CROSS-SECTIONAL STUDY

Antibiotic Prescribing Patterns Among Dental Professionals In Massachusetts

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Abstract: ***Purpose:*** *The purposes of this study were to investigate prescribing patterns of antibiotics for the management of common pediatric oral infections, and to and identify the independent predictors of antibiotic preference across different groups of dental practitioners in Massachusetts, USA.* ***Methods:*** *A cross-sectional survey assessed antibiotic prescribing practices of general dentists, pediatric dentists, endodontists, and oral surgeons based on a series of clinical scenarios where antibiotic coverage may be warranted.* ***Results:*** *The appropriate therapeutic management of patients with facial cellulitis occurred across all clinical groups. Endodontists were least likely to prescribe antibiotics for patients with irreversible pulpitis, and those with pulpal necrosis with associated parulis. Seventy-four percent of respondents prescribed antibiotics for patients suffering from pericoronitis and trismus.* ***Conclusion:*** *With the exception of the management of facial cellulitis, adherence to published guidelines for the prescription of antibiotics is low. Specifically, antibiotics are being prescribed too often for patients with tooth pain or localized abscesses and infrequently when the systemic spread of infection is less obvious, such as with trismus but no fever. Universally promulgated guidelines formulated by professional bodies may lead to improved adherence and a reduction in negative outcomes resulting from the overprescription of antibiotics.* *(Pediatr Dent 2019;41(1):25-30) Received April 11, 2018 | Last Revision December 4, 2018 | Accepted December 10, 2018*

KEYWORDS: ANTIBIOTICS, PRESCRIBING, DENTISTS, SPECIALISTS

The prescription of antibiotics is an important adjunct in the management of orofacial infections. Dental practitioners account for 13.2 percent of all antibiotic prescriptions,[1] prescribing between seven percent and 11 percent of all common antibiotics, including betalactams, macrolides, tetracyclines, clindamycin, and metronidazole.[2] The judicious use of antibiotics can shorten periods of infection and reduce the risk of systemic involvement and the spread of infection to adjacent anatomical spaces.[3]

Overprescribing is wasteful and can cause unnecessary adverse effects. Multiple studies have documented the systemic overuse of antibiotics in dentistry. In Liverpool and Turkey, antibiotics are used inappropriately in 75 percent of cases involving dental conditions without signs of infection.[14,15] In Germany, 43 percent of patients have been needlessly prescribed antibiotics[16]; in Britain, 30 percent of patients receiving antibiotics lacked the proper indication.[17] In the United States, 52 percent of dentists prescribed antibiotics for irreversible pulpitis, and 62.5 percent for chronic apical abscesses.[18]

There are risks associated with the inappropriate use of antibiotics, including gastrointestinal disturbances, as antibiotics may alter the normal gut flora. Allergic responses, ranging from the development of a rash to anaphylactic reactions, are common. It is estimated that 100 to 300 deaths per year in the United States are due to a penicillin allergy.[19] Furthermore, multiple adverse drug reactions occur between commonly prescribed antibiotics such as erythromycin and clarithromycin and other drugs used for medical conditions.[20] The most serious complication of the widespread use of antibiotics is the development of bacterial resistance.[21]

Few efforts have been made to identify factors that account for the overprescription of antibiotics. Specialist dentists and recent graduates prescribed prophylactic antibiotics less frequently than general dentists, although the results were inconsistent.[22] Prescriptions fell by 50 percent after a consensus on the rationale for antibiotic use was published.[23] Subsequently, various organizations published guidelines to aid clinical decisions on antibiotic use, including the American Dental Association (**ADA**),[21] American Academy of Pediatric Dentistry (**AAPD**),[24] and the American Association of Endodontics (**AAE**)[25] (Figure 1). Antibiotic prescribing practices of pediatric dentists and general dentists reported disturbingly low levels of adherence to published guidelines, from 10 to 42 percent, dependent on the specific clinical scenario. Pediatric dentists prescribed antibiotics more judiciously than general dentists; moreover, rural clinicians were significantly less likely to adhere to professional guidelines than those in urban or suburban areas.[26]

Few studies have assessed patterns of antibiotic prescribing practices among U.S. dentists; fewer related their data to dental specialties. The purposes of this study were to investigate prescribing patterns for the management of common pediatric oral infections managed by dental practitioners in Massachusetts, USA, and identify the independent predictors of antibiotic preference.

Methods

Study population. Dental practitioners in Massachusetts included four groups: general practitioners (**GPs**), pediatric dentists (**PDs**), endodontists (**EDs**), and oral and maxillofacial surgeons (**OMSs**). A cross-sectional survey, approved by the Institutional Review Board of Boston Children's Hospital, Boston, Mass., assessed antibiotic prescribing practices of GPs, PDs, EDs, and OMSs. Electronic data capture software

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(REDCap, Vanderbilt University, Nashville, Tenn., USA) was utilized for both survey construction and data collection.[27] Practitioners' demographic information and four clinical scenarios (Figure 2) were remitted via electronic mail to 2,366 GPs, 760 PDs, 156 EDs, and 152 OMSs. All email addresses were collected from the Massachusetts Dental Society and Massachusetts Academy of Pediatric Dentistry websites.

The clinical scenarios warranting antibiotic coverage included one patient with facial cellulitis and fever and one patient with pericoronitis and trismus. The two scenarios not warranting antibiotic coverage included an afebrile patient with irreversible pulpitis and spontaneous nocturnal pain and an afebrile patient with a parulis secondary to pulpal necrosis. For each scenario, the clinician indicated whether an antibiotic would be prescribed and, if so, which would be chosen. Professional guidelines (AAPD and AAE) were used to measure adherence to recommended protocols. Because ADA guidelines do not provide clinical information about patients' signs and symptoms, the AAPD and AAE guidelines were relied on for determination of adherence.

Statistical analysis. Initial tests for normality (assessment for skewness, kurtosis, and Shapiro-Wilk) were performed to determine parametric and nonparametric univariate analysis testing. Categorical variables were analyzed using a chi-square analysis and a one-way analysis of variance. Crude estimates of effect (odds ratio) for each variable of interest and confidence interval estimates for chi-square tests of association were also determined. All statistical tests were two-sided; a value of $P<0.05$ was considered statistically significant. To account for the relationship of multiple predictors of practitioner experience, a multivariable logistic regression model determined the independent relationship of the predictors using a variable stepwise algorithm. A second multivariable logistic regression model identified independent predictors of antibiotic preference. To account for multiple testing,

Professional Guidelines for Antibiotic Use

ADA *

- Make an accurate diagnosis.
- Use appropriate antibiotics and dosing schedules.
- Consider using narrow-spectrum antibacterial drugs in simple infections to minimize disturbance of the normal microflora, and preserve the use of broad-spectrum drugs for more complex infections.
- Avoid unnecessary use of antibacterial drugs in treating viral infections.
- If treating empirically, revise treatment regimen based on patient progress or test results.
- Obtain thorough knowledge of the side effects and drug interactions of an antibacterial drug before prescribing it.
- Educate the patient regarding proper use of the drug and stress the importance of completing the full course of therapy (that is, taking all doses for the prescribed treatment time).
- Diagnosis and antibiotic selection should be based on thorough medical and dental history.
- Weigh the known risks against the potential benefits of antibiotic use.
- Use antibacterial drugs in a prudent and appropriate manner.

AAPD †

- Oral wound management: Antibiotic therapy should be considered with oral wounds that are at an increased risk of bacterial contamination; examples are soft-tissue lacerations, complicated crown fractures, severe tooth displacement, extensive gingivectomy and severe ulcerations.
- Pulpitis/apical periodontitis/draining sinus tract localized intraoral swelling: If a child has acute symptoms of pulpitis and the infection is contained within the pulpal tissue or the immediate surrounding tissue, treatment should be performed and an antibiotic should not be prescribed.
- Acute facial swelling of dental origin: Facial swelling secondary to a dental infection should receive immediate dental attention; depending on clinical findings, treatment may consist of treating or extracting the tooth or teeth in question with antibiotic coverage or prescribing antibiotics for several days to contain the spread of infection and then treating the involved tooth or teeth.
- Dental trauma: Application of an antibiotic to the root surface of an avulsed tooth is recommended to prevent resorption and increase rate of pulpal revascularization; the need for systemic antibiotics with avulsed teeth is unclear.
- Pediatric periodontal diseases: In pediatric perio-dontal diseases associated with systemic diseases such as neutropenia, Papillon-LeFevre syndrome, and leukocyte adhesion deficiency, antibiotic therapy is indicated.

AAE ‡

- Indications for adjunctive antibiotics
  - Fever >100°F
  - Malaise
  - Lymphadenopathy
  - Trismus
  - Increased swelling
  - Cellulitis
  - Osteomyelitis
  - Persistent infection
- Conditions not requiring adjunctive antibiotics
  - Pain without signs and symptoms of infection
    - Symptomatic irreversible pulpitis
    - Acute periradicular periodontitis
  - Teeth with necrotic pulps and a radiolucency
  - Teeth with a sinus tract (chronic periradicular abscess)
  - Localized fluctuant swellings

Figure 1. Current professional guidelines for therapeutic antibiotic use.

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† Adapted with permission from the American Academy of Pediatric Dentistry, Council on Clinical Affairs.[24]

‡ Reprinted with permission from the American Association of Endodontists.[25]

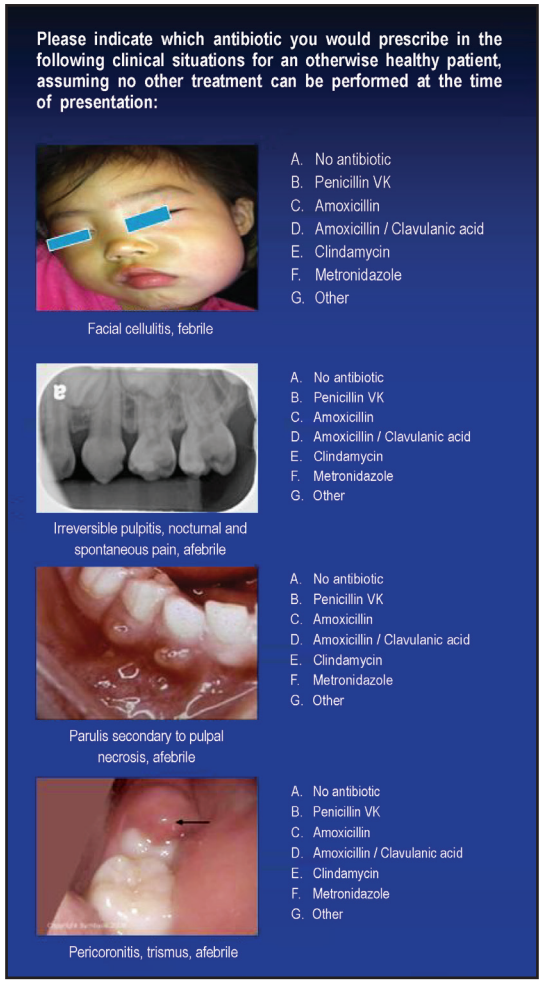

Figure 2. Representation of the survey sent to each participant.

Table 1. PERCENT OF PRACTITIONERS IN FOUR SPECIALTY GROUPS WHO SAY THEY WOULD PRESCRIBE ANTIBIOTICS IN EACH OF FOUR CLINICAL SCENARIOS

Clinical scenario	General dentistry	Pediatric dentistry	Endodontics	OMFS
Cellulitis* (%)	99	100	100	100
Pulpitis† (%)	48	50	3‡	47
Parulis† (%)	60‡	41	20§	49
Pericoronitis* (%)	79‡	58	89‡	95‡
Maximum column (N)	396	197	36	43

OMFS = Oral and maxillofacial surgeons.
* Scenario warranting antibiotics (thus % adherence).
† Scenario not warranting antibiotics (thus % adherence =100% – percent shown).
‡ Significantly different from pediatric dentistry at $P<0.005$ (logistic regression).
§ Significantly different from pediatric dentistry at $P<0.01$ (logistic regression).

Table 2. PERCENT OF PRACTITIONERS WHO HAVE BEEN IN PRACTICE LESS THAN 10 YEARS VERSUS 10 OR MORE YEARS WHO SAY THEY WOULD PRESCRIBE ANTIBIOTICS IN EACH OF FOUR CLINICAL SCENARIOS

Clinical scenario	<10 years	≥10 years
Cellulitis * (%)	100	100
Pulpitis† (%)	39‡	47
Parulis† (%)	45‡	54
Pericoronitis * (%)	70	76
Maximum column (N)	146	523

* Scenario warranting antibiotics (thus % adherence).
† Scenario not warranting antibiotics (thus % adherence =100% – percent shown).
‡ Significantly different from the ≥10 years group at $P<0.01$ (Fisher's exact test).

Table 3. PERCENT OF PRACTITIONERS IN FOUR SPECIALTY GROUPS WHO NAMED A PARTICULAR ANTIBIOTIC IN THE CLINICAL SCENARIO OF CELLULITIS*

Clinical scenario	General dentistry	Pediatric dentistry	Endodontics	OMFS
Penicillin (%)	24	23	25	21
Amoxicillin (%)	31	24	17	19
Amoxicillin + clavulanic acid (%)	17	24	22	28
Clindamycin (%)	24	26	36	23
Metronidazole (%)	1	0	0	0
Other (%)	3	5	0	9
Column (N)	393	197	36	43

OMFS = Oral and maxillofacial surgeons.
* No differences among specialty groups by Pearson's chi-square test=16.1699; $P=0.184$.

corrections were made for multiplicity using the Bonferonni method to reduce the likelihood of type one errors; the alpha level of significance for the score test statistic (SLS) and the Wald chi-square test statistic (SLE) was reduced to 0.01.

Previous electronic surveys conducted by the Dental Department at Boston Children's Hospital that sampled health care professionals yielded a 15 percent response rate. Based on a conservative estimate of a response rate range of 2.5 to 15 percent, a variance (H_0) of 0.1 for the regression model of eight predictors, and an alpha level of 0.05, the power calculations derived that 200 returns gave a power of 90 percent, while 300 gave a power of 98 percent. All data were analyzed using Stata 11.2 statistical software (StataCorp, College Station, Texas, USA).

Results

Among 3,434 surveys sent, 672 (20 percent) were returned; for the study groups, the response rate was 17 percent for GPs, (a significantly lower rate; $P<.005$), 26 percent for PDs, 23 percent for EDs, and 28 percent for OMSs. The study sample consisted of 59 percent GPs, 29 percent PDs, five percent EDs, and six percent OMSs. Notably, 22 percent of respondents had been in practice less than 10 years, and 78 percent for 10 or more years. Respondents were deemed to be compliant if they reported prescribing antibiotics for the appropriate collective signs and symptoms in clinical scenarios one and four (Tables 1 and 2).

Antibiotics were prescribed for facial cellulitis in 99 percent of responses, with no significant differences between clinicians or their years in practice. Thus, adherence to guidelines for facial cellulitis was impressive. Penicillin, amoxicillin, augmentin, and clindamycin were prescribed evenly among each of the clinical groups (Table 3).

Antibiotics were prescribed for irreversible pulpitis in 45 percent of responses. EDs (three percent) prescribed significantly less ($P<.005$) than all other dentists. Practitioners with less than 10 years' practice (39 percent) prescribed significantly less ($P<.05$) than those with 10 or more years' experience (47 percent). Thus, adherence for irreversible pulpitis ranged from 97 percent for EDs to around 50 percent for all other dentists. Penicillin and amoxicillin were prescribed evenly among GPs and OMSs, and PDs tended to favor amoxicillin over penicillin, although not significantly (Table 4).

Table 4. PERCENTAGE OF PRACTITIONERS WHO SPECIFIED A PARTICULAR ANTIBIOTIC TO BE PRESCRIBED IN ADDRESSING PULPITIS*

Clinical scenario	General dentistry	Pediatric dentistry	Endodontics	OMFS
Penicillin (%)	36	27	100	45
Amoxicillin (%)	54	68	0	55
Amoxicillin + clavulanic acid (%)	3	4	0	0
Clindamycin (%)	4	0	0	0
Metronidazole (%)	0	0	0	0
Other (%)	3	1	0	0
Column (N)	188	97	1	20

OMFS = Oral and maxillofacial surgeons.
* No differences among specialty groups by Pearson's chi-square=10.1290; $P=0.119$.

Table 5. PERCENTAGES OF PRACTITIONERS WHO CHOSE A PARTICULAR ANTIBIOTIC FOR PARULIS*

Clinical scenario	General dentistry	Pediatric dentistry	Endodontics	OMFS
Penicillin (%)	37	28	71	62
Amoxicillin (%)	51	68	28	38
Amoxicillin + clavulanic acid (%)	4	4	0	0
Clindamycin (%)	5	0	0	0
Metronidazole (%)	0.4	0	0	0
Other (%)	3	0	0	0
Column (N)	237	81	7	21

OMFS = Oral and maxillofacial surgeons.

* Endodontists and oral and maxillofacial surgeons are significantly more likely to prescribe penicillin, while general dentists and pediatric dentists are significantly more likely to prescribe amoxicillin. Pearson's chi-square=19.5479; *P*=0.003.

Table 6. PERCENTAGES OF PRACTITIONERS WHO SPECIFIED A PARTICULAR ANTIBIOTIC TO BE PRESCRIBED FOR PERICORONITIS*

Clinical scenario	General dentistry	Pediatric dentistry	Endodontics	OMFS
Penicillin	45	35	53	41
Amoxicillin	42	52	28	39
Amoxicillin + clavulanic acid	3	5	3	7
Clindamycin	5	2	13	10
Metronidazole	1	1	3	2
Other	4	5	0	0
Column (N)	310	115	32	41

OMFS = Oral and maxillofacial surgeons.

* No differences among specialty groups by Pearson's chi-square=8.5089; *P*=0.203.

Antibiotics were prescribed for pulpal necrosis with associated parulis in 52 percent of responses. EDs (20 percent) prescribed significantly less (*P*<.05) than other practitioners. Those with less than 10 years' experience (45 percent) prescribed significantly less (*P*<.05) than others with 10 or more years in practice (54 percent). Thus, adherence for this scenario ranged from 80 percent for EDs to 40 percent for GPs. GPs and PDs prescribed amoxicillin significantly more often (*P*<.05) than EDs and OMSs, who prescribed penicillin significantly more often (*P*<.05) than GPs and PDs (Table 5).

Antibiotics were prescribed for pericoronitis with trismus in 74 percent of responses. PDs (58 percent) prescribed significantly less (*P*<.05), than all other dentists, with no differences in the number of years of practice. Thus, the adherence for pericoronitis with trismus ranged from 95 percent for OMSs to 58 percent for PDs. Penicillin and amoxicillin were prescribed evenly among all specialties. EDs and OMSs also favored clindamycin, although not significantly more so than GPs and PDs (Table 6).

Discussion

This study investigated the use of therapeutic antibiotics in Massachusetts by GPs, PDs, EDs, and OMSs. We report low levels of adherence to published guidelines, with a trend toward the overprescription by dental practitioners. This finding concurs with previous studies. Only the prescribing practices of EDs were consistent with recommended practices in AAPD, ADA, and AAE guidelines.

We hypothesized a difference in antibiotic use between GPs and specialty dentists, as the latter usually have more comprehensive training. Additionally, AAPD and AAE guidelines are more specific than ADA Guidelines (Figure 1). We predicted that OMSs would practice a high level of adherence because of their extensive training. Surprisingly, the American Academy of Oral and Maxillofacial Surgery (**AAOMS**) does not have published guidelines on therapeutic antibiotic use. We hypothesized that recent graduates may be more likely to prescribe antibiotics more appropriately, possibly being more informed of current guidelines. Our data weakly support this prediction.

For facial cellulitis, there was virtual unanimity in the use of antibiotics. Clearly, antibiotics are necessary with the danger of anatomical spread of infection. In cases of irreversible pulpitis and pulpal necrosis with associated parulis, with no evidence of systemic spread, 50 percent of GPs, PDs, and OMSs still prescribed antibiotics. EDs were the only group who differed significantly (*P*<.005) from the others for cases of irreversible pulpitis and for cases of pulpitis with associated parulis (*P*<.05). These findings concur with data from previous studies by Dailey[14] and Salako.[5] Since GPs, PDs, and OMSs performed equally poorly in these scenarios, it was concluded that those additional years of specialist educational training were not a contributing factor to adherence to prescription guidelines.

However, the lack of clear guidelines could account for this finding. The AAOMS does not have published recommendations, and the ADA guidelines are vague. The most recent update to AAPD guidelines has provided further clarification for the appropriate use of adjunctive antimicrobial therapy. For example, for pulpitis and a draining sinus tract, AAPD guidelines state: "*treatment (i.e., pulpotomy, pulpectomy, or extraction) should be rendered,*" and "*antibiotic therapy usually is not indicated if the dental infection is contained within the pulpal tissue or the immediately surrounding tissue…the child will have no systemic signs of an infection (i.e., no fever and no facial swelling).*"[24] In the current study, instructions were given to clinicians as to whether an antibiotic was warranted in the context of no other treatment being rendered. AAPD guidelines have been recently edited to reflect that multiple studies demonstrate antibiotics are of no benefit for pulpitis or necrosis with or without associated parulis.[6-11]

For irreversible pulpitis and pulpal necrosis, there was a significant difference (*P*<.05) between clinicians in practice less than 10 years. We propose that recent graduate dentists are better able to recall the didactic principles of their undergraduate years and stay abreast of published guidelines and other primary literature. We also postulate that younger practitioners may be more aware of the growing problem of antibiotic resistance.

Antibiotics were indicated for cases of pericoronitis and trismus, which are signs of systemic infection. PDs performed significantly worse (*P*<.05) compared to all other dentists; EDs and OMSs performed the best. Notably, AAPD guidelines

lack specificity about clinical signs and symptoms that warrant antibiotics; consider the following: "*treatment may consist of prescribing antibiotics for several days to contain the spread of infection…*"[24] This statement relates to facial cellulitis; however, other signs and symptoms of systemic spread of infection are not delineated. Not surprisingly, EDs acted appropriately, as trismus is specifically listed as an objective sign warranting antibiotics. OMSs performed well for cases of pericoronitis and trismus, because they are experienced in the management of TMD.

The most commonly prescribed antibiotics by dentists are amoxicillin, penicillin V, metronidazole, amoxicillin, and clavulanate.[28] This pattern was reflected in the current study, where amoxicillin, penicillin, clavulanate, and clincamycin were the most favored antibiotic choices. Their use was encouraging based on current bacterial identification and susceptibility studies. *Prevotella*, *Porphyromonas*, *Fusobacterium*, and *Peptostreptococcus* predominate in odontogenic infections.[13,29] Periapical and third molar pericoronitis infections contain 68 percent gram-positive facultative anaerobes, 30 percent gram-negative strict anaerobes, and two percent gram-positive facultative anaerobes.[30] Penicillin remains the gold standard for treating dental infections, due to its efficacy in polymicrobial infections, relatively narrow spectrum for bacteria in endodontic infections, low toxicity, and low cost.[4,12,13,25] For more serious infections, amoxicillin is advised due to its greater efficacy, more rapid absorption, and higher and sustained serum levels, although its broader spectrum of activity may select for resistant bacteria.[12,25,30]

Amoxicillin with clavulanate is the most effective agent against susceptible oral microorganisms and may be used for serious infections and/or infections in which resistant species are suspected.[12,13,25,29,30] Clindamycin, has a high level of efficacy against both gram-positive facultative bacteria and anaerobes. This is a different action than the betalactam group, and it has excellent tissue penetration; it is an alternative for patients allergic to penicillin or for resistant bacterial strains.[12,13,25,29] Metronidazole alone has low efficacy for odontogenic resistant infections; it may be used if a patient's symptoms worsen 48 to 72 hours after initial treatment with a betalactam or macrolide alone.[12,13,25,29] In the current study, the only significant finding on the specific choice of antibiotic was that, in cases of pulpal necrosis and parulis, GPs and PDs prescribed amoxicillin more than EDs and OMSs, who favored penicillin. One explanation may be that GPs and PDs are more likely to see children in their practice rooms, for whom amoxicillin is dosed three times daily compared to four times daily for penicillin. Amoxicillin promotes better patient compliance.

Cases warranting antibiotic prescription require the choice of drugs with the highest efficacy and narrowest spectrum of activity. Prescribing the appropriate duration of therapy helps reduce adverse events and alleviates the problem of antibiotic resistance. Strains of virtually every oral microorganism exhibit varying degrees of antibiotic resistance common to all currently available antibiotics.[31,32] Patients should continue their course of antibiotics for two to three days after resolution of symptoms to prevent a rebound infection.[4,25] A seven-day course is usually adequate, as symptoms typically resolve two to four days after the source of an infection is removed.[25] Longer duration antibiotic courses increase the risk of destroying normal flora[33] and selecting for resistant bacterial strains.[34] Through interventions, including seminars, grand rounds, and a pocket-sized reference card, adherence to guidelines by the Pediatric Infectious Disease Society and the Infectious Disease Society of America rose to near 100 percent.[35]

The results of the present study need to be considered in light of some limitations. The cross-sectional nature of a survey limits the ability to draw causal inferences. Also, given that the surveys were completed voluntarily, the data were susceptible to self-selection bias; those dentists choosing to respond to the survey may not have been a representative sample of all dentists in Massachusetts. Responders may have been informed about the topic of antibiotic use. Furthermore, reporting bias is a concern, as dentists' responses may not truly reflect their actual practice. Taken together, these limitations suggest that dentists' adherence to the guidelines for antibiotic use may be worse than reported here. Notwithstanding these limitations, this study supports the need for publication of clear guidelines for all dentists when contemplating the use of antibiotics.

Conclusions

Based on this study's results, the following conclusions can be made:

1. With the exception of endodontists, dentists in Massachusetts display low adherence to published guidelines on the prescription of antibiotics.
2. Antibiotic therapy is likely prescribed too often for patients with odontogenic pain or a localized abscess and too infrequently when the systemic spread of an infection is less obvious, such as with trismus but no fever.
3. Although the choices of antibiotics were appropriate overall, clearer, more specific guidelines, as provided by the American Association of Endodontics, may lead to improved adherence and a reduction in the negative outcomes of overprescription of antibiotics.

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