.¹ Overuse, misuse, and overprescription of antibiotics lead to antibiotic resistance.²

Antibiotics are intended for diseases with bacterial origins. However, at least 75% of adults in the US seeking treatment for acute bronchitis – usually caused by a virus – are prescribed antibiotics.³ Out of 531 paediatric office visits for colds, URIs, or bronchitis, antibiotics were prescribed to 44% of patients with a common cold, to 46% with upper respiratory infections, and to 75% with bronchitis.⁴ According to the CDC, approximately 50% of antibiotic prescriptions written in the outpatient settings are inappropriate.⁵

Although several studies have reviewed antibiotic prescriptions from various factors including age, sex, race, and insurance type,^{4,6,7} there is a dearth of studies evaluating the relationship between time spent with a doctor and antibiotic prescriptions. Only a few qualitative studies related to the time spent with the doctor have been conducted in the US^{8,9}; the results of these studies indicate that physicians complain about tight schedules, and the authors argue that increasing the duration of a doctor–patient encounter could reduce the likelihood of an antibiotic prescription for a viral infection.^{8,10} This study uses the National Ambulatory Medical Care Survey data-sets from 2006 to 2012 to identify any relationship between the time spent with the doctor and the likelihood of receiving an unnecessary prescription for antibiotics during ambulatory visits.

Methods

The data used for the analysis are from the National Ambulatory Medical Care Survey data-sets of 2006–2012, which are probability sample surveys of office-based physicians in the US and include both urgent care and scheduled visits but not any visits to hospitals.

The sampling unit for National Ambulatory Medical Care Survey is a physician–patient encounter or visit.

The CDC's National Center for Health Statistics conducts the survey. Since 1989, the U.S. Census Bureau has been responsible for National Ambulatory Medical Care Survey data collection. National Ambulatory Medical Care Survey provides national estimates for reasons people seek medical attention, including clinical services provided during the visit, patient demographic information, physician diagnosis, the reason for the visit (up to three diagnosis codes per visit based on International Classification of Diseases, 9th version), and a list of medications prescribed (maximum of eight medications per visit).¹¹ This study obtained approval from the Texas A&M Institutional Review Board (IRB-0651M).

Study design

The CDC implemented an awareness programme entitled Get Smart to improve the general public's knowledge about antibiotic resistance. The Get Smart programme contains information about in which cases prescriptions for antibiotics are unnecessary.¹² Based on the CDC's Get Smart guidelines, the following diseases were characterised as unnecessary causes for antibiotic prescriptions and are used in this study to assess improper prescription of antibiotics: the common cold, runny noses, bronchitis, chest colds in otherwise healthy children and adults, the flu, sore throats except strep throat, and fluid in the middle ear (otitis media with effusion). In the present document, for simplicity's sake, the aforementioned diseases are sometimes referred to as viral diseases.

Antibiotics were identified by the National Drug Code Directory Classes. Visits were coded to identify visits during which antibiotics were prescribed; furthermore, all antibiotics were classified as either narrow or broad spectrum. Based on previous studies, penicillin, amoxicillin, ampicillin, erythromycin, tetracycline, doxycycline, trimethoprim, and sulfamethoxazole are classified as narrow spectrum agents, and cephalosporin, macrolides, fluoroquinolones, and amoxicillin–clavulanic acid are classified as broad-spectrum agents.^{13,14}

All cases with the International Classification of Diseases (ICD-9) codes of 460, 478.19, 490, 466, 519.8, 487, 487.1, and 38589 were extracted from the combined National Ambulatory Medical Care Survey surveys for the years 2006 to 2012. Since these patients might have had other conditions as a second or even third diagnosis that required antibiotic prescriptions, to the next step was to determine the most frequent reasons for visits by patients with a

primary diagnosis of the common cold, a runny nose, bronchitis, a chest cold, the flu, a sore throat, or fluid in the middle ear (otitis media with effusion). Subsequently, two tables including a second and third diagnosis for patients with viral source diseases were created. Two family medicine practitioners and the author went through each diagnosis to determine whether the antibiotic prescription was justified or not. As a result, patients with solely viral diseases defined as a patient with a first, second, and third diagnosis of viral diseases and the rest of diagnosis as missing or blank were included. Furthermore, patients with primary and/or secondary diagnoses of viral diseases with the remaining diagnoses being conditions that do not benefit from antibiotics, e.g. diabetes, hypertension, allergies, were included in the sample data. For example, a visit in which a patient had a common cold (first diagnosis), diabetes (second diagnosis), and hypertension (third diagnosis) was included in the sample data. However, patients with diseases that might benefit from antibiotics, such as fever and sinusitis, were excluded from the sample data to avoid any potential bias in the results. Extracted data were imported into the SAS® 9.4 software program (SAS Institute Inc., 2014) for analysis.

Variables

Studies show that patients' race, age, gender, ethnicity, and physicians' office location affect the rate of unnecessary antibiotic prescription.^{4,6,7} Moreover, several studies reviewed antibiotic prescriptions with a concentration on insurance and the physician's specialty.^{15,16} Therefore, the following variables were included in the model to control for their effects: age, sex, ethnicity, race, payment source, geographic region, metropolitan/non-metropolitan location of the physician, physician specialty, the interaction time and physician's specialty, and the rate of antibiotic prescription per doctor. The National Ambulatory Medical Care Survey datasets contain a single variable for combined race and ethnicity; therefore, the study uses a combined 'race/ethnicity' variable instead of using each one separately. Payment type was contained in the following categories: Medicare, Medicaid, self, and private payment. The physicians' specialties were divided into the following categories: family medicine, internal medicine, paediatrics, otolaryngology, and other.

Kumar *et al.*'s results showed that physicians' experience plays a key role in prescribing antibiotics. Some experienced physicians often refer to their level of experience to justify their unnecessary prescription of antibiotics. For example, a practitioner might believe that a patient with a sore throat will

eventually develop streptococcal septicaemia in the absence of antibiotic treatment, and therefore, might prescribe antibiotics for such patients.¹⁷ On the other hand, a 2005 study found that physicians with more than 20 years of experience are less likely to prescribe unnecessary antibiotics.¹⁸ Thus, creating an antibiotic prescription rate variable allowed researchers to control for it and isolate the effect of time on unnecessary antibiotic prescription.

The variable rate of antibiotic prescription was generated as follows: the number of antibiotic prescriptions that a given physician prescribed was divided by the number of cases (patients) that he/she saw. We multiplied the rate per doctor by 100 patients that a given doctor saw for six years (2006–2012).

The main independent variable in this study was the time that physicians spent with patients during the patient encounter. This time was defined as the face-to-face time between a patient and a physician. The unit of time was minute. The main dependent variable in this study was antibiotic prescription, whether an antibiotic was prescribed during a visit or not.

Statistical analysis

First, a descriptive analysis of the data was conducted using chi-square (Table 1) and t-test (Table 2) measurements. There were no statistically significant differences between groups in patients' gender and race/ethnicity nor in three of the four payment types and office location present in the sample. However, the results indicated a statistically significant difference among the five types of physician specialties (chi-square with four degrees of freedom = 14.4012, p = 0.0061) as well as a statistically significant difference among patients who have private insurance and patients who do not have insurance (p-value < 0.05).

A multivariate logistic regression was used to test the independent associations of the variables, included in the following model, and antibiotic prescription:

$$\text{Antibiotic prescription} = b_0 + b_1 X_1 \text{ time spent} + b_2 X_1 \text{ age} + b_3 X_1 \text{ gender} + b_4 X_1 \text{ ethnicity/race} + b_5 X_1 \text{ Medicare} + b_6 X_1 \text{ Medicaid} + b_7 X_1 \text{ self pay} + b_8 X_1 \text{ private} + b_9 X_1 \text{ specialty} + b_{10} X_1 \text{ specialty*time} + b_{11} X_1 \text{ MSA} + b_{12} X_1 \text{ region} + b_{13} X_1 \text{ rate of antibiotic prescription} + \epsilon$$

Results

There were 261,623 patient visits recorded (representing 6,814,501,568 estimated annual visits to office-based physicians in the US) in the National Ambulatory Medical Care Survey database from

Table 1. Categorical variables associated with antibiotic prescriptions for viral diseases.

Factor	Percentage of sample	p-value
Overall sample	21.31	
Patient gender		
Male	7.87	0.23
Female	13.44	
Patient race/ethnicity		
Non-Hispanic White	16.56	0.71
Non-Hispanic Black	1.64	
Hispanic	2.3	
Asian	0.66	
American Indian/Alaska Native	0.16	
Type of payment		
Medicare	2.61	0.71
Medicaid	4.08	0.37
Self-pay	0.65	0.28
Private	15.17	0.012*
Office location		
Metropolitan statistical area	18.2	0.97
Non-MSA	3.11	
Region		
Northeast	3.11	0.58
Midwest	5.08	
South	9.02	
West	4.1	
Specialty of doctor		
Otolaryngology	4.1	0.0061*
Internal	1.48	
Paediatric	7.05	
Family	7.7	
Other	0.98	

*Indicates a statistically significant p-value.

Table 2. Continuous variables associated with antibiotic prescriptions for viral diseases.

Factor	Mean of sample	Standard deviation
Patient age (years)	29.78	25.03
Doctor–patient encounter (min)	18.82	12.42
Antibiotic prescriptions per doctor per 100 patient visits	11.51	8.98

2006 to 2012. In total, 21.31% of the visits had a primary diagnosis of a common cold, runny nose, bronchitis, chest cold, flu, sore throat, fluid in the middle ear (otitis media with effusion) and secondary and tertiary diagnosis as missing, blank, or a condition that does not require any antibiotics (e.g. hypertension). The sample data represented an estimated 29,352,300 national annual visits for the aforementioned diagnosis. Total number of physicians who participated in the survey and saw patients with viral origin diseases was 6569 (unweighted).

Socio-demographically, the sample records were predominantly from non-Hispanic white patients (16.56%). Non-Hispanic black and Hispanic patients accounted for 1.64 and 2.30%, respectively, of the overall sample. The mean age of patients who visited office-based physicians from 2006 to 2012 was 29 years old. Female patients tended to visit office-based physicians for viral origin diseases more than their male counterparts, 13.44% versus 7.87% of the sample. People with private insurance were diagnosed with viral origin diseases more often than those with other types of insurances (15.17%). In terms of physicians' specialties, family medicine doctors were more involved in seeing patients with viral diseases (7.70%) than were others. Office-based physicians located in the south region of the US accounted for 9.02% of patients seen with viral diseases. Offices located in metropolitan areas had more patients with viral diseases compared to those in non-metropolitan areas (18.20% vs. 3.11%). The mean visit duration for people who were diagnosed with a viral origin disease was 18.82 min. The mean rate of antibiotic prescriptions for participating physicians was 11.51 prescriptions per 100 patients that a given doctor saw during a survey period.

Multivariate analyses

A multivariate logistic regression analysis revealed five significant predictors of antibiotic prescriptions:

(1) time spent in an encounter with a doctor, (2) patient gender, (3) the interaction between time and family medicine, (4) having private insurance, and (5) the rate of antibiotic prescriptions made by each physician per 100 patients that a given doctor saw. The results of multivariate regressing were displayed in Table 3. Furthermore, due to existence of an interaction term in the model, the predicted probability for each variable in the model was calculated (Table 4). Interpreting the odds ratios for interaction term is not justified. Therefore, the predicted probability was used to interpret the results.

Significant variables

The estimated coefficient of variable 'time' was negative and significant; longer times spent with a physician reduce the predicted probability of receiving unnecessary antibiotics. In addition, the estimated coefficient of the antibiotic prescription rate was positive and significant, which means, for a given physician, the higher the rate of antibiotic prescription means the higher the predicted probability of prescribing unnecessary antibiotic. Female patients had a higher predicted probability of receiving unnecessary antibiotics compared to male patients. The mean predicted probability of receiving unnecessary antibiotics for a female patient was 20%, while the mean predicted probability for male patients was 13%. The effect of time spent with a physician during a visit on decreasing the predicted probability of prescribing unnecessary antibiotics was reversed whenever a patient had an encounter (spends time) with a family medicine practitioner. The mean predicted probability of receiving unnecessary antibiotics for patients with private insurance was 24%, while the mean predicted probability for patients without private insurance was 15%.

Discussion

No definite evidence indicates that antibiotics have a clinical benefit for patients with viral origin diseases, yet evidence suggests that antibiotics continue to be prescribed for diseases of viral aetiologies. A survey study in 2003 of 370 primary physicians' visits found that 54.7% of physicians prescribed antibiotics for a diagnosis of acute bronchitis – a disease for which antibiotics are not indicated.¹⁹

The results of this study align with previous literature on the subject of antibiotic overprescription by demonstrating that 18.27% of office-based visits for viral diseases resulted in antibiotic prescriptions.

These findings suggest that spending more time at a doctor's office can lead to fewer unnecessary

Table 3. Results from the multivariate regression.

Parameter	Categories	Estimate	Standard error	p-value
Time		−0.0247	0.0116	0.0327*
Age		−0.0062	0.00558	0.2664
Gender	Female	0.1992	0.0914	0.0293*
Race ethnicity	White non-Hispanic	0.1395	0.1672	0.404
	Black non-Hispanic	0.0289	0.2596	0.9113
	Hispanic	0.0906	0.2343	0.6988
Physician specialty	Family	−0.0994	0.3566	0.7805
	Internal	−0.238	0.591	0.6872
	Otolaryngologist	0.00796	0.4624	0.9863
	Others	−0.3449	0.6116	0.5728
Time* Physician specialty	Family	0.0369	0.0172	0.0319*
	Internal	0.0132	0.0279	0.6375
	Otolaryngologist	−0.0004	0.0223	0.9843
	Others	0.0011	0.0243	0.9625
Medicare	Yes	0.3587	0.1939	0.0644
Medicaid	Yes	0.195	0.1857	0.2936
Self-payment	Yes	0.0071	0.2632	0.9784
Private payment	Yes	0.4093	0.1639	0.0125*
Metropolitan statistical area	MSA	0.1236	0.1353	0.3609
Region in the US	Midwest	0.2121	0.164	0.196
	Northeast	0.0028	0.1949	0.9885
	South	−0.0817	0.1423	0.5661
Rate of antibiotic prescription		0.077	0.0098	<.0001*

*Indicate a statistically significant p-value.

antibiotic prescriptions (these findings apply to all specialties except family physicians). The implications of these findings might be that in cases of viral origin diseases physicians need to spend more time explaining the origin of the disease and ineffectiveness of antibiotics to the patient. Doctors should clarify the reasons for not prescribing antibiotics and the consequences of overuse and misuse of antibiotics.

The findings of this study are in alignment with the Lundkvist *et al.* study, which was conducted in southeast Sweden, and 6734 patients along with 41

primary care centres participated in the study. Researchers found that when more time is spent by doctors listening to patients, fewer antibiotic prescriptions result without reducing a patient's level of satisfaction.²⁰ Similarly, Linder *et al.* found that antibiotic prescriptions were associated with a shorter visit duration. They studied patients between age 18 and 60 with URIs including acute nasopharyngitis, acute bronchitis, sinusitis, a streptococcal sore throat, acute pharyngitis, and acute tonsillitis (or otitis media) from 1995 through 2000.²¹ Findings of the

Table 4. Predicted probability of each variable in the model.

Variable	Mean predicted probability	Standard deviation
Female	0.2	0.14
Male	0.15	0.12
White, non-Hispanic	0.19	0.14
Black, non-Hispanic	0.17	0.15
Hispanic	0.16	0.11
Other race/ethnicity	0.14	0.1
Family medicine specialty	0.23	0.14
Internal specialty	0.16	0.13
Paediatric specialty	0.2	0.13
Otolaryngology specialty	0.12	0.08
Paediatrician	0.09	0.07
Medicare	0.16	0.14
Medicaid	0.16	0.11
Self-pay	0.12	0.1
Private insurance	0.24	0.14
Metropolitan area	0.18	0.13
Non-metropolitan area	0.17	0.1
Northeast	0.17	0.11
South	0.19	0.15
West	0.15	0.12
Midwest	0.19	0.12
Time and family medicine	0.15	0.017
Time and paediatrician	0.02	0.12
Time and internal	0.16	0.1
Time and otolaryngologist	0.12	0.11
Time and other specialties	0.09	0.07

current study agree with Linder's conclusions. However, the findings of the current study contradict the 2006 study by Hare *et al.*, which used National Ambulatory Medical Care Survey data from 1993 to 2003 for patients under age 18. They found that 'not prescribe' antibiotics for children with viral

respiratory tract infections does not take any longer than prescribing them falsely.²² These differences may stem in part from a different study population and the exclusion of criteria for different diagnoses. The current study includes a first, second, and third diagnosis for each visit and limited the analysis to patients for whom there was no need for antibiotic prescriptions. In contrast, Hare *et al.* excluded the visits that resulted in a secondary or tertiary diagnosis that could have influenced the duration of the visit or justified the prescription of an antibiotic.

By every additional minute spent with a family practitioner, the mean predicted probability of receiving unnecessary antibiotics was 15% higher. Hicks *et al.*²³ conducted a study that determined family physicians prescribed the highest overall number of antibiotic courses, followed by paediatricians and internists (24%). Future studies are needed to investigate the family physicians' behaviour on antibiotic prescriptions in unnecessary cases.

Physicians with a higher rate of antibiotic prescriptions have a higher predicted probability of prescribing inappropriate antibiotics. This likely has a connection to the physician's general prescribing behaviour. Doctors who tend to prescribe more antibiotics have a greater tendency to prescribe more antibiotics even when they are not necessary. A study published in 2016 found that a physician's professional characteristics are one of the main drivers of antibiotic prescriptions, specifically that physicians' knowledge, attitude, workload, and emergency activities impact their prescribing behaviour.²⁴

The limitations of this study relate primarily to the use of the National Ambulatory Medical Care Survey data rather than collecting it personally or using other databases. The National Ambulatory Medical Care Survey data does not permit a longitudinal view of individual physicians' antibiotic prescription rates so tracking change over time is not possible. Additional antibiotic prescriptions or changes in prescriptions could have happened outside of regular visits such as over the phone, which would not be captured in National Ambulatory Medical Care Survey data-set. The survey did not capture any errors such as misdiagnosis or even miscoding. The duration and the severity of symptoms were not recorded in the data-set; therefore, drawing a broad conclusion regarding the validity of the decision to prescribe antibiotics in a specific case is impossible, forcing researchers to treat the data as if they were completely correct.

Conclusion

To date, efforts to reduce unnecessary antibiotic prescriptions for viral diseases have yielded some modest

results. This research extends our knowledge about the overprescription of antibiotics in the US, showing that physicians frequently prescribe antibiotics for viral diseases in office-based settings as well as in inpatient settings. Inappropriate antibiotic prescriptions for viral infections appear to be influenced by the complex interaction between circumstances, patients, and physicians.

This study provides evidence that physicians in the US continue to prescribe antibiotics for viral diseases at an unacceptable rate. These findings show that spending more time in an encounter with a doctor may result in fewer antibiotic prescriptions for unnecessary cases, except in the case of family physicians. Perhaps this is because more contact time gives doctors an opportunity to explain and provide rationales for not prescribing antibiotics. Without enough information and justification, patients may seek unnecessary antibiotics.

The findings of this study are useful not only for US medical supervisory institutions such as the CDC, the Infectious Diseases Society of America, the American Medical Association, and even the Food and Drug Administration but for medical and public health professionals around the world. They provide a better understanding of the factors that have statistical associations with prescribing antibiotics in office-based settings, providing insight into doctors' responsibilities towards patients including explaining the reasons behind a prescribed treatment. In order to continue improving antibiotic prescription behaviour, future studies are needed to investigate factors that could stop physicians from elaborating more about antibiotics and being more open about the consequences of antibiotic overuse with their patients.

Declarations

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