

## Characteristics of Primary Care Physicians Associated With High Outpatient Antibiotic Prescribing Volume

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Our objective was to identify characteristics associated with high-volume antibiotic prescribing among office-based primary care physicians to target antibiotic stewardship efforts. Physicians aged 40 years and older who were male, located in the South, and in solo or 2-physician practices prescribed higher volumes of antibiotics than their peers by specialty.

**Keywords.** antibiotic; antimicrobial stewardship; antibiotic prescribing; antibiotic stewardship.

Antibiotic use is the primary modifiable driver of antibiotic resistance, a major global public health threat [1], and the majority of human antibiotic use occurs among outpatients [2, 3]. Half of the 260 million outpatient antibiotic prescriptions dispensed in the United States in 2011 were prescribed by primary care physicians: family practitioners, internists, and pediatricians [4]. At least 30% of US outpatient antibiotic prescribing is estimated to be unnecessary [5]. Clinicians vary in their propensity to prescribe antibiotics, even when controlling for diagnosis [6], but few US data exist regarding demographic groups of physicians who are most likely to prescribe antibiotics, whether appropriately or inappropriately. Understanding these patterns can inform health systems and public health programs about important physician groups to target with outpatient antibiotic stewardship efforts. Our objective was to identify characteristics associated with high-volume antibiotic prescribing among office-based family practitioners, internists, and pediatricians.

### METHODS

We conducted a retrospective study using antibiotic prescription data from QuintilesIMS Xponent (QuintilesIMS, Danbury,

CT) and physician data from the American Medical Association (AMA) Physician Professional Data. Xponent, a proprietary database, includes data collected from US community pharmacies reporting their entire business weekly. QuintilesIMS reported capture >70% of outpatient prescriptions nationally in 2011 and used a routinely validated, patented method to reconcile captured prescriptions to wholesale deliveries and project to 100% coverage [4]. These data represent all outpatient antibiotic prescriptions dispensed in nonfederal community and mail-order pharmacies. The AMA Physician Professional Data 2011 file is AMA's proprietary demographic database on US-based physicians and medical students. The AMA Physician Professional Data also contain unique provider identification numbers that can be matched to provider identification numbers used in QuintilesIMS. This study was approved by the Centers for Disease Control and Prevention's (CDC's) Institutional Review Board with a waiver of informed consent.

We included office-based physicians in the 50 US states (excluding territories) engaged in direct patient care as their primary professional activity with primary specialties of family practice, pediatrics, or internal medicine. We excluded physicians with nonmatching primary specialties in the data sets, degrees other than medical doctor as non-MDs were not systematically included in the AMA database, and any who were "presumed dead." To focus on primary care, we excluded physicians with self-designated primary specialties of pediatric or medical subspecialties, including infectious diseases. To select physicians who are most likely to have similar practices, we excluded physicians who reported rounding in hospitals, had 3 or more offices, had antibiotic prescriptions listed in multiple states in 2011, or had no antibiotic prescriptions included in the database. Additionally, we excluded physicians in training programs, aged <30 or ≥65 years, and physicians less than 5 years after graduation to focus on physicians who were likely to be in full-time practice as attending physicians during all of 2011.

Systemic oral antibiotics were extracted from the QuintilesIMS Xponent database for 2011. Antibiotic prescriptions, in this customized extract, were aggregated by clinician with unique provider identification numbers. We determined the median number and interquartile ranges of antibiotic prescriptions written by physicians stratified by each primary care specialty: family practice, pediatrics, and internal medicine. We investigated 6 factors—medical school location (within 50 US states vs outside); sex (male and female); age categories (30–<40, 40–<50, 50–<65 years); years since medical school graduation (5–<10, 10–<20, 20–<30, ≥30 years); office type (solo or 2-physician practice, group, other, missing); and region of physician practice (Northeast, Midwest, South, West).

Received 1 August 2017; editorial decision 21 December 2017; accepted 4 January 2018.

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Open Forum Infectious Diseases®

Published by Oxford University Press on behalf of Infectious Diseases Society of America 2018. This work is written by (a) US Government employee(s) and is in the public domain in the US. DOI: 10.1093/ofid/ofx279

We then classified clinicians as “high-volume antibiotic prescribers” or not based on a cutoff of the highest 25th percentile of number of antibiotic prescriptions in 2011 for each specialty and performed multivariable log-binomial regression to compute adjusted prevalence ratios for factors associated with being a high-volume antibiotic prescriber using SAS Proc Genmod (see the Supplementary Materials). As age and years since medical school graduation are highly correlated, we included only age in the model. Finally, we examined the top 5 antibiotic agents and classes for high-volume antibiotic prescribers and physicians who were not high-volume prescribers by specialty. All analyses were conducted using SAS 9.3 (SAS Institute, Cary, NC). We considered a *P* value of <.05 to be significant.

## RESULTS

Of 95 344 family practitioners in both data sets, 43 350 (45.9%) met the inclusion criteria (Supplementary Table 1). For internists, 41 313 (36.5%) of 113 301 were included, and 24 380 (40.4%) of 60 201 pediatricians were included. The median number of antibiotic prescriptions written per physician was higher among older age groups for both family practitioners and internists, while median antibiotic prescriptions peaked for pediatricians at age 40–<50 years. Across all 3 specialties, the median number of antibiotic prescriptions increased with each decade since medical school graduation, was higher among male physicians, was highest among physicians located in the South, and was highest among physicians in solo or 2-physician practices (Table 1). Family practitioners and internists who attended medical school in a US state had higher median antibiotic prescribing numbers than their peers educated in medical schools outside US states. However, pediatricians educated in medical schools in US states had a lower median number of antibiotic prescriptions than those with medical education outside US states. These same factors were significantly associated with being a high-volume antibiotic prescriber in multivariable modeling after adjustment for the additional factors except medical school location for internists, which switched direction for US medical schools to have a small association with lower antibiotic prescribing (prevalence ratio, 0.95; 95% confidence interval, 0.92–0.98) (Table 1). Unadjusted prevalence ratios are shown in Supplementary Table 2. The top 5 antibiotic agents and classes were similar among high prescribers and family practitioners/internists and identical among pediatricians (Supplementary Table 3).

## DISCUSSION

In 2011, male primary care physicians aged 40 to 64 years were more likely to be high-volume antibiotic prescribers than their younger female colleagues. Additionally, primary care physicians in the South and in solo or 2-physician practices prescribed more antibiotics than their peers. These findings mirror previous work in which older, male physicians in England were found to prescribe antibiotics at higher rates [7] and previous

US studies demonstrating higher antibiotic prescribing in the South [4, 5]. Because antibiotic prescribing was not normalized to the number of visits or even the number of patients in these practices, these findings reflect the number of antibiotic prescriptions per physician and their role in the overall antibiotic prescribing burden on the patient population. However, understanding demographic groups of primary care physicians who prescribe more antibiotics on a per-physician level is critical to prioritizing antibiotic stewardship interventions.

Antibiotic stewardship programs have traditionally focused on improving antibiotic use in hospitals [8], and some hospital-based antibiotic stewardship programs have begun to address antibiotic prescribing in outpatient clinics within their health systems. This analysis demonstrates that antibiotic stewardship efforts also need to include independent and small outpatient practices, especially solo and 2-physician practices. In 2016, the CDC released the *Core Elements of Outpatient Antibiotic Stewardship* as a framework for antibiotic stewardship for outpatient settings, which contains recommendations that can be instituted in small, independent practices [9]. In 2016, the Quality Innovation Network–Quality Improvement Organizations (QIN-QIOs) was tasked by the Centers for Medicare and Medicaid Services to collaborate with regional partners including public health to recruit outpatient clinics serving Medicare beneficiaries and implement the CDC’s Core Elements by July 2018 [10]. Regional stewardship collaboratives, such as the QIN-QIOs, may serve as a model for inclusion of small, independent clinics in antibiotic stewardship efforts. Additionally, the American Academy of Pediatrics offers quality improvement activities targeted at improving antibiotic prescribing in primary care pediatrics [11]. Activities offered through health care professional societies can help physicians in small practices improve antibiotic prescribing while meeting requirements to maintain licensure and certifications.

Additionally, these analyses demonstrate that family practitioners educated in US medical schools are as or more likely to be high-volume antibiotic prescribers than their peers educated outside the 50 US states. This finding may highlight an opportunity to incorporate antibiotic stewardship education into all medical education, including by US medical schools and residency training programs.

Our analysis was subject to at least the following limitations. These data are the most recent years in which our team had access to both data sets. While antibiotic prescriptions have decreased since 2011 for children, adult antibiotic prescribing remained stable from 2011 to 2014 [12]. Xponent data are collected as dispensing data, which do not lend themselves to optimal use for public health. Xponent data lack diagnoses; thus, we are unable to assess appropriateness. We cannot compare across the 3 primary care specialties without diagnoses. Internists likely have more visits for chronic disease management, which would result in a lower number of antibiotic prescriptions per provider without affecting appropriateness of antibiotic prescribing. We

**Table 1. Median Number and Interquartile Range of Antibiotic Prescriptions per Provider and Adjusted Prevalence Ratio for Outcome of Being a High-Volume Antibiotic Prescriber (in top 25%) for Primary Care Physicians by Specialty—United States, 2011**

Provider Characteristics	Median Number of Antibiotic Prescriptions per Provider (IQR)			Adjusted Prevalence Ratio (95% CI)		
	Family Practitioners	Internists	Pediatricians	Family Practitioners	Internists	Pediatricians
Age group, y						
30–<40	379 (675)	81 (230)	359 (693)	Referent	Referent	Referent
40–<50	456 (769)	216 (521)	513 (864)	1.12 (1.08–1.17)	1.81 (1.71–1.91)	1.32 (1.25–1.40)
50–<65	457 (821) <sup>a</sup>	300 (591) <sup>a</sup>	506 (981) <sup>a</sup>	1.05 (1.01–1.10)	1.85 (1.75–1.96)	1.28 (1.21–1.36)
Years since medical school graduation						
5–<10	293 (526)	62 (148)	250 (583)	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>
10–<20	355 (649)	76 (201)	340 (682)	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>
20–<30	457 (770)	171 (471)	483 (815)	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>
30+	473 (832) <sup>a</sup>	310 (604) <sup>a</sup>	523 (998) <sup>a</sup>	NA <sup>b</sup>	NA <sup>b</sup>	NA <sup>b</sup>
Sex						
Male	547 (887)	228 (562)	589 (1053)	1.81 (1.74–1.88)	1.45 (1.40–1.51)	1.45 (1.39–1.51)
Female	324 (595) <sup>a</sup>	125 (377) <sup>a</sup>	406 (733) <sup>a</sup>	Referent	Referent	Referent
Medical school location						
Other	400 (739)	170 (484)	503 (987)	Referent	Referent	Referent
US state	448 (771) <sup>a</sup>	182 (485) <sup>a</sup>	443 (792) <sup>a</sup>	1.04 (1.00–1.08)	0.95 (0.92–0.98)	0.85 (0.81–0.89)
Region						
West	271 (570)	106 (356)	275 (620)	Referent	Referent	Referent
Midwest	503 (773)	185 (487)	516 (850)	1.88 (1.78–1.98)	1.43 (1.36–1.52)	1.89 (1.75–2.05)
Northeast	344 (555)	171 (448)	402 (694)	1.14 (1.05–1.22)	1.30 (1.23–1.37)	1.28 (1.18–1.39)
South	589 (936) <sup>a</sup>	260 (599) <sup>a</sup>	629 (1035) <sup>a</sup>	2.33 (2.22–2.45)	1.73 (1.65–1.81)	2.38 (2.22–2.55)
Primary present employment <sup>c</sup>						
Solo or 2-physician practice	594 (848)	461 (618)	781 (1066)	1.09 (1.05–1.14)	1.36 (1.31–1.41)	1.34 (1.28–1.41)
Group	486 (752)	246 (510)	540 (781)	Referent	Referent	Referent
Other	116 (389)	41 (160)	54 (219)	0.50 (0.43–0.58)	0.35 (0.29–0.42)	0.26 (0.19–0.35)
Missing	187 (545) <sup>a</sup>	62 (172) <sup>a</sup>	98 (468) <sup>a</sup>	0.59 (0.56–0.62)	0.43 (0.41–0.46)	0.47 (0.44–0.51)

Abbreviations: CI, confidence interval; IQR, interquartile range.

<sup>a</sup> P value <.001 for differences among the category within each specialty by Wilcoxon 2-sample/Kruskal Wallis.

<sup>b</sup> As physician age and years since medical school graduation are highly correlated, only age was included in the model.

<sup>c</sup> Primary present employment options were: “self-employed solo practice,” “2-physician practice full- or part-owner,” “other patient care,” “group practice,” “HMO,” “medical school,” “city/county/state other than hospital,” and “no classification.” “Self-employed solo practice” and “2-physician practice full- or part-owner” were categorized as solo or 2-physician practice for this analysis; “group practice” as group. All others were placed into the other category. Missing information was categorized as missing.

are unable to determine practice location. For example, we cannot determine if physicians work in urgent care, which would affect their case mix and volume of antibiotic prescribing.

As Xponent data are prescription based, we are unable to determine the volume of visits to physicians. Physicians who see more patients will likely have higher volumes of antibiotic prescriptions, which may not be associated with appropriateness. Visit volume may vary by physician age or gender. It is also likely that adherence to antibiotic prescribing guidelines may also vary with physician age and gender. Previous work has suggested that female physicians may more often provide guideline-concordant care [13]. These analyses will help identify physician groups who prescribe high volumes of antibiotics, and thus inform the CDC’s efforts to target important physician groups to include in outpatient antibiotic stewardship efforts.

Understanding physician demographics associated with the highest volume or burden of antibiotic prescribing can help direct stewardship efforts. Innovative stewardship interventions that engage outpatient physicians in small practices are needed.

## Acknowledgments

We thank Robert Hunkler of QuintilesIMS for his review of the methods and manuscript.

**Disclaimer.** The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

**Financial support.** This work was supported by the Centers for Disease Control and Prevention.

**Potential conflicts of interest.** All authors: no reported conflicts of interest. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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