

# Use of Antibiotic Prophylaxis for Tooth Extractions, Dental Implants, and Periodontal Surgical Procedures

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**Background.** Guidelines for antibiotics prior to dental procedures for patients with specific cardiac conditions and prosthetic joints have changed, reducing indications for antibiotic prophylaxis. In addition to guidelines focused on patient comorbidities, systematic reviews specific to dental extractions and implants support preprocedure antibiotics for all patients. However, data on dentist adherence to these recommendations are scarce.

**Methods.** This was a cross-sectional study of veterans undergoing tooth extractions, dental implants, and periodontal procedures. Patients receiving antibiotics for oral or nonoral infections were excluded. Data were collected through manual review of the health record.

**Results.** Of 183 veterans (mean age, 62 years; 94.5% male) undergoing the included procedures, 82.5% received antibiotic prophylaxis (mean duration, 7.1 ± 1.6 days). Amoxicillin (71.3% of antibiotics) and clindamycin (23.8%) were prescribed most frequently; 44.7% of patients prescribed clindamycin were not labeled as penicillin allergic. Of those who received prophylaxis, 92.1% received postprocedure antibiotics only, 2.6% received preprocedural antibiotics only, and 5.3% received pre- and postprocedure antibiotics. When prophylaxis was indicated, 87.3% of patients received an antibiotic. However, 84.9% received postprocedure antibiotics when preprocedure administration was indicated. While the majority of antibiotics were indicated, only 8.2% of patients received antibiotics appropriately. The primary reason was secondary to prolonged duration. Three months postprocedure, there were no occurrences of *Clostridium difficile* infection, infective endocarditis, prosthetic joint infections, or postprocedure oral infections.

**Conclusion.** The majority of patients undergoing a dental procedure received antibiotic prophylaxis as indicated. Although patients for whom antibiotic prophylaxis was indicated should have received a single preprocedure dose, most antibiotics were prescribed postprocedure. Dental stewardship efforts should ensure appropriate antibiotic timing, indication, and duration.

**Keywords.** antibiotic prophylaxis; dental implant; dentist; periodontal surgery; tooth extraction.

Antibiotic resistance, driven by antibiotic prescribing, is one of the most serious health threats facing the world today [1], and approximately 30% of antibiotics prescribed in primary care settings are considered unnecessary [2, 3]. Dentists prescribe 10% of all antibiotics in the community, ranking fourth after family practitioners, pediatricians, and internists [4, 5]. While the indication for the majority of dental antibiotics is for infection prophylaxis [6], appropriateness of dental prescribing of antibiotics for prophylaxis prior to a dental procedure has not been determined in the United States.

Current evidence indicates that antibiotics administered prior to most dental procedures lack a clear benefit and that when antibiotics are not given, the risk of infection is minimal

[7]. In fact, transient bacteremia from dental procedures has been estimated to occur at rates similar to those of daily oral health activities [8–11]. In addition, unnecessary use of antibiotics can have serious adverse drug events, including allergic reactions, bacterial resistance, and *Clostridium difficile* infection (CDI). Use of antibiotics for short durations for dental infection prophylaxis has been associated with CDI [6]. In a population-based study of the epidemiology of community-associated CDI, dental antibiotic prophylaxis was one of the most common indications for antibiotics, second only to upper respiratory tract infections [12].

Guidelines from the American Heart Association (AHA) and the American Academy of Orthopaedic Surgeons (AAOS) for antibiotic prophylaxis prior to dental procedures were changed in 2007 and 2013, respectively, secondary to a lack of evidence to support the utility of antibiotic prophylaxis in preventing infective endocarditis or prosthetic joint infections [8, 13–16]. Thus, the AHA and AAOS guidelines significantly revised their recommendations for preprocedure infection prophylaxis. Guidelines for the use of antibiotics for infective endocarditis prophylaxis prior to dental procedures recommend the

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use of antibiotics in patients with specific cardiac conditions undergoing certain dental procedures [8]. Cardiac conditions for which prophylaxis is indicated include a prosthetic cardiac valve, prosthetic material used for a cardiac valve repair, history of infective endocarditis, specific congenital heart defects, and cardiac transplant patients who develop cardiac valvulopathy [8]. Prophylaxis should be recommended in these patients undergoing dental procedures that involve manipulation of gingival tissue or the periapical region of teeth or perforation of the oral mucosa (such as extractions and implants). Following the AHA/ADA guidelines, in 2013 and 2016, the AAOS/ADA recommended discontinuing the practice of routinely prescribing antibiotics for patients with hip and knee prosthetic joint implants undergoing any dental procedure [13, 14].

However, data on the appropriateness of prescribing since these updated guidelines were published are scarce. Thus, the primary objective was to determine if dental antimicrobial prophylaxis at a VA dental clinic was in accordance with guidelines. Secondary objectives were to evaluate the use of post-procedure antibiotics and to identify any adverse effects that may be associated with the antibiotics 3 months postprocedure.

## METHODS

### Study Design, Setting, and Population

This study was a cross-sectional study of antibiotic use in patients 18 years of age and older receiving dental procedures at a Department of Veterans Affairs (VA) dental clinic located in a VA medical center from January 1, 2015, through December 31, 2015. The dental procedures evaluated included tooth extractions, dental implants, and periodontal procedures (bone and gum grafting; scaling and root planing). These procedures were selected because they are the most common procedures performed in the study clinic and entail manipulation of the gingival tissue or the periapical region of the teeth or perforate the oral mucosa, as stated in the AHA/ADA guidelines [8]. In the case of a patient receiving multiple procedures at different visits, only the first dental procedure meeting the inclusion criteria that occurred during the study period was assessed. Postoperative follow-up visits and preventative visits (eg, routine dental cleanings) were not included. Patients were excluded if they were receiving antibiotics for a separate indication (eg, urinary tract infection or extra-oral infection).

The dental clinic provided a list of patients who received tooth extractions, dental implants, and periodontal procedures. This list was screened for inclusion and exclusion criteria and proceeded to full review of the electronic health record where appropriate. The systematic chart review involved the use of a standardized data collection tool. Variables collected include patient characteristics, past medical history, pharmacy records, laboratory information, and hospital, medical clinic, and dental clinic encounter data. Data were entered into a secure relational database for analysis.

### Definitions of Appropriateness of Infection Prophylaxis

Appropriate infection prophylaxis prescribing was defined using various recommendations. First, appropriate infective endocarditis and prosthetic joint infection prophylaxis were based on recommendations from the AHA/ADA (for cardiac conditions) and AAOS/ADA (for prosthetic joints) [8, 13]. Infective endocarditis prophylaxis was considered appropriate if the patient met the criteria as defined in the AHA guidelines. These criteria include the patient having an appropriate cardiac condition, dental procedure, and a single dose of an antibiotic administered 1 hour before the procedure (“preprocedure”) without a postprocedure antibiotic [8]. Appropriate cardiac conditions comprise diagnoses prior to a dental procedure including infective endocarditis, congenital heart disease, prosthetic cardiac valve/material, and cardiac transplant with cardiac valvulopathy [8]. In patients with the aforementioned cardiac conditions, appropriate dental procedures include those that involve gingival manipulation or mucosal incision (which included tooth extractions, dental implants, bone and gum grafting, scaling, and root planing). Antibiotic prescribing for prosthetic joint infection prophylaxis was defined as inappropriate (in the absence of another indication) [13, 14].

Second, a subset of dental procedures potentially at high risk for infection (tooth extractions, dental implants) was considered separately from patient comorbidities. In the absence of national guidelines, systematic reviews by the Cochrane Collaboration were used to formulate the definition for appropriateness of antibiotic prescribing for tooth extraction and implant placement [17, 18]. Regardless of the patient’s history of cardiac conditions or prosthetic joint implant, preprocedural antibiotic prophylaxis was considered appropriate administered 1 hour prior to tooth extraction and implant placement (without postprocedure antibiotic prophylaxis) [18]. Antibiotic prophylaxis for bone grafting, gum grafting, scaling, and root planing was considered inappropriate.

Secondary outcomes include serious antibiotic-related adverse effects (allergic reactions, CDI), infective endocarditis, prosthetic joint infections, and postprocedural infections. Secondary outcomes were evaluated three months postprocedure by review of laboratory results, inpatient notes, medical clinic notes, and dental clinic notes.

### Statistical Analyses

SAS 9.3 (SAS, Inc; Cary, NC) was used for statistical analyses. For categorical data, a chi-square or Fisher exact test was applied as appropriate. The Student’s *t* test was used for continuous data. A *P* value  $\leq 0.05$  was considered statistically significant.

## RESULTS

Over the 1-year study period, a total of 183 unique veterans met the inclusion criteria and were included in the analysis. Of the excluded patients ( $n = 24$ ), 58.3% did not undergo a procedure, 25.0% had an oral infection, 12.5% had an extra-oral

infection, and 4.2% had a follow-up appointment. The average age of the patients was 62.0 years, 94.5% of the patients were male, and 71.0% were white (Table 1). The most common dental procedure was tooth extraction, followed by periodontal surgeries (Table 1).

The majority (82.5%, n = 151) of patients undergoing dental procedures received 160 antibiotic prescriptions for prophylaxis. Amoxicillin and clindamycin were prescribed most frequently for infection prophylaxis (71.3% and 23.8% of antibiotic prescriptions, respectively). The other antibiotics prescribed for dental procedures included amoxicillin-clavulanate (3.1%), azithromycin, metronidazole, and trimethoprim-sulfamethoxazole (each <1%). Almost half of patients (44.7%) prescribed clindamycin did not have a penicillin allergy noted. The mean duration of antibiotics was 7.1 ± 1.6 days (1–14 days), where the majority of patients received a 7-day supply (82.5%).

Of the 151 patients who received antibiotic prophylaxis, 92.1% (n = 139) received postprocedure antibiotics only, 2.6% (n = 4) were prescribed preprocedure antibiotics only, and 5.3% (n = 8) were prescribed both pre- and postprocedure antibiotics.

Of the 183 veterans in the sample, 17 were not indicated to receive antibiotic prophylaxis, and the majority (64.7%, n = 11) did not receive antibiotics (Table 2). Ninety percent (n = 166) of patients had an indication (procedure and/or cardiac condition) to receive antibiotics. Of these patients, 87.3% (n = 145) received

some type of antimicrobial prophylaxis (preprocedure and/or postprocedure). However, 84.9% (n = 141) received postprocedure antibiotics for a mean of 7.2 days when only preprocedure administration was indicated. Only 8.2% of the 183 patients received antibiotics appropriately based on administration time, procedure, and comorbidities; 6.0% (n = 11) did not receive antibiotics when none were indicated, and 2.2% (n = 4) received preprocedure antibiotics appropriately without postprocedure antibiotics.

Of the 12 patients who received preprocedure antibiotics (alone and/or in combination with postprocedure antibiotics), all received a tooth extraction or dental implant, appropriate indications for antibiotics. Five (41.7%) of the preprocedure antibiotic patients also had a cardiac indication for preprocedure infective endocarditis prophylaxis; all were appropriately prescribed an antibiotic prior to the dental procedure. All patients with a prosthetic joint in the cohort (n = 9) also underwent an implant/extraction procedure; 66.7% (n = 6) appropriately received an antibiotic secondary to the dental procedure. The primary reason for inappropriate prescribing was postprocedure antibiotics when 1 dose preprocedure was indicated. Appropriate prescribing of antibiotics for infection prophylaxis was not found to be associated with any patient characteristic or dental procedure (Table 3).

Three months postprocedure, there were no occurrences of CDI, infective endocarditis, prosthetic joint infections, oral infections, or allergic reactions to antibiotics.

**Table 1. Baseline Demographics of Cohort Undergoing Dental Procedures**

Characteristic	Included Patients (n = 183)
Age, mean ± SD (range)	62.0 ± 12.7 (24–91)
Male sex, n (%)	173 (94.5)
Race, n (%)	
Asian	1 (0.5)
Black	36 (19.7)
Hispanic	7 (3.8)
Other	2 (1.0)
White	130 (71.0)
Unknown	8 (4.4)
Penicillin allergic, n (%)	27 (14.8)
Dental procedure <sup>a</sup>	
Extraction, n (%)	119 (65.0)
Periodontal surgery, n (%)	94 (51.4)
Dental implant placement, n (%)	63 (34.4)
Cardiac condition included in AHA guidelines, n (%)	5 (2.7)
History of infective endocarditis	0
Congenital heart defect	0
Cardiac transplant with valvulopathy	0
Prosthetic cardiac valve/material	5 (2.7)
Orthopedic joint replacement, n (%)	9 (4.9)
History of a prosthetic joint infection, n (%)	1 (0.6)

<sup>a</sup>Some patients underwent multiple dental procedures at 1 visit (eg, tooth extraction and implant replacement).

**Table 2. Antibiotic Indication, Timing, and Appropriateness of the Prescription**

Indication, Timing, and Appropriateness	Frequency (%) (n = 183)
Indicated to receive antibiotics (procedure/cardiac) <sup>a</sup>	166 (90.7)
Received pre- and/or postprocedure antibiotics (denominator = 166)	145 (87.3)
Not indicated to receive antibiotics	17 (9.3)
Did not receive antibiotic prophylaxis (denominator = 17)	11 (64.7)
Antibiotic prescribing consistent with study definitions	15 (8.2)
No antibiotics prescribed; no antibiotics were indicated	11 (6.0)
Preprocedure antibiotics were prescribed; preprocedure antibiotics were indicated	4 (2.2)
Antibiotic prescribing inconsistent with study definitions	168 (91.8)
No antibiotics prescribed; preprocedure antibiotics were indicated	21 (11.5)
Postprocedure antibiotics were prescribed; no antibiotics were indicated	6 (3.3)
Postprocedure antibiotics were prescribed; preprocedure antibiotics were indicated	141 (77.0) <sup>b</sup>
Preprocedure and postprocedure antibiotics were prescribed; preprocedure antibiotics were indicated (denominator = 141)	8 (5.7)

<sup>a</sup>Unless otherwise indicated, the denominator for percentages equals 183.

<sup>b</sup>Of those patients who had an indication to receive antibiotics (n = 166), 84.9% (141/166) received postprocedure antibiotics when only preprocedure administration was indicated.

**Table 3. Covariates Assessed for an Association With Prescribing of Antimicrobial Prophylaxis (n = 183)**

Characteristics	Antibiotic Prophylaxis Indication Consistent With Guidelines (n = 156)	Antibiotic Prophylaxis Indication Inconsistent With Guidelines (n = 27)	PValue
Age, mean	62.2 ± 12.0	60.7 ± 16.6	.6580
Male sex, n (%)	148 (94.9)	25 (92.6)	.6439
Nonwhite, n (%)	48 (30.8)	5 (18.5)	.1951
White, n (%)	108 (69.2)	22 (81.5)	
Extraction, n (%)	105 (67.3)	14 (51.9)	.1200
Dental implant placement, n (%)	54 (34.6)	9 (33.3)	.8970
Periodontal surgery, n (%)	79 (50.6)	15 (55.6)	.3344
Penicillin allergic, n (%)	23 (14.7)	3 (11.1)	.7714
Indication based on AHA guidelines, n (%)	5 (3.2)	0 (n/a)	1.0
Orthopedic joint replacement, n (%)	8 (5.1)	1 (3.7)	1.0

## DISCUSSION

To our knowledge, this is the first US report of the appropriateness of antibiotic prophylaxis prescribing prior to dental procedures in adults. Evidence from other countries has demonstrated that 58%–81% of dental antibiotic prescribing for infection prophylaxis is inconsistent with guidelines [19–26]. Our results in a VA clinic identified that while 87.3% of antibiotics were indicated, 91.8% of antibiotics prescribed for infection prophylaxis were inconsistent with recommendations. In our study, postprocedure antibiotic prophylaxis was administered for the majority of patients undergoing tooth extraction or implant surgery despite evidence supporting administering antibiotics preprocedure only [8, 13, 17, 18]. Postprocedure antibiotics used in this setting were prescribed for an extended duration (mean, 7.2 days for an excess of 824 days in the cohort), for which evidence is lacking.

In the clinical notes, dental providers were occasionally unaware of the oral health and procedures to be completed prior to the appointment and, thus, the need for preprocedure antibiotic prophylaxis. This may explain the high frequency of postprocedure antibiotics when a preprocedure antibiotic was indicated. While patients with cardiac conditions listed in the AHA guidelines were limited, preprocedure antibiotic prophylaxis prescribing was consistent with these guidelines for the prevention of infective endocarditis. In a larger cohort of 1351 patients over 10 years, only 8.6% of visits received antibiotic prophylaxis inconsistent with the infective endocarditis guidelines [27]. However, adherence with these guidelines in a larger cohort should be assessed.

Limitations to this study include the retrospective design, small sample size, and use of a single dental clinic. In addition, providers may choose to administer prophylactic antibiotics to patients with poor oral health or uncontrolled co-morbidities; however, this was infrequently documented in the dental notes, thus making it difficult to take this factor into consideration. Another limitation is that congenital heart disease will always be limited in VA studies as these persons are typically excluded from military service. Adverse drug events and postprocedure infections

may have also been missed if patients sought care from non-VA providers/facilities. Finally, national guidelines for dental procedure antibiotic prophylaxis are lacking in the absence of comorbidities (ie, cardiac conditions, prosthetic joints). However, a systematic review by the Cochrane Collaboration on the use of antibiotics for infection prophylaxis following tooth extractions found that antibiotics reduced the risk of infection, but also increased the risk of adverse events [17]. The authors concluded that due to the risk of adverse events and resistant bacteria, clinicians should carefully consider treating healthy patients with postprocedural prophylactic antibiotics [17]. A second Cochrane review evaluating the role of antibiotics at the time of dental implant placement in preventing complications found that participants receiving antibiotics were less likely to experience implant failure compared with participants not receiving antibiotics, with a number needed to treat of 25 [18]. The authors concluded that antibiotics are beneficial for reducing failure of dental implants, specifically amoxicillin 2 or 3 grams by mouth as a single dose 1 hour before the procedure, but it is still unknown whether postoperative antibiotics are beneficial [18].

## CONCLUSION

The majority of patients who underwent a dental procedure were administered antibiotic prophylaxis as indicated. However, only 8.2% of antibiotic prescribing for infection prophylaxis was appropriate based on currently available evidence, the majority receiving antibiotics post-procedure. Modifying postprocedure antibiotic prescribing for implants and extractions to only 1 dose prior to the procedure could significantly decrease overprescribing in dentistry. Guidelines beyond the prevention of infective endocarditis and prosthetic joint infections should be developed to provide guidance in the prescribing of antibiotics for prophylaxis. Implementing antimicrobial stewardship efforts, including documentation of the medication indication, in dental clinics may be an opportunity to improve antibiotic prescribing for infection prophylaxis.

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