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Concordance of Antibiotic Prescribing with the American Dental Association Acute Oral Infection Guidelines within Veterans Affairs (VA) Dentistry

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Abstract

Objective: United States dentists prescribe 10% of all outpatient antibiotics. Assessing appropriateness of antibiotic prescribing has been challenging due to a lack of guidelines for oral infections. In 2019, the American Dental Association (ADA) published clinical practice guidelines (CPG) on the management of acute oral infections. Our objective was to describe baseline national antibiotic prescribing for acute oral infections prior to the release of the ADA CPG and to identify patient-level variables associated with an antibiotic prescription.

Design: Cross-sectional analysis.

Methods: We performed an analysis of national VA data from 1/1/2017 – 12/31/2017. We identified cases of acute oral infections using ICD-10-CM codes. Antibiotics prescribed by a dentist within ± 7 days of a visit were included. Multivariable logistic regression identified patient-level variables associated with an antibiotic prescription.

Results: Of the 470,039 VA dental visits with oral infections coded, 12% of patient visits with irreversible pulpitis, 17% with apical periodontitis, and 28% with acute apical abscess received antibiotics. Although the median days' supply was 7, prolonged use of antibiotics was frequent (42–49% ≥8 days). Patients with high risk cardiac conditions, prosthetic joints, and endodontic, implant, and oral and maxillofacial surgery dental procedures were more likely to receive antibiotics.

Conclusions: The majority of irreversible pulpitis and apical periodontitis cases were found to be concordant with new ADA guidelines. However, in cases where antibiotics were prescribed, prolonged antibiotic courses greater than 7 days were frequent. These findings demonstrate opportunities for the new ADA guidelines to standardize and improve dental prescribing practices.

Introduction

In the United States (US), the majority of antibiotics are used in the outpatient setting with physicians prescribing 81% of outpatient antibiotics followed by dentists which prescribe 10% of all outpatient antibiotics.[1–4] Negative public health and patient-level outcomes are associated with antibiotic use such as increasing antimicrobial drug resistance and *Clostridioides* [formerly Clostridium] *difficile* infections (CDI).[5–7] Although dentists comprise a significant proportion of outpatient antibiotic prescribers, a lack of comprehensive, consensus guidelines within the US on treatment of acute oral infections has limited assessments of dental antibiotic prescribing.

In November of 2019, the American Dental Association (ADA) released its first clinical practice guideline (CPG) on the management of common acute oral infections.[8] This guideline addresses the role of antibiotics for irreversible pulpitis (IP), apical periodontitis (AP), and acute apical abscess (AAA). In this CPG, the ADA recommends short courses of amoxicillin or penicillin for three to seven days for common acute oral infections when antibiotics are indicated (See Table 1 for CPG recommendations summary). For most uncomplicated acute oral infections in immunocompetent patients without systemic signs of infection (fever, malaise, cellulitis), definitive source control with no adjunctive antibiotic therapy is the recommended course of treatment.[8] Examples of definitive source control include pulpotomy, pulpectomy, nonsurgical root canal treatment, extraction or incision for drainage of apical abscesses. For patients with acute apical abscesses with systemic involvement, amoxicillin or penicillin are recommended in addition to definitive source control.

With the recent release of the ADA CPG, the goal of this study was to identify historical concordance in patients treated in Department of Veterans Affairs (VA) facilities for IP, AP, and AAA. We analyzed national 2017 VA data prior to the release of the 2019 ADA CPG to identify opportunities to improve guideline concordance for antibiotic prescribing and guide future dental antimicrobial stewardship efforts.

Methods

This study was a retrospective cross-sectional analysis of national VA data from January 1, 2017 through December 31, 2017. The data were extracted from the VA Corporate Data Warehouse (CDW) which includes data on medical, dental, laboratory, and pharmacy encounters of Veterans who receive care at a VA facility.

Study Population

Dental visits within the study period with an associated International Statistical Classification of Diseases and Related Health Problems 10th revision (ICD-10) code for IP, AP, and AAA were included (See Supplemental Table 5). One patient could contribute multiple patient visits. In the United States, dentists typically document their dental procedure codes using Current Dental Terminology (CDT) and do not typically code using ICD-10. However, VA dentists code using ICD-10 and CDT codes providing an opportunity to more accurately assign a diagnosis (e.g., acute oral infection) with a prescription for an antibiotic. Inpatient dental encounters and outpatient telephone encounters were excluded from the analysis.

Study Definitions

IP, AP, and AAA all represent a continuum of acute oral infections with IP typically having a milder presentation. As a result, patient visits were classified in a hierarchical manner due to the potential for multiple non-mutually exclusive, acute oral infection ICD-10 codes.[9] Patient visits with only IP ICD-10 codes composed the IP group. Patient visits with AP ICD-10 codes were placed into the AP group. AP patient visits could also have IP ICD-10 codes. Patient visits with AAA ICD-10 codes were placed into the AAA group but could also have ICD-10 codes for IP and/or AP. An associated antibiotic prescription was defined as any oral antibiotic prescribed by a VA dentist +/−7 days from the dental visit, regardless of antibiotic treatment duration.

Covariates

Patient demographics, medical conditions, and CDT codes were extracted from the VA CDW. Dental visit CDT codes were aggregated into categories per a standardized coding structure established by the American Dental Association. Because multiple CDT codes could be coded for a visit, our analyses assessed visits with a specific CDT category coded as compared with visits without the CDT category coded. Additional variables collected include presence of high-risk cardiac conditions as defined by American Heart Association guidelines (AHA) (history of infective endocarditis, congenital heart condition, or prosthetic cardiac valve/material used for cardiac valve repair, and heart transplant recipients who develop cardiac valvulopathy),[10] presence of a prosthetic joint, patient demographics (age, sex, race, ethnicity), US Census Bureau region, number of dental procedures per visit, and Charlson comorbidity index. Cardiac conditions and prosthetic joints were identified from 1992 (the oldest data available in CDW) until the date of the dental visit. The Charlson comorbidity index was calculated 1 year prior to the dental visit.

Assessment of CPG Concordance

Guideline concordance was determined based on the recommendations of the November 2019 ADA CPG (table 1).[11] IP visits with an associated antibiotic prescription were deemed guideline discordant, as the ADA guideline recommends immediate source control (e.g., pulpectomy, pulpotomy, root canal, etc.), rather than antibiotics. Similarly, AP visits that received antibiotics were deemed guideline discordant. However, guideline concordance for AAA could not be assessed in this analysis. The ADA recommendations for the role of antibiotic therapy in the management of AAA depends on the presence of systemic signs of infection such as malaise, fever, and fascial space or lymph node involvement. Unfortunately, these data are not easily captured in administrative data.

Statistical Analysis

To describe the sample, we calculated frequencies, proportions, and unadjusted odds ratios and 95% confidence intervals (CIs) for demographic and medical characteristics and receipt of antibiotics with an independent t-test, Chi square, and Fisher's exact test. Multivariable logistic regression clustered within veteran to account for multiple visits for the same patient was used to identify variables associated with antibiotic prescribing for each infection. A different model was created for each infection. Beginning with variables that were statistically significant ($p<0.05$ or CI did not include 1) in the unadjusted analysis, variables with a p value ≥ 0.05 were then removed in a backwards selection process until the most parsimonious model was achieved.

All analyses were conducted with the statistical program SAS version 9.4 (SAS, Institute, Cary, NC).

Sensitivity Analysis

Three sensitivity analyses were conducted to assess the robustness of the primary analysis. In the first sensitivity analysis, visits associated with an antibiotic prescription of less than three days' duration were excluded, due to the potential for these prescriptions to be prophylaxis rather than treatment for an acute oral infection. In the second sensitivity analysis, visits for patients with high-risk cardiac conditions as defined by AHA guidelines were removed.[10] In the third sensitivity analysis, immunocompromised patients (defined as receiving chemotherapy in the previous year, immunosuppressive for conditions such as rheumatoid arthritis/systemic lupus erythematosus, ≥85 days of systemic steroid therapy in the previous 90 days, history of bone marrow, stem cell, solid organ transplant, or HIV/AIDS) were excluded, given that the ADA CPG do not address antibiotic therapy in immunocompromised patients.[11]

Results

After applying inclusion and exclusion criteria, 470,039 dental visits (318,422 unique patients) were identified in VA dental clinics with corresponding ICD-10 codes for IP (n=385,040), AP (n=33,938), and AAA (n=51,061) during 2017 (Figure 1). Patient demographics including median age, sex, race, and US region were similar across the three acute oral infection types (Table 2). Patients were predominantly male (90%) with an average age of 61 years old with most patients residing in the Southern United States.

Of the 470,039 VA dental visits with oral infections coded, 12% of IP, 17% of AP, and 28% of AAA visits were associated with antibiotic prescribing. Amoxicillin (59.8%) was prescribed most frequently for all infections (Supplemental Table 2) followed by clindamycin (14.3%). The most common antibiotics present in the “other” category in order of decreasing frequency include sulfamethoxazole/trimethoprim, ciprofloxacin, metronidazole, levofloxacin, nitrofurantoin, minocycline, and rifaximin. Although the median days’ supply was 7 days for patient visits associated with an antibiotic prescription, prolonged use of antibiotics was frequent (42.5% of IP visits, 44.9% of AP visits, 49.4% of AAA visits received antibiotics for ≥8 days) (Table 3).

Unadjusted Analysis

Female gender was protective against antibiotic prescribing for IP but positively associated with increased antibiotic prescribing for AP and AAA. With white race as a reference group, black race was associated with increased antibiotic prescribing for AAA while the category of other race (defined as not white, black or missing) was associated with decreased antibiotic prescribing for IP and AAA.

High-risk cardiac conditions, prosthetic joints, and CDT codes for endodontic procedures, implant procedures, and oral maxillofacial surgical procedures were associated with antibiotic prescribing for all three acute oral infection types. No further significant differences were observed among infection types when comparing characteristics associated with antibiotic prescribing (Table 2).

Adjusted Analysis

When compared with the Northeastern United States, patient visits occurring in the Western United States had lower odds of antibiotic prescribing for IP and AP (IP: aOR, [95% CI] 0.87 [0.83–0.91]; AP: 0.83 [0.73–0.94]). For AAA, the Midwest (aOR, [95% CI] 1.15 [1.05–1.27]) and the South (aOR, [95% CI] 1.21 [1.12–1.31]) were both associated with antibiotic prescribing. Patients with high-risk cardiac conditions, prosthetic joints, and endodontic, implant, and oral maxillofacial surgery procedures had higher odds of receiving antibiotics (Table 2). Presence of prosthetic joints were observed to have a greater association with antibiotic prescribing when compared to presence of high-risk cardiac conditions for IP (adjusted odds ratio (aOR), [95% CI] 1.69 [1.64–1.74] vs. 1.49 [1.44–1.54]), AP (aOR, [95% CI] 1.46 [1.33–1.61] vs. 1.29 [1.17–1.43]), and AAA (aOR, [95% CI] 1.34 [1.25–1.44] vs. 1.2 [1.11–1.29]).

Visits with preventive CDT codes were protective against antibiotic prescribing. In contrast, visits with oral maxillofacial surgery CDT codes had the highest association with antibiotic prescribing across all three infections (IP: aOR [95% CI] 4.96 [4.81–5.12]; AP: 3.55 [3.24–3.89]; AAA: 3.47 [3.28–3.67]) followed by implant codes (IP aOR [95% CI]: 3.16 [2.95–3.38]; AP: 4.13 [3.37–5.06]; AAA: 1.74 [1.45–2.1]) and endodontic codes (IP: aOR [95% CI] 2.4 [2.29–2.51]; AP: 1.64 [1.48–1.82]; AAA: 1.89 [1.77–2.03]).

The three sensitivity analyses produced similar results when compared to the full analysis (Tables 2, 3, and 4 in the Supplement). Notable variables which remained associated with antibiotic prescribing for IP and AP after performing sensitivity analyses included a presence of prosthetic joint and presence of CDT codes for implant procedures, endodontic procedures, and oral maxillofacial surgical procedures.

Discussion

Our findings demonstrate that antibiotic prescribing for oral infections by VA dentists was mostly consistent with the ADA CPG prior to its release: 88.3% of IP and 82.6% of AP visits did not receive antibiotics and, thus, were consistent with the guidelines. However, 11.7% of IP visits and 17.4% of AP visits were associated with potentially unnecessary antibiotic prescriptions. Prolonged use of antibiotics was frequent for visits that were associated with antibiotic prescribing (42.5% of IP visits, 44.9% of AP visits, 49.4% of AAA visits received antibiotics for ≥8 days). Interestingly, the Western U.S had lower odds of antibiotic prescribing for IP and AP while the Midwest was associated with antibiotic prescribing for IP. These geographic trends are consistent with work done in primary care medical clinics,[12] but are inconsistent with the highest prevalence of unnecessary antibiotic prophylaxis in the Western US.[13] Furthermore, specific dental procedure categories were associated with antibiotic prescribing for all infection types including oral maxillofacial surgery, tooth implants, and root canals (endodontic procedures). The guideline-discordant antibiotic prescribing observed within the study may represent unnecessary antibiotic prescribing placing patients at increased risk of adverse events without providing any meaningful benefit.[14] Antimicrobial stewardship programs which have reduced unnecessary dental antibiotics through employment of education and institutional guidelines have been successfully implemented in other facilities, therefore showing potential for this prescribing group.[15]

It is important to highlight that not all antibiotics used for acute oral infections carry the same risk of adverse events. Clindamycin, a lincosamide antibiotic, has a higher likelihood of causing *C. difficile* infections relative to other antibiotic agents and carries a significantly higher rate of fatal adverse drug reactions when compared to penicillins.[16–19] *C. difficile* is an infection which not only causes great economic losses to society, but also imparts deep suffering for patients and their families.[5] Efforts to reduce unnecessary clindamycin usage has been executed successfully with significant decreases in CDI.[20,21] One teaching hospital observed a >80% reduction in CDI following the restriction of clindamycin in their orthopedic ward.[20] With dentists currently being the top prescribers of clindamycin,[22] reducing use of clindamycin by limiting treatment durations and promoting first-line use of amoxicillin or clindamycin alternatives in penicillin-allergic patients, for acute oral infections is critical. To achieve the latter, antimicrobial stewardship efforts geared towards thorough investigation of beta-lactam allergy history can mitigate unnecessary clindamycin use.

With higher rates of adverse effects occurring with prolonged exposure to antibiotic therapies, using the shortest effective course is a prudent practice.[23–26] Antibiotic courses of three to five days for acute oral infections are likely as effective as seven-day courses.[8] Although there is a paucity of literature supporting three-day versus seven-day courses for acute oral infections, similar studies from medical literature support using the shortest effective treatment to maximize benefit while minimizing risk of antibiotic collateral damage.[24−26]

VA dental patients are more medically compromised than the general population with a higher rate of expected poor healing.[27] Although in the full model the Charlson comorbidity index was not significant, when excluding those patients with probable premedication dosing or immunocompromised status, a higher Charlson comorbidity index did become significant. These patients may be considered more medically compromised than the general population described in the ADA guidelines.

Although most antimicrobial stewardship interventions have been conducted in inpatient settings, there has been an increasing focus on outpatient antimicrobial stewardship, including some successful dental stewardship interventions.[25,26] Previous studies have shown both audit/feedback and education to be effective in curbing inappropriate dental antibiotic prescribing while also promoting accuracy in agent and dose selection.[28,29] A recent study showed that implementation of a dental antibiotic stewardship program was successful in reducing antibiotic prescribing rates for acute oral infections by more than 70%. This stewardship program formulated an institutional guideline with recommendations largely consistent with the ADA CPG. As a behavioral “nudge”, recommendations in the institutional guideline were provided in a poster format and hung chairside (next to the dental chair). The results of the study confirm that implementing measures to promote adherence to the ADA CPG recommendations are a feasible and effective approach to curbing unnecessary antibiotic use.[15] Due to the association of antibiotic prescribing with oral and maxillofacial surgery, implant procedures, and endodontic procedures across all infection types observed in this study, it seems reasonable for a dental stewardship program to implement focused initiatives with the goal of preventing unnecessary antibiotic use for patients undergoing these specific procedures.

A limitation of this work is that the results are dependent on the accuracy of ICD-10 coding in the dental setting; prescribing data suggests that antibiotics were prescribed for extra-oral infections (e.g, nitrofurantoin, rifaximin). An additional limitation is the study population includes only Veterans seen within the Veterans Health Administration national healthcare system which may not be representative of the general population. Dental visits associated with antibiotic courses shorter than three days and prescribed to patients with high risk cardiac conditions or receiving dental implants were not excluded in the primary analysis and thus pre-procedure prophylactic antibiotics may have been incorporated into the data. Patients without access to oral health care and those presenting to emergency/urgent care with oral conditions were not included. Thus, these results are not generalizable to antibiotic prescribing for oral infections in these groups. Additionally, the ADA guidelines provide recommendations for immunocompetent patients exclusively, but immunocompromised patients were not excluded from the current study. However, sensitivity analyses were performed which excluded visits with patients with immunocompromising conditions. To account for the possibility that the antibiotic was prescribed for prophylaxis (vs treatment of an oral infection), additional sensitivity analysis excluded patient visits that received antibiotic courses shorter than three days and patients with high-risk cardiac conditions. These three sensitivity analyses produced similar results to our primary analysis. Systemic signs of infection including extending infection, fever, and generalized malaise were not collected making assessment of ADA guideline concordance for the treatment of AAA not feasible. Finally, these findings are based on data prior to publication of the ADA guidelines, and thus practice may have changed since the study period.

Regardless, the findings of this study suggest an opportunity for improving judicious antibiotic use in the outpatient dental setting by promoting concordance with the ADA acute oral infection guidelines. Due to ICD-10 codes not being commonly used in private sector dental clinics, these unique VA data provide valuable insight into dental antibiotic prescribing practices for specific acute oral infections. These data provide additional evidence for antimicrobial stewardship initiatives targeting the reduction in the use of unnecessary antibiotics for IP and AP cases, especially for prolonged courses. Decreasing antibiotics prescribed for oral infections can lead to reductions in community-onset *Clostridioides difficile* infections and infections caused by multidrug resistant organisms.[30]

Prior to the release of the ADA guidelines, 88.3% and 82.6% of IP and AP visits in the VA setting were concordant with the ADA guidelines. Data from the current study identifies opportunities to improve acute oral infection antibiotic prescribing in outpatient dental settings. These results may serve as a benchmark for future outpatient antimicrobial stewardship efforts within the dental setting. Opportunities for future work in this area include the assessment of guideline concordance of antibiotic prescribing for AAA as well as acute oral infection antibiotic prescribing practices for both emergency department settings and for populations without access to health care.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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References:

1. Suda KJ, Hicks LA, Roberts RM, Hunkler RJ, Matusiak LM, Schumock GT. Antibiotic expenditures by medication, class, and healthcare setting in the United States, 2010–2015. Clin Infect Dis 2018; 66: 185–90. [PubMed: 29020276]
2. Hicks LA, Bartoces MG, Roberts RM, et al. US outpatient antibiotic prescribing variation according to geography, patient population, and provider specialty in 2011. Clin Infect Dis 2015; 60: 1308–1316. [PubMed: 25747410]
3. Suda KJ, Roberts RM, Hunkler RJ, Taylor TH. Antibiotic prescriptions in the community by type of provider in the United States, 2005–2010. J Am Pharm Assoc (2003) 2016; 56: 621–621.e1. [PubMed: 27745794]
4. Durkin MJ, Hsueh K, Sallah YH, et al. An evaluation of dental antibiotic prescribing practices in the United States. J Am Dent Assoc 2017; 148: 878–886.e1. [PubMed: 28941554]
5. Centers for Disease Control and Prevention (CDC). Antibiotic resistance threats in the United States, 2013. cdc.gov/drugresistance/threat-report-2013/pdf/ar-threats-2013-508.pdf. Accessed September 24, 2018.
6. World Health Organization. Antibiotic resistance: Global report on surveillance, 2014. http://www.who.int/drugresistance/documents/surveillancereport/en/. Accessed September 1, 2018.
7. Dantes R, Mu Y, Hicks LA, et al. Association between outpatient antibiotic prescribing practices and community-associated *Clostridium difficile* infection. Open Forum Infect Dis 2015; 2: ofv113. [PubMed: 26509182]
8. Antibiotic use for the emergency management of dental pain and swelling clinical practice guideline, 2019. https://ebd.ada.org/en/evidence/guidelines/antibiotics-for-dental-pain-and-swelling. Accessed June 23, 2019.
9. Chow AW. Infections of the Oral Cavity, Neck, and Head. In: Bennett JE, Dolin R, Blaser MJ. Mandell, Douglas, and Bennett's Principles and Practice of Infectious Diseases. Updated 8th ed. Philadelphia, PA: Saunders, an Imprint of Elsevier Inc., 2015; 789–800.
10. Wilson W, Taubert KA, Gewitz M, et al. Prevention of infective endocarditis: Guidelines from the American Heart Association: A guideline from the American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee, Council on Cardiovascular Disease in the Young, and the Council on Clinical Cardiology, Council on Cardiovascular Surgery and Anesthesia, and the Quality of Care and Outcomes Research Interdisciplinary Working Group. Circulation 2007; 116: 1736–1754. [PubMed: 17446442]
11. American Dental Association Clinical Practice Guideline on the Use of Antibiotics for the Emergency Management of Symptomatic Irreversible Pulpitis, Symptomatic Apical Periodontitis, and Localized Acute Apical Abscess, 2019. https://jada.ada.org/article/S0002-8177(19)30617-8/fulltext. Accessed January 15, 2019.
12. Fleming-Dutra KE, Hersh AL, Shapiro DJ, et al. Prevalence of inappropriate antibiotic prescriptions among US ambulatory care visits, 2010–2011. JAMA 2016; 315: 1864–1873. [PubMed: 27139059]
13. Suda KJ, Calip GS, Zhou J, et al. Assessment of the appropriateness of antibiotic prescription for infection prophylaxis before dental procedures, 2011 to 2015. JAMA Netw Open 2019; 2: e193090.
14. Thornhill MH, Dayer MJ, Prendergast B, Baddour LM, Jones S, Lockhart PB. Incidence and nature of adverse reactions to antibiotics used as endocarditis prophylaxis. J Antimicrob Chemother 2015; 70: 2382–8. [PubMed: 25925595]

15. Gross AE, Hanna D, Rowan SA, Bleasdale SC, Suda KJ. Successful implementation of an antibiotic stewardship program in an academic dental practice. Open Forum Infect Dis 2019; 6: ofz067. [PubMed: 30895206]
16. Gross AE, Suda KJ, Zhou Z, et al. Serious antibiotic-related adverse effects following unnecessary dental prophylaxis in the United States. Infect Control Hosp Epidemiol. 2020 (epub ahead of print).
17. Deshpande A, Pasupuleti V, Thota P, et al. Community-associated *Clostridium difficile* infection and antibiotics: a meta-analysis. J Antimicrob Chemother 2013; 68: 1951–61. [PubMed: 23620467]
18. Thornhill MH, Dayer MJ, Durkin MJ, Lockhart PB, Baddour LM. Risk of adverse reactions to oral antibiotics prescribed by dentists. J Dent Res 2019; 98: 1081–1087. [PubMed: 31314998]
19. Teng C, Reveles KR, Obodozie-ofoegbu OO, Frei CR. Infection risk with important antibiotic classes: an analysis of the FDA Adverse Event Reporting System. Int J Med Sci 2019; 16: 630–635. [PubMed: 31217729]
20. Cruz-rodríguez NC, Hernández-garcía R, Salinas-caballero AG, Pérez-rodríguez E, Garza-gonzález E, Camacho-ortiz A. The effect of pharmacy restriction of clindamycin on Clostridium difficile infection rates in an orthopedics ward. Am J Infect Control 2014; 42: e71–3. [PubMed: 24837129]
21. Climo MW, Israel DS, Wong ES, Williams D, Coudron P, Markowitz SM. Hospital-wide restriction of clindamycin: effect on the incidence of *Clostridium difficile*-associated diarrhea and cost. Ann Intern Med 1998; 128: 989–95. [PubMed: 9625685]
22. Suda KJ, Roberts RM, Hunkler RJ, Taylor TH. Antibiotic prescriptions in the community by type of provider in the United States, 2005–2010. J Am Pharm Assoc (2003) 2016; 56: 621–6 e1. [PubMed: 27745794]
23. Tamma PD, Avdic E, Li DX, Dzintars K, Cosgrove SE. Association of adverse events with antibiotic use in hospitalized patients. JAMA Intern Med 2017; 177(9): 1308–1315. [PubMed: 28604925]
24. Vaughn VM, Flanders SA, Snyder A, et al. Excess antibiotic treatment duration and adverse events in patients hospitalized with pneumonia: A multihospital cohort study. Ann Intern Med 2019; 171: 153–163. [PubMed: 31284301]
25. Spellberg B. The maturing antibiotic mantra: “shorter is still better”. J Hosp Med 2018; 13: 361.362. [PubMed: 29370317]
26. Royer S, Demerle KM, Dickson RP, Prescott HC. Shorter versus longer courses of antibiotics for infection in hospitalized patients: A systematic review and meta-analysis. J Hosp Med 2018; 13: 336–342. [PubMed: 29370318]
27. Jurasic MM, Gibson G, Wehler CJ, Orner MB, Jones JA. Caries prevalence and associations with medications and medical comorbidities. J Public Health Dent 2019; 79: 34–43. [PubMed: 30440082]
28. Chate RA, White S, Hale LR, et al. The impact of clinical audit on antibiotic prescribing in general dental practice. Br Dent J 2006; 201: 635–41. [PubMed: 17128233]
29. Seager JM, Howell-jones RS, Dunstan FD, Lewis MA, Richmond S, Thomas DW. A randomised controlled trial of clinical outreach education to rationalise antibiotic prescribing for acute dental pain in the primary care setting. Br Dent J 2006; 201: 217–22. [PubMed: 16902573]
30. Tampi MP, Pilcher L, Urquhart O, et al. Antibiotics for the urgent management of symptomatic irreversible pulpitis, symptomatic apical periodontitis, and localized acute apical abscess: Systematic review and meta-analysis-a report of the American Dental Association. J Am Dent Assoc 2019; 150: e179–e216. [PubMed: 31761029]

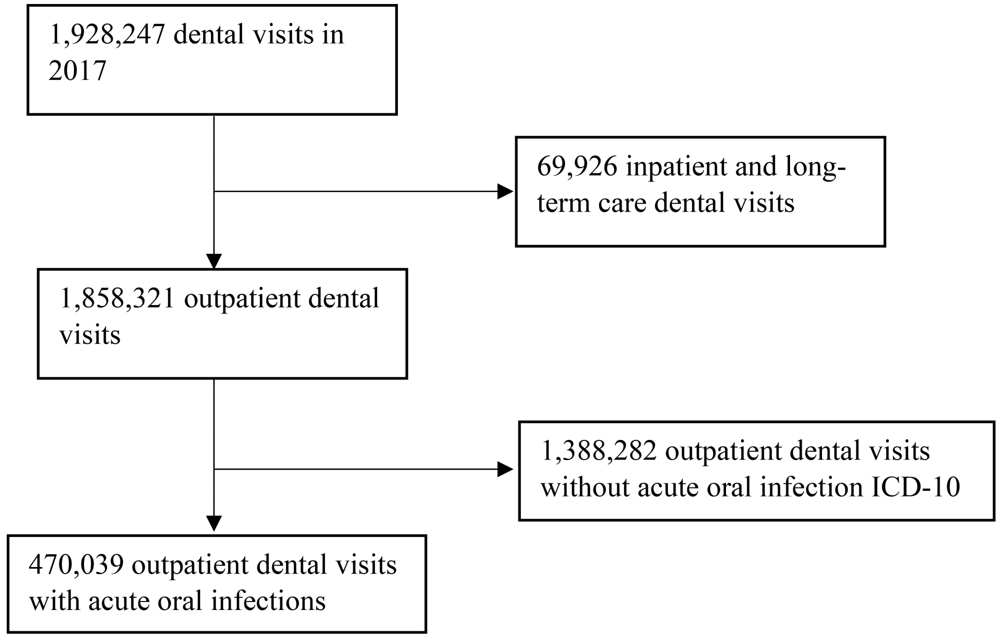

Figure 1.
Study flowchart.

Table 1.

Summary of ADA recommendations where source control is an immediate option for immunocompetent patients

Acute Oral Infection	**2019 ADA Draft Guideline Antibiotic Recommendation**
Irreversible Pulpitis	Antibiotics not recommended
Apical Periodontitis	Antibiotics not recommended
Acute Apical Abscess without systemic involvement	Antibiotics not recommended
Acute Apical Abscess with systemic involvement	Antibiotics recommended • *Penicillin VK or Amoxicillin 3–7 days*

ADA: American Dental Association

Table 2.

Characteristics of eligible dental visits in 2017 and unadjusted and adjusted associations by acute oral infection type

Irreversible Pulpitis								
		Frequencies			**Odds Ratios (95% Confidence Intervals)**			
Variable	**Value**	**Total No. (%) N=385040**	**Antibiotic prescribed No. (%) n=45240 (11.7%)**	**No antibiotic prescribed No. (%) n=339800 (88.3%)**	**Unadjusted OR (95% CL)**	**p-value**	**Adjusted OR (95% CL)**	**p-value**
Age	Mean(SD), range(Median)	61.76 (13.56) 19–103 (66)	62.45 (12.92) 20–99 (66)	61.67 (13.64) 19–103 (66)				
Race	White	260392 (67.6)	30610 (11.8%)	229782 (88.2%)	Reference		Reference	
	Black	88269 (22.9)	10592 (12%)	77677 (88%)	1.02 (1–1.05)	0.0521	-	-
	Other	15266 (4%)	1659 (10.9%)	13607 (89.1%)	0.92 (0.87–0.96)	0.0009	-	-
	Missing	21113 (5.5)	2379 (11.3%)	18734 (88.7%)	0.95 (0.91–1)	0.0346	-	-
Gender	Male	349620 (90.8)	41213 (11.8%)	308407 (88.2%)	Reference		Reference	
	Female	35420 (9.2)	4027 (11.4%)	31393 (88.6%)	0.96 (0.93–0.99)	0.0199	-	-
U.S. region	Northeast	52813 (13.7)	6235 (11.8%)	46578 (88.2%)	Reference		Reference	
	Midwest	67304 (17.5)	9155 (13.6%)	58149 (86.4%)	1.18 (1.14–1.22)	<0.0001	1.21 (1.16–1.26)	<0.0001
	South	175472 (45.6)	20700 (11.8%)	154772 (88.2%)	1 (0.97–1.03)	0.9571	1.04 (1–1.08)	0.0546
	West	84253 (21.9)	8568 (10.2%)	75685 (89.8%)	0.85 (0.82–0.88)	<0.0001	0.87 (0.83–0.91)	<0.0001
	Other/Missing	5198 (1.3)	582 (11.2%)	4616 (88.8%)	0.94 (0.86–1.03)	0.1983	1.03 (0.93–1.14)	0.6065
Cardiac condition	Yes	51788 (13.5)	8313 (16.1%)	43475 (83.9%)	1.53 (1.5–1.57)	<0.0001	1.49 (1.44–1.54)	<0.0001
Prosthetic joint	Yes	61508 (16)	10490 (17.1%)	51018 (82.9%)	1.71 (1.67–1.75)	<0.0001	1.69 (1.64–1.74)	<0.0001
CDT Procedure Code Present	Adjunct procedure		4446 (13.3%)	28973 (86.7%)	1.17 (1.13–1.21)	<0.0001	1.2 (1.15–1.24)	<0.0001
	Diagnostic procedure	166444 (43.2)	24277 (14.6%)	142167 (85.4%)	1.61 (1.58–1.64)	<0.0001	1.51 (1.47–1.56)	<0.0001
	Endodontic procedure	15939 (4.1)	3017 (18.9%)	12922 (81.1%)	1.81 (1.74–1.88)	<0.0001	2.4 (2.29–2.51)	<0.0001
	Implant procedure	4069 (1.1)	1343 (33%)	2726 (67%)	3.78 (3.54–4.04)	<0.0001	3.16 (2.95–3.38)	<0.0001
	Maxillofacial prosthetics	563 (0.1%)	61 (10.8%)	502 (89.2%)	0.91 (0.7–1.19)	0.5554	-	-

	Oral maxillofacial surgical procedure	32999 (8.6)	12258 (37.1%)	20741 (62.9%)	5.72 (5.58–5.86)	<0.0001	4.96 (4.81–5.12)	<0.0001
	Orthodontic procedure	240 (0.1)	9 (3.8%)	231 (96.3%)	0.29 (0.15–0.57)	<0.0001	0.31 (0.16–0.59)	0.0004
	Periodontic procedure	60606 (15.7)	5086 (8.4%)	55520 (91.6%)	0.65 (0.63–0.67)	<0.0001	0.76 (0.73–0.79)	<0.0001
	Preventive procedure	91639 (23.8)	5849 (6.4%)	85790 (93.6%)	0.44 (0.43–0.45)	<0.0001	0.6 (0.58–0.62)	<0.0001
	Removable prosthodontic procedure	16449 (4.3)	1514 (9.2%)	14935 (90.8%)	0.75 (0.71–0.79)	<0.0001	0.69 (0.65–0.73)	<0.0001
	Fixed prosthodontic procedure	6153 (1.6)	441 (7.2%)	5712 (92.8%)	0.58 (0.52–0.63)	<0.0001	0.65 (0.58–0.72)	<0.0001
	Restorative procedure	101639 (26.4)	8105 (8%)	93534 (92%)	0.57 (0.56–0.59)	<0.0001	0.62 (0.6–0.64)	<0.0001
Apical Periodontitis								
		Frequencies			**Odds Ratios (95% Confidence Intervals)**			
Variable	**Value**	**Total No. (%) N=33938**	**Antibiotic prescribed No. (%) n=5922 (17.4%)**	**No antibiotic prescribed No. (%) n=28016 (82.6%)**	**Unadjusted OR (95% CL)**	**p-value**	**Parsimonious Adjusted OR (95% CL)**	**p-value**
Age	Mean(SD), range(Median)	60.7 (13.97) 20–98 (64)	60.38 (12.92) 21–98 (64)	60.76 (12.98) 20–98 (65)				
Race	White	21433 (63.2)	3751 (17.5%)	17682 (82.5%)	Reference		Reference	
	Black	8821 (26%)	1543 (17.5%)	7278 (82.5%)	1 (0.94–1.07)	1	-	-
	Other	1593 (4.7%)	270 (16.9%)	1323 (83.1%)	0.96 (0.84–1.1)	0.6079	-	-
	Missing	2091 (6.2)	358 (17.1%)	1733 (82.9%)	0.97 (0.86–1.1)	0.6949	-	-
Gender	Male	30284 (89.2)	5216 (17.2%)	25068 (82.8%)	Reference		Reference	
	Female	3654 (10.8)	706 (19.3%)	2948 (80.7%)	1.15 (1.05–1.26)	0.0018		
U.S. region	Northeast	4796 (14.1)	848 (17.7%)	3948 (82.3%)	Reference		Reference	
	Midwest	5346 (15.8)	919 (17.2%)	4427 (82.8%)	0.97 (0.87–1.07)	0.5292	0.95 (0.83–1.09)	0.47
	South	14687 (43.3)	2818 (19.2%)	11869 (80.8%)	1.11 (1.02–1.2)	0.0204	1.11 (0.99–1.24)	0.0758
	West	8858 (26.1)	1286 (14.5%)	7572 (85.5%)	0.79 (0.72–0.87)	<0.0001	0.83 (0.73–0.94)	0.003
	Other/Missing	251 (0.7%)	51 (20.3%)	200 (79.7%)	1.19 (0.87–1.63)	0.3095	1.26 (0.88–1.8)	0.2044
Cardiac condition	Yes	4460 (13.1)	936 (21%)	3524 (79%)	1.3 (1.21–1.41)	<0.0001	1.29 (1.17–1.43)	<0.0001
Prosthetic joint	Yes	5261 (15.5)	1194 (22.7%)	4067 (77.3%)	1.49 (1.38–1.6)	<0.0001	1.46 (1.33–1.61)	<0.0001

CDT Procedure Code Present	Adjunct procedure	3763 (11.1)	825 (21.9%)	2938 (78.1%)	1.38 (1.27–1.5)	<0.0001	1.34 (1.22–1.47)	<0.0001
	Diagnostic procedure	15492 (45.6)	3518 (22.7%)	11974 (77.3%)	1.96 (1.85–2.08)	<0.0001	-	-
	Endodontic procedure	3248 (9.6%)	757 (23.3%)	2491 (76.7%)	1.5 (1.38–1.64)	<0.0001	1.64 (1.48–1.82)	<0.0001
	Implant procedure	484 (1.4)	230 (47.5%)	254 (52.5%)	4.42 (3.69–5.29)	<0.0001	4.13 (3.37–5.06)	<0.0001
	Maxillofacial prosthetics	37 (0.1)	7 (17.9%)	32 (82.1%)	1.03 (0.46–2.35)	0.8355	-	-
	Oral maxillofacial surgical procedure	2755 (8.1)	1218 (44.2%)	1537 (55.8%)	4.46 (4.11–4.84)	<0.0001	3.55 (3.24–3.89)	<0.0001
	Orthodontic procedure	18 (0.1)	1 (5.6%)	17 (94.4%)	0.28 (0.04–2.09)	0.3454	-	-
	Periodontic procedure	10621 (31.3)	1357 (12.8%)	9264 (87.2%)	0.6 (0.56–0.64)	<0.0001	0.55 (0.51–0.59)	<0.0001
	Preventive procedure	2618 (7.7)	217 (8.3%)	2401 (91.7%)	0.41 (0.35–0.47)	<0.0001	0.39 (0.33–0.45)	0.0079
	Removable prosthodontic procedure	913 (2.7)	120 (13.1%)	793 (86.9%)	0.71 (0.58–0.86)	0.0004	-	-
	Fixed prosthodontic procedure	458 (1.3)	61 (13.3%)	397 (86.7%)	0.72 (0.55–0.95)	0.0184	-	-
	Restorative procedure	6872 (20.2)	711 (10.3%)	6161 (89.7%)	0.48 (0.45–0.53)	<0.0001	0.43 (0.39–0.47)	<0.0001

Acute Apical Abscess

		Frequencies			**Odds Ratios (95% Confidence Intervals)**			
Variable	**Value**	**Total No. (%) N=51061**	**Antibiotic prescribed No. (%) n=14121 (27.7%)**	**No antibiotic prescribed No. (%) n=36940 (72.3%)**	**Unadjusted OR (95% CL)**	**p-value**	**Parsimonious Adjusted OR (95% CL)**	**p-value**
Age	Mean(SD), range(Median)	61.56 (12.76) 20–102 (66)	60.41 (12.96) 20–98 (64)	62 (12.65) 21–102 (66)				
Race	White	33541 (65.7)	9135 (27.2%)	24406 (72.8%)	Reference			
	Black	12226 (23.9)	3646 (29.8%)	8580 (70.2%)	1.14 (1.08–1.19)	<0.0001	-	-
	Other	2217 (4.3)	1239 (55.9%)	978 (44.1%)	0.8 (0.74–0.88)	<0.0001	-	-
	Missing	3077 (6%)	1714 (55.7%)	1363 (44.3%)	0.8 (0.74–0.86)	<0.0001	-	-
Gender	Male	46201 (90.5)	12690 (27.5%)	33511 (72.5%)	Reference		Reference	
	Female	4860 (9.5)	1431 (29.4%)	3429 (70.6%)	1.1 (1.03–1.18)	0.0035	-	-
U.S. region	Northeast	8063 (15.8)	2046 (25.4%)	6017 (74.6%)	Reference		Reference	

	Midwest	9018 (17.7)	2514 (27.9%)	6504 (72.1%)	1.14 (1.06–1.22)	0.0002	1.15 (1.05–1.27)	0.0031
	South	22138 (43.4)	14022 (63.3%)	8116 (36.7%)	1.23 (1.16–1.3)	<0.0001	1.21 (1.12–1.31)	<0.0001
	West	11095 (21.7)	2808 (25.3%)	8287 (74.7%)	1 (0.93–1.06)	0.9196	0.96 (0.88–1.05)	0.3362
	Other/Missing	747 (1.5%)	474 (63.5%)	273 (36.5%)	1.22 (1.03–1.44)	0.0203	0.97 (0.8–1.18)	0.749
Cardiac condition	Yes	6618 (13%)	1991 (30.1%)	4627 (69.9%)	1.15 (1.08–1.21)	<0.0001	1.2 (1.11–1.29)	<0.0001
Prosthetic joint	Yes	8067 (15.8)	2606 (32.3%)	5461 (67.7%)	1.3 (1.24–1.37)	<0.0001	1.34 (1.25–1.44)	<0.0001
CDT Procedure Code Present	Adjunct procedure		1532 (29.2%)	3722 (70.8%)	1.09 (1.02–1.16)	0.0106	1.23 (1.14–1.32)	<0.0001
	Diagnostic procedure	28675 (56.2)	9887 (34.5%)	18788 (65.5%)	2.26 (2.16–2.35)	<0.0001	2.47 (2.35–2.6)	<0.0001
	Endodontic procedure	5653 (11.1)	1784 (31.6%)	3869 (68.4%)	1.24 (1.16–1.31)	<0.0001	1.89 (1.77–2.03)	<0.0001
	Implant procedure	564 (1.1)	229 (40.6%)	335 (59.4%)	1.8 (1.52–2.13)	<0.0001	1.74 (1.45–2.1)	<0.0001
	Maxillofacial prosthetics	38 (0.1%)	2 (5.3%)	36 (94.7%)	0.15 (0.03–0.6)	0.0008	0.21 (0.05–0.91)	0.0376
	Oral maxillofacial surgical procedure	7390 (14.5)	3660 (49.5%)	3730 (50.5%)	3.12 (2.96–3.28)	<0.0001	3.47 (3.28–3.67)	<0.0001
	Orthodontic procedure	24 (0.01%)	6 (25%)	18 (75%)	0.87 (0.35–2.2)	1	-	-
	Periodontic procedure	4682 (9.2%)	903 (19.3%)	3779 (80.7%)	0.6 (0.56–0.65)	<0.0001	0.85 (0.78–0.93)	0.0002
	Preventive procedure	4658 (9.1)	521 (11.2%)	4137 (88.8%)	0.3 (0.28–0.33)	<0.0001	-	-
	Removable prosthodontic procedure	1583 (3.1)	300 (19%)	1283 (81%)	0.6 (0.53–0.69)	<0.0001	0.62 (0.54–0.71)	<0.0001
	Fixed prosthodontic procedure	847 (1.7)	110 (13%)	737 (87%)	0.39 (0.32–0.47)	<0.0001	0.52 (0.42–0.65)	<0.0001
	Restorative procedure	12809 (25.1)	1767 (13.8%)	11042 (86.2%)	0.34 (0.32–0.35)	<0.0001	0.48 (0.45–0.5)	<0.0001

SD: Standard deviation

Diagnostic CDT codes include examinations and radiology and laboratory procedures; Preventive CDT codes include cleanings, fluoride, and sealants; Restorative CDT codes include fillings and crowns; Endodontic CDT codes include root canals; Periodontic CDT codes includes gum-related procedures; Prosthodontics CDT codes include dentures (removable) and bridges (fixed); Maxillofacial prosthetic CDT codes includes facial, ocular, and other prostheses; Implant CDT codes include implant procedures; Oral and Maxillofacial Surgery CDT codes include extractions, biopsies, and other surgical procedures; Orthodontic CDT codes include Braces; Adjunctive CDT codes include anesthesia, professional visits, medication administration and tooth whitening and adjustments.

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Table 3.

Descriptive characteristics of antibiotic days' supply stratified by infection type.

Days' supply	Irreversible Pulpitis (N= 45,240 visits; 11.7%)	Apical Periodontitis (N= 5,922 visits; 17.4%)	Acute Apical Abscess (N= 14,121 visits; 27.7%)
Duration 1 d	7.4% (3337)	4.1% (240)	2.4% (334)
Duration 2 d	2.8% (1255)	1.5% (91)	0.8% (112)
Duration 3–7 d	49.8% (22552)	49.5% (2933)	47.4% (6698)
Duration 8–10 d	22% (8824)	24.3% (1438)	27.7% (3906)
Duration >10 d	20.5% (9272)	20.6% (1220)	21.7% (3071)
Antibiotic days' supply, Median (IQR)			
Median (IQR)	7 (5–10)	7 (7–10)	7 (7–10)
Mean (StDev)	11.1 (14.6)	10.8 (11.7)	10.5 (8.7)

IQR: Interquartile range