Antibiotic Use in 2016 by Members of the American Association of Endodontists: Report of a National Survey

Mark Germack, DDS, Christine M. Sedgley, MDS, MDSc, PhD,* Wael Sabbah, BDS, DDPH, MSc, PhD,† and Brian Whitten, DDS**

Abstract

Introduction: This study surveyed the antibiotic prescribing practices of endodontists, and data were compared with previous surveys conducted in 1994 and 1999. **Methods:** A 17-question survey was sent via www.surveymonkey.com to 3000 active members of the American Association of Endodontists for responses about antibiotic prescribing practices and demographics. The data were analyzed using descriptive statistics, chi-square tests, and linear regression analyses. **Results:** Six hundred eighty-six participants (22.86%) completed the survey. The most frequently prescribed antibiotics were amoxicillin (60.71%) followed by penicillin V (30.43%) and clindamycin for patients with allergies (95.4%). Respondents reported prescribing antibiotics for irreversible pulpitis with mild symptoms (1.75%), irreversible pulpitis with moderate symptoms (6.41%), necrotic pulp with symptomatic apical periodontitis (43.59%), chronic apical abscess without (10.50%) or with symptoms (29.74%), acute apical abscess (95.92%), avulsion (70.26%), endodontic surgery (41.69%), retreatment (silver point [23.76%] or gutta-percha [15.60%]), postoperative pain after instrumentation or obturation (12.39%), and perforation repair (5.98%). The type of practice (solo/group) and geographic region (Southeast) were significant predictors of increased antibiotic prescribing; 36.89% of respondents reported prescribing antibiotics that are not necessary, most commonly because of patient expectations. **Conclusions:** Since 1999, there has been a significant shift from prescribing penicillin V to amoxicillin as endodontists' first choice of antibiotic and a significant increase in the use of clindamycin for penicillin-allergic patients. Antibiotics continue to be prescribed in clinical situations for which they are typically not indicated, most commonly because of patient expectations. Regional differences in antibiotic prescribing practices by endodontists exist in the United States. *(J Endod 2017;43:1615–1622)*

Key Words

Amoxicillin, antibiotics, clindamycin, endodontic therapy, endodontists, penicillin, root canal, survey

Significance

AAE members were surveyed about their antibiotic prescribing practices. Since 1999, amoxicillin and clindamycin prescribing has significantly increased, and penicillin has decreased. 37% of respondents reported prescribing antibiotics that are not necessary, most commonly because of patient expectations. Regional differences in prescribing practices exist in the US.

Alexander Fleming's 1929 seminal publication on penicillin helped usher in the antibiotic era in medicine (1). However, within a decade, antibiotic resistance to sulfanilamide was reported in 1937 followed by penicillin in 1940 (2, 3). By the 1950s, antibiotic resistance outbreaks in hospitals were a serious concern (4). Attempts to combat resistant microorganisms by developing new antibiotics helped, but it became apparent that the new antibiotics were not immune from resistance (5). Multidrug-resistant bacteria are now commonly identified in hospitals around the world, including a class of bacteria resistant to all known therapies (pandrug-resistant bacteria) (6).

The inappropriate use of antibiotics contributes to the spread of antibiotic resistance. It is estimated that over 250,000 people per year in the United States are diagnosed with an antibiotic-resistant infection, of which 23,000 will succumb and die (7). Conservatively, each year the US health care system spends an additional $20 billion treating antibiotic-resistant infections (7). Those infections lead to an estimated $35 billion in lost worker productivity and pose a major threat to the national health care system and the economy at large (8). A presidential executive order to combat antibiotic-resistant bacteria was issued in 2014; this document included a section on the need for the implementation of improved antibiotic stewardship in health care settings by the end of 2016 (8).

Dentistry's contribution to antibiotic resistance is difficult to calculate; it has been estimated that dentists prescribe 10% of the antibiotics consumed by humans (5, 9). A recent study of a centralized, population-based prescription database in British Columbia found that antibiotic prescribing by dentists increased by 62.2% from 1996 to 2013 (10). Given that 50% or more of the antibiotics provided in the United States are estimated to be prescribed incorrectly (7), dentistry is likely to have had an impact on the development of antibacterial resistance (5, 7, 9, 11). Bacteria showing resistance to common antibiotics have been isolated from deep neck

From the *Department of Endodontology, School of Dentistry, Oregon Health and Science University, Portland, Oregon; and †Division of Population and Patient Health, Dental Institute, King's College London, England, United Kingdom.

Address requests for reprints to Dr Christine M. Sedgley, Department of Endodontology, School of Dentistry, Oregon Health and Science University, 2730 SW Moody Ave, Portland, OR 97201. E-mail address: sedgley@ohsu.edu

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Baseline demographics

1. What year did you graduate from dental school?

2. What year did you graduate from your endodontic residency?

3. How many years have you been in practice?

4. What is your gender?
   Male
   Female

5. Which of the following best describes your working situation? (Please select one.)
   Full-time private practice
   Academics only
   Retired
   Part-time private practice
   Part-time practice/part time academics

6. Which type of practice best describes your practice? (Please select one.)
   Corporate practice
   Group practice
   Solo practice
   Military
   Academics

7. In which region do you practice?
   Northeast (MA,RI,CT,VT,NH,ME,NY,NJ)
   Mid Atlantic (PA, MD, DE,WV,VA,NC,SC, Wash. DC)
   Southeast (KY,TN,AR,LA, MS, AL,GA,FL)
   Great Lakes (MN,WI, IL, IN, MI, OH)
   Midwest (NM,CO,WY,MT,ND,SD,NE,KS,OK,TX,IA,MO)
   Western (WA,OR,CA,ID,NV,UT,AZ,AK,HI)
   Other_____

8. On average how many patients do you treat in a week?

9. On average how many times in a week do you prescribe antibiotics?

10. In which of the following situations would you prescribe antibiotics? (Please select all that apply.)
- Irreversible Pulpitis; mod/severe pre-op symptoms
- Irreversible Pulpitis with Symptomatic Apical Periodontitis; mod/severe pre-op symptoms
- Necrotic Pulp with Symptomatic Apical Periodontitis; no swelling, mod/severe pre-op symptoms
- Necrotic Pulp with Chronic Apical Abscess; sinus tract present; no/mild pre-op symptoms
- Necrotic Pulp with Chronic Apical Abscess; sinus tract present; mod/severe pre-op symptoms
- Necrotic Pulp with Acute Apical Abscess; swelling present; mod/severe pre-op symptoms

11. In which of the following situations would you prescribe antibiotics? (Please select all that apply.)
- Avulsion
- I & D of a localized intraoral swelling, no external swelling
- I & D of a diffuse intraoral swelling, no external swelling
- I & D of a diffuse intraoral oral swelling, external swelling present
- Post-op pain after instrumentation or obturation
- Retreatment of silver points
- Retreatment of gutta percha
- Perforation repair (before or after)
- Endodontic surgeries (before or after)

Antibiotic selection

12. Please **select** the **antibiotic** and **dosage** you prescribe most often for patients with **no medical allergies**.

Drug	Dosage (please circle)	Number of Days
Amoxicillin	250mg, tid | 500mg, tid	_____
Ampicillin	250mg, qid | 500mg, qid	_____
Augmentin	250mg, tid | 500mg, tid	_____
Azithromycin (Zithromax)	250mg, qid	_____
Cephalexin	250mg, qid | 500mg, qid	_____
Ciprofloxacin (Cipro)	500mg, bid | 750mg, bid	_____
Clarithromycin (Biaxin)	250mg, bid | 500mg, bid	_____
Clindamycin	150mg, qid | 300mg, qid	_____
Erythromycin Base	250mg, qid | 500mg, qid	_____
Metronidazole (Flagyl)	250mg, qid | 500mg, qid	_____
Penicillin V	250mg, qid | 500mg, qid	_____
Tetracycline	250mg, qid | 500mg, qid	_____
Other: _____	Dosage: _____	Number of Days: _____

13. Please **select** the **antibiotic** and **dosage** you prescribe most often for patients with an **allergy to penicillin**.

Drug	Dosage (please circle)	Number of Days
Azithromycin	250mg, qid	_____
Cephalexin	250mg, qid | 500mg, qid	_____
Ciprofloxacin	500mg, bid | 750mg, bid	_____
Clarithromycin	250mg, bid | 500mg, bid	_____
Clindamycin	150mg, qid | 300mg, qid	_____
Erythromycin base	250mg, qid | 500mg, qid	_____
Metronidazole	250mg, qid | 500mg, qid	_____
Tetracycline	250mg, qid | 500mg, qid	_____
Other: _____	Dosage: _____	Number of Days: _____

Antibiotic prescribing practices

14. Do you prescribe a loading dose?
   Yes
   No

15. If your antibiotic prescription is ineffective after 2-3 days what would you do? (Select all that apply.)
   Change antibiotics?
      If so, to which antibiotic? _____
   Add a second antibiotic?
      If so, which antibiotic?_____
   Other
      Please explain: _____

16. Do you prescribe antibiotics differently based on the day of the week?
   Yes
   No
   If yes, please explain:_____

17. Do you ever prescribe antibiotics that are not necessary?
   Yes
   No
      If yes, what percentage?_____
      Please explain: _____

Figure 1. The survey questionnaire.

infections of odontogenic origin as well as primary and persistent endodontic infections (12–16). Complicating matters further, horizontal transfer of bacterial-resistant genes can occur between different bacterial species in root canals (17), and resistant isolates with high biofilm production capacity have the potential to turn endodontic infections into reservoirs for bacterial resistance (14).

Since 1977, several surveys on antibiotic prescribing practices of members of the American Association of Endodontists (AAE) have been published (18–21). In a survey conducted in 1994 of general dentists and AAE members regarding routine nonemergency endodontic treatment and antibiotic usage, Whitten et al (20) reported that antibiotics were incorrectly prescribed as much as 67% of the time. More recently, in 2002, Yingling et al (21) similarly reported inappropriate antibiotic prescribing practices based on a survey conducted in 1999. Since then, prescription guidelines have become more standardized and easily accessible (7, 22). Given our greater understanding of the consequences of antibiotic resistance and the need for antibiotic stewardship (7), the aim of this study was to obtain current information on the antibiotic prescribing practices of endodontists in the United States and compare it with previous reports.

Materials and Methods

This study was reviewed and declared exempt by the institutional review board. To allow comparisons, the survey was based on a report by Yingling et al (21). A pilot questionnaire was distributed to 20 endodontists for their input; after which, the 17-question survey instrument was finalized (Fig. 1). The questions were entered into www.surveymonkey.com. Wherever possible, the questions were formatted as drop-down or selection options. Other questions (year graduated from dental school, year graduated from endodontic residency, number of years in practice, number of cases treated per week, and the average number of antibiotics prescriptions written per week) were fillable. Three thousand active member e-mail addresses were obtained from the AAE online directory, and invitations to participate in the study were e-mailed to each participant in June 2016. The invitation included instructions and details regarding the study's purpose. Invitations were sent twice, 3 weeks apart, giving respondents a total of 6 weeks to respond.

Data Analyses

All data were evaluated using descriptive statistics. Because the number of patients per week varied considerably between respondents, each respondent had his or her weekly prescribing percentage (WPP) determined (ie, patients prescribed antibiotics as a percentage of the total number of patients per week). Linear regression analyses were used to evaluate the associations between WPP and the following demographic variables: sex, year of graduation from an endodontic residency program (2002 or earlier vs 2003 or later), type of practice (solo, group, and other types of practice), and region (Northeast, Mid-Atlantic, Southeast, Great Lakes, Mid-West, and Western).

TABLE 1. Baseline Demographics

	Responses (*n*)	%	Mean	SD	Range
Year graduated					
Dental school	684		1995		1964–2013
Endodontic residency	685		2000		1970–2015
Years in practice	685		18.34	10.70	1–52
Since dental school	684		21.37	10.41	
Since endodontic residency	685		15.64	9.72	
Sex (*N* = 686)					
Male	527	76.82			
Female	159	23.18			
Category of practice (*n* = 670)					
Full-time private	569	82.94			
Academics only	39	5.69			
Retired	26	3.79			
Part-time private practice	34	4.96			
Part-time private/part-time academics	2	0.29			
Type of practice (*N* = 686)					
Corporate	28	4.08			
Group	302	44.02			
Solo	305	44.46			
Military	14	2.04			
Academics	39	5.69			
Region of practice (*n* = 682)					
Northeast	95	13.93			
Mid-Atlantic	76	11.14			
Southeast	106	15.54			
Great Lakes	124	18.18			
Midwest	100	14.66			
Western	181	26.54			
Number of patients per week (*n* = 685)			26.03	11.69	0–100
Male	527	76.93	26.93	11.87	0–100
Female	158	23.07	23.04	10.54	0–55
Antibiotic prescriptions per week (*n* = 676)			5.90	6.17	0–45
Male	519	76.78	6.20	6.42	0–45
Female	157	23.22	4.92	5.18	0–30

SD, standard deviation.

TABLE 2. Antibiotic Prescribing Practices by Endodontists

	Responses (*n*)	%
Clinical situations in which antibiotics are prescribed		
Pulpal and periapical diagnoses (*N* = 686)		
IP, moderate/severe preoperative symptoms	12	1.75
IP, SAP, moderate/severe preoperative symptoms	44	6.41
NP, SAP, no swelling, moderate/severe preoperative symptoms	299	43.59
NP, CAA, ST, no/mild preoperative symptoms	72	10.50
NP, CAA, ST, mod/severe preoperative symptoms	204	29.74
NP, AAA, swelling present	658	95.92
Other clinical situations (*N* = 686)		
Avulsion	482	70.26
I&D localized intraoral swelling, no external swelling	278	40.52
I&D diffuse intraoral swelling, no external swelling	488	71.14
I&D diffuse intraoral oral swelling, external swelling	652	95.04
Postoperative pain after instrumentation or obturation	85	12.39
Retreatment silver points	163	23.76
Retreatment gutta-percha	107	15.60
Perforation repair (before or after)	41	5.98
Endodontic surgeries (before or after)	286	41.69
Antibiotic selection		
Antibiotic preference with no medical allergies (*n* = 677)		
Amoxicillin	411	60.71
Penicillin V	206	30.43
Augmentin	31	4.58
Clindamycin	23	3.40
Cephalexin	5	0.74
Erythromycin base	1	0.15
Other	0	0.00
Antibiotic preference with medical allergies (*n* = 678)		
Clindamycin	647	95.43
Azithromycin	20	2.95
Cephalexin	9	1.33
Clarithromycin	2	0.29
Other	0	0.00
Antibiotic prescribing practices		
Loading dose (*n* = 678)		
Yes	486	71.68
No	192	28.32
If antibiotic prescription is ineffective after 2–3 days (*n* = 674)		
Change antibiotics	392	58.16
Add a second antibiotic	282	41.84
Prescribing antibiotics differently based on day of week (*n* = 682)		
Yes	45	6.60
No	637	93.40
Prescribing antibiotics that are not necessary (*n* = 675)		
Yes	249	36.89
No	426	63.11

AAA, acute apical abscess; CAA, chronic apical abscess; I&D, incision and drainage; IP, irreversible pulpitis; NP, necrotic pulp, SAP, symptomatic apical periodontitis; ST, sinus tract.

Chi-square tests with Yates correction were used to compare percentages in this and previous studies. Significance was set at $P < .05$.

Results

Six hundred eighty-six endodontists responded to the survey, representing a 22.86% response rate. Baseline demographics are presented in Table 1; it should be noted that the number of responses for each question may differ because of partially completed surveys. The results of questions about antibiotic prescribing practices are found in Table 2. The most frequently prescribed antibiotics were amoxicillin (60.71%) followed by penicillin V (30.43%) and clindamycin for patients allergic to penicillin V (95.43%). Approximately two thirds of respondents provided their dosage regimens. These were consistent for amoxicillin (500 mg 3 times daily) and penicillin V (500 mg 4 times daily). In contrast, for clindamycin, three quarters of respondents prescribed 300 mg and the remainder 150 mg; the number of doses per day was independent of milligrams per dose with two thirds prescribing 4 times daily and the remainder 3 times daily. More than 80% of respondents prescribed a 7-day course of antibiotics. If ineffective after 2 to 3 days, 58.16% of respondents reported they would change antibiotics, and 41.84% would add a second antibiotic; 6.60% of respondents indicated they would prescribe antibiotics differently based on the day of the week, with antibiotics more likely to be provided on a Friday or the last day of the workweek; and 36.89% of respondents reported prescribing antibiotics that were not necessary. A breakdown of explanations provided is shown in Figure 2.

There was no significant association between WPP and the number of years since completing an endodontic residency program or between WPP and sex (Table 3). Multivariable linear regression determined that the WPP for those who worked in solo practice was higher by 5.95% (95% confidence interval, −10.32 to −1.58) than those who practiced in other types of practice (military, university, public services, etc) ($P < .01$) and higher by 6.51% (95% confidence interval, 1.30–11.71) for those practicing in the Southeast compared with the Northeast ($P < .05$). Comparisons with previous studies

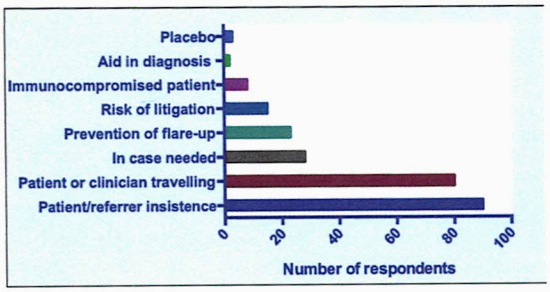

Figure 2. Reasons for prescribing antibiotics that are not necessary.

show significant changes in prescribing patterns for both pulpal and periapical diagnoses (20) and antibiotic prescribing preferences (20, 21) (Table 4).

Discussion

This Web-based survey was developed to allow for comparisons with previous studies. It should be noted that in 2009 the AAE updated their diagnostic terms (23), making a survey identical to previous ones (18–21) unfeasible. Although the 22.86% response rate is similar to a recent Web-based survey of the same group (24), it is less than the 50.1% (21) and 58.2% (20) responses to mail surveys and, therefore, further limits extrapolation of the current findings to reflect the practices of all AAE members compared with other studies. It should also be noted that this survey did not provide options for taking medical history into account. Apart from an increase since 1999 in female respondents from 10.3%–23.2%, demographic characteristics are similar to those reported in Yingling et al's study (21).

Since 1994, there has been a significant change in prescribing habits for patients who are allergic to penicillin, with clindamycin currently the primary recommended antibiotic (22). In 1994, almost two thirds of respondents reported using erythromycin for those patients with a penicillin allergy. By 1999, 57.03% of respondents preferred clindamycin for those with a penicillin allergy compared with 95.43% in the present study, a trend also reported by Kyu in 2009 (25).

Penicillin V has been previously recommended as the antibiotic of choice for dental infections in patients without a penicillin allergy (22) based in part on reports of its efficacy against microorganisms recovered from endodontic infections (26, 27) as well as its narrow spectrum, low toxicity, and low cost (22). In a survey conducted in 1999, the primary antibiotic of choice in patients without allergies was penicillin V (61.5%) followed by the broader spectrum amoxicillin (27.5%) (21). The present data show a significant reversal of these numbers since 1999 (Table 4). This is in agreement with Marra et al (10), who reported a 2000% increase from 1996 to 2013 in the use of amoxicillin alone and in combination with enzyme inhibitors, and in line with prescribing practices in Europe (28). Advantages of amoxicillin over penicillin include better absorption, longer half-life, and more sustained serum levels that allow dosage regimens of 3 times daily compared with 4 times daily for penicillin V (29). On the other hand, a major disadvantage of the entire beta-lactam family of antibiotics relates to their degradation by various beta-lactamases excreted outside the cell wall by gram-positive bacteria and in the periplasmic space by gram-negative bacteria (29). This can be mitigated by the addition of beta-lactamase inhibitors such as clavulanic acid to amoxicillin, which acts by binding to the beta-lactamase catalytic site, thus hindering its activity, and penicillin-binding proteins of the bacteria, thereby increasing the antibiotic's activity (29).

In the present study, 4.58% of respondents reported that amoxicillin with clavulanic acid was their antibiotic of first choice. Despite studies showing that this combination was 100% effective against clinical isolates from acute endodontic infections compared with 81%–85% for penicillin V and 85%–91% for amoxicillin (26, 27), it should be noted that amoxicillin with clavulanic acid has been associated with a greater incidence of serious adverse reactions (eg, Stevens-Johnson syndrome, purpura, and hepatotoxicity) compared with amoxicillin (30). It has been recommended that amoxicillin in combination with clavulanic acid should be reserved for immunocompromised patients, refractory cases, and the most severe infections (22, 26).

TABLE 3. Associations between Demographic Variables and Weekly Prescribing Percentage

			Regression analyses				
			Model 1		Model 2		
	Mean (%)	95% confidence intervals	Binary associations	95% confidence intervals	Multivariable linear regression	95% confidence intervals	*P* value
Year of graduation from endodontic residency				Years completed DDS (reference <2002)			
2002 or earlier	21.93	20.19–23.66	−1.88	−5.03 to 1.26	−1.91	−5.06 to 1.24	NS
2003 or later	20.04	17.70–22.39					
Sex				Sex (reference male)			
Female	20.49	17.72–23.14	1.23	−2.10 to 4.57	0.75	−2.60 to 4.11	NS
Male	21.67	20.02–23.31					
Type of practice				Type of practice (reference solo)			
Solo	21.98	19.83–24.12					
Group	22.69	20.53–24.83	0.71	−2.31 to 3.73	1.2	−1.84 to 4.25	
Others	15.55	11.99–19.11	−6.42*	−10.73 to −2.12	−5.95*	−10.33 to −1.58	<.01
Region				Region (reference group Northeast)			
Northeast	19.02	15.39–22.65					
Mid-Atlantic	19.93	16.28–23.58	0.91	−4.75 to 6.56	1.58	−4.08 to 7.24	
Southeast	24.9	20.78–29.02	5.88*	0.69–11.07	6.51*	1.30 to 11.71	<.05
Great Lakes	22.68	19.28–26.07	3.65	−1.36 to 8.66	3.83	−1.17 to 8.84	
Midwest	21.44	17.51–25.38	2.42	−2.84 to 7.68	2.83	−2.43 to 8.10	
Western	19.93	17.44–22.41	0.9	−3.75 to 5.56	1.26	−3.42 to 5.93	

DDS, doctor of dental surgery; NS, not significant.

*Indicated significant difference.

TABLE 4. Trends in Antibiotic Prescribing Practices by Endodontists (%)

	A	B	C	Chi-square tests (*P* value)	
	Whitten et al, 1996 (20)	Yingling et al, 2002 (21)	This study	A vs C	B vs C
Pulpal and periapical diagnoses for which antibiotics were prescribed					
IP, mod/severe preoperative symptoms	9.3	3.47	1.75	NS	NS
IP, SAP, mod/severe preoperative symptoms	25.4	13.29	6.41	.001	NS
NP, SAP, no swelling, mod/severe preoperative symptoms	67.3	53.93	43.59	.005	NS
NP, CAA, ST, no/mild preoperative symptoms	29.2	11.91	10.5	.003	NS
NP, AAA, swelling present	96.6	99.21	95.92	NS	NS
Other clinical situations					
Avulsion	NA	61.39	70.26	NS	NS
I&D localized intraoral swelling, no external swelling	NA	44.83	40.52	NS	NS
I&D diffuse intraoral swelling, no external swelling	NA	69.36	71.14	NS	NS
I&D diffuse intraoral oral swelling, external swelling	NA	89.91	95.04	NS	NS
Postoperative pain after instrumentation and/or obturation	NA	12.58	12.39	NS	NS
Retreatment silver points	NA	27.02	23.76	NS	NS
Retreatment gutta-percha	NA	15.38	15.60	NS	NS
Perforation repair	NA	9.34	5.98	NS	NS
Endodontic surgery	NA	37.30	41.69	NS	NS
Antibiotic preference by clinician for patients with no medical allergies					
Amoxicillin	25.0	27.51	60.71	<.0001	<.0001
Penicillin V	61.8	61.48	30.43	<.0001	<.0001
Amoxicillin/clavulanic acid	0.03	NA	4.58	NS	NS
Clindamycin	0	1.91	3.40	NS	NS
Cephalexin	4.1	2.84	0.74	NS	NS
Other (AMP, CIP, MTZ, TET)	9.6	3.96	0	NT	NS
Antibiotic preference by clinician for patients with medical allergies					
Clindamycin	21.6	57.03	95.43	<.0001	<.0001
Azithromycin	NA	2.89	2.95	NS	NS
Cephalexin	12.4	5.58	1.33	.007	NS
Clarithromycin	NA	2.79	0.29	NS	NS
Erythromycin	65.5	26.65	0.10	<.0001	<.0001
Metronidazole	1.7	1.03	0	NS	NS
Ciprofloxacin	2.4	1.03	0	NS	NS
Loading dose	NA	85.14	71.68	NA	NS

AAA, acute apical abscess; AMP, ampicillin; CAA, chronic apical abscess; CIP, ciprofloxacin; IP, irreversible pulpitis; MTZ, metronidazole; NA, not available; NP, necrotic pulp; NS, not significant; NT, not tested; SAP, symptomatic apical periodontitis; ST, sinus tract; TET, tetracycline.

In the present survey, more than 80% of respondents reported routinely prescribing a 7-day course of antibiotics, which may be unnecessarily long. It is worth noting that the longer the duration of treatment, the greater the potential for adverse events such as gastrointestinal disturbances and the development of resistant strains. For example, when patients with orofacial odontogenic infections received beta-lactam antibiotics for 3 days or more, 50% or more of the cases acquired beta-lactamase–producing bacteria (31). Ideally, patients placed on antibiotics for an orofacial infection should be evaluated daily and the antibiotic therapy terminated once there is sufficient evidence that the patient's infection is resolving or resolved (22). However, the present survey indicates that the likelihood of this occurring is diminished, considering that 249 respondents prescribe antibiotics when not needed (Fig. 2); the most common reasons were because of patient insistence (36%) or when the patient or clinician had travel plans (32%).

An initial review of the raw data (Table 1) showed that males prescribed more often than females. However, males also saw more patients per week. After evaluating the data according to patient-prescribed antibiotics as a percentage of the total number of patients per week (WPP), linear regression analysis showed that sex played no role in antibiotic prescribing practices. Linear regression analyses also showed that respondents working in solo practice reported a higher WPP than those in the "other" category (military, academic, and corporate). However, the latter group accounted for less than 11.81% of respondents. The small sample size of this group combined with the feasibility that institutions and corporations might use a different practice model than private practice led us to interpret these results with caution. Analysis of the data additionally revealed that endodontists in the Southeast are significantly more likely to prescribe antibiotics than their peers in the Northeast. Interestingly, this aligns with recent outpatient monitoring reports conducted by the Centers for Disease Control and Prevention and others (32, 33); these yearly monitoring reports (2010–2015) revealed that practitioners in the South (particularly family practitioners) are more likely to prescribe antibiotics than their peers in the West.

Randomized controlled studies have shown that antibiotics are unnecessary in irreversible pulpitis (34). In 1977, Dorn et al (18) reported that 14.7% of patients with irreversible pulpitis and acute apical periodontitis were prescribed antibiotics. This decreased marginally to 13.7% in 1988 (19), increased to 25.4% in 1994 (20), and decreased to 13.29% in 1999 (21). Compared with 1999, in this study, the number of respondents prescribing antibiotics in cases of irreversible pulpitis alone and with symptomatic apical periodontitis decreased by over half to 1.7% and 6.4%, respectively (Table 4), which, although not statistically significant, is at least a positive trend. Nonetheless, a recent commentary indicates that enthusiasm for prescribing antibiotics for irreversible pulpitis is ongoing in the dental community (35) despite the lack of clinical efficacy (34).

The use of systemic antibiotics after adequate debridement and drainage in cases of necrotic pulp and localized endodontic infections and to prevent postoperative infection in endodontic surgical procedures has been shown to be ineffective in randomized clinical trials (36–38). Table 4 shows a significant decrease in the use of antibiotics across clinical scenarios involving necrotic pulp in the absence of spreading infection since the earlier studies were published, but no change for endodontic surgical procedures for which more than 40% of respondents routinely prescribe antibiotics. The decrease in prescribing practices for specific clinical pulpal diagnoses may be attributable to evidence-based support (34, 36, 37, 39, 40). In this study, almost 30% of respondents reported prescribing antibiotics for symptomatic patients with necrotic pulp and chronic apical abscesses (Table 2), a clinical scenario for which no evidence could be found. Similarly, for other types of clinical scenarios without evidence-based studies, a comparable reduction in the number of respondents who would prescribe antibiotics was not noted (Table 4). For example, the number of respondents who would prescribe antibiotics for postoperative pain control (12%) and gutta-percha retreatment (15%) is essentially unchanged from 1999. It could be speculated that when a provider is given (or makes) a diagnosis, it may provide a mental framework, allowing him or her to make a more objective prescription decision. On the other hand, when no diagnosis is given, practitioners may use a more subjective method (eg, based on past experiences) when making prescribing decisions.

Conclusions

Comparisons with previous studies show significant changes in prescribing patterns for both pulpal and periapical diagnoses (20) and antibiotic prescribing preferences (20, 21). There has been a significant shift from prescribing penicillin V to amoxicillin as the endodontist's first choice of antibiotic and an increase in the use of clindamycin for penicillin-allergic patients. Antibiotics are still prescribed in clinical situations for which they are typically not indicated. The type of practice (solo/group) and geographic region (Southeast) were significant predictors of increased antibiotic prescribing. More than one third of respondents reported prescribing antibiotics that are not necessary, most commonly because of patient expectations.

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