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Assessment of inappropriate antibiotic prescribing among a large cohort of general dentists in the United States

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ABSTRACT

Background. The purpose of this study was to assess dental antibiotic prescribing trends over time, to quantify the number and types of antibiotics dentists prescribe inappropriately, and to estimate the excess health care costs of inappropriate antibiotic prescribing with the use of a large cohort of general dentists in the United States.

Methods. We used a quasi-Poisson regression model to analyze antibiotic prescriptions trends by general dentists between January 1, 2013, and December 31, 2015, with the use of data from Express Scripts Holding Company, a large pharmacy benefits manager. We evaluated antibiotic duration and appropriateness for general dentists. Appropriateness was evaluated by reviewing the antibiotic prescribed and the duration of the prescription.

Results. Overall, the number and rate of antibiotic prescriptions prescribed by general dentists remained stable in our cohort. During the 3-year study period, approximately 14% of antibiotic prescriptions were deemed inappropriate, based on the antibiotic prescribed, antibiotic treatment duration, or both indicators. The quasi-Poisson regression model, which adjusted for number of beneficiaries covered, revealed a small but statistically significant decrease in the monthly rate of inappropriate antibiotic prescriptions by 0.32% (95% confidence interval, 0.14% to 0.50%; $P = .001$).

Conclusions. Overall antibiotic prescribing practices among general dentists in this cohort remained stable over time. The rate of inappropriate antibiotic prescriptions by general dentists decreased slightly over time.

Practical Implications. From these authors' definition of appropriate antibiotic prescription choice and duration, inappropriate antibiotic prescriptions are common (14% of all antibiotic prescriptions) among general dentists. Further analyses with the use of chart review, administrative data sets, or other approaches are needed to better evaluate antibiotic prescribing practices among dentists.

Key Words. Antibiotics; dentistry; prophylaxis; treatment; epidemiology; public health.

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Since the first use of penicillin in 1942,¹ antibiotics have become an essential tool in modern health care. Antibiotics have reduced the rate of morbidity and mortality from infections and have facilitated the advancement of surgical treatments, cancer care, transplantation, and the treatment of many other diseases. The Centers for Disease Control and Prevention (CDC) estimates that more than 262 million antibiotics are prescribed in US outpatient settings annually.² However, approximately 30% to 50% of antibiotic prescriptions are unnecessary.^{1,3} Although antibiotics are indispensable in treating bacterial infections, the misuse and overuse of antibiotics have serious negative consequences. Increased antibiotic use is associated with development of increasing antibiotic resistance,^{4,5} *Clostridium difficile* infections,^{6,7} adverse drug events, and additional health care costs.⁸ Antibiotic resistant infections account for 23,000 deaths and billions of dollars in excess spending in the United States annually.¹

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Several organizations have made efforts to improve antibiotic prescribing. In the mid-1990s, the CDC spearheaded efforts to better characterize, monitor, and reduce the inappropriate use of antibiotics and antibiotic resistance. Specifically, the CDC's *Be Antibiotics Aware* campaign aims to reduce unnecessary antibiotic use in the outpatient and hospital settings⁹ and provides clinical guidelines for antibiotic stewardship programs in multiple health care settings.¹⁰⁻¹² Other health care stakeholders, such as The Pew Charitable Trusts and The Joint Commission (TJC), a US health care organization and program accreditation agency, have also provided public commitments to improve antibiotic prescribing practices.^{13,14} In addition, the Centers for Medicare & Medicaid Services (CMS) are developing a Condition of Participation policy that requires antimicrobial stewardship programs in hospitals in line with the new standards of TJC.¹⁴ Although these initiatives represent large efforts by the CDC and other organizations, most of the work has been aimed at improving antimicrobial stewardship programs directed toward the antibiotic prescribing patterns of physicians.

Prescriptions by dentists account for 10% of all antibiotic prescriptions in the United States^{2,15}; however, compared with the literature on physicians, fewer articles have evaluated antibiotic prescribing practices among dentists.¹⁶⁻²⁰ Some of the available dental studies suggest that inappropriate (nonguideline adherent) antibiotic prescribing among dentists is present.^{16-18,20} For example, Roberts and colleagues¹⁶ reported that dentists prescribed several antibiotic agents that have no dental indications.¹⁶ In addition, in a survey of dentists about the American Heart Association (AHA) recommendations for antibiotic prophylaxis before dental procedures, approximately 70% of dentists reported prescribing antibiotics for prophylaxis outside the AHA guidelines.¹⁷ Furthermore, antibiotic prescribing may be increasing among dentists, according to 1 Canadian study.¹⁸ This is in contrast to some studies that report declines in antibiotic prescribing rates among US physicians.²¹⁻²³

The aim of our study was to evaluate longitudinal antibiotic prescribing trends among dentists, to quantify the number of potentially inappropriate antibiotic prescriptions, and to estimate the health care costs of inappropriate antibiotic prescriptions among a large cohort of patients prescribed antibiotics by dentists in the United States.

METHODS

We analyzed data about outpatient antibiotic prescriptions from January 1, 2013, through December 31, 2015. The data were obtained from Express Scripts Holding Company (ESHC), the largest independent prescription benefits manager in the United States. ESHC holds detailed prescription data for more than 80 million American beneficiaries. We extracted data on provider specialty, name of antibiotic, dose, and treatment duration (days' supply) for people in this large cohort in the United States. We defined the United States as all 50 states and Washington, DC. Other nonstate US territories were excluded from our analysis. Provider specialty was obtained from the ESHC database that uses designations from the CMS, in addition to a proprietary source. We also obtained data about total costs for antibiotics and the number of beneficiaries in the database during the study period. Costs examined in this study were calculated by adding the prescription drug plan costs and out-of-pocket patient costs. Plan costs included ingredient costs, taxes, dispensing fees, and administrative fees and were not adjusted to exclude rebates. Prescriptions with missing claims, provider information, or both were excluded. Topical antibiotics, systemic or topical antifungal agents, antiparasitic agents, and antiviral agents were also excluded. Antibiotics with the same active ingredient but a different formulation (for example, extended-release tablets) were combined. Antimicrobial agents with antibacterial properties (for example, methenamine) were included.

We analyzed the count and cost of antibiotics prescribed by general dentists to people 18 years or older. People who were younger than 18 years were specifically excluded to ensure an accurate estimation of antibiotic prescription duration (defined as days' supply). This was done to prevent possible errors in estimates of antibiotic prescription duration that were generated from pediatric weight-based antibiotic dosing. We then used antibiotic duration to categorize prescriptions into 3 separate purpose categories: prophylaxis, indeterminate, and treatment. Antibiotic prescriptions for 1 day or less were defined as prophylaxis, antibiotic prescriptions for 2 to 4 days were defined as indeterminate, and antibiotic prescriptions for 5 days or more were defined as treatment. Antibiotic purpose classified as prophylaxis or treatment was defined as appropriate, whereas those classified as indeterminate were defined as inappropriate. This designation was made by expert opinion, American Dental Association (ADA) website materials on antibiotic stewardship,²⁴ and consensus among our group. Of note, with the exception of erythromycin (which our group thought was

ABBREVIATION KEY

ADA:	American Dental Association.
AHA:	American Heart Association.
CDC:	Centers for Disease Control and Prevention.
CMS:	Centers for Medicare & Medicaid Services.
ESHC:	Express Scripts Holding Company.
TJC:	The Joint Commission.

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