Title
Antibiotic Prescribing Practices in Periodontal Surgeries with and without Bone Grafting

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Antibiotic Prescribing Practices in Periodontal Surgeries with and without Bone Grafting

by
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The utmost appreciation goes to my beloved family, co-residents, faculty, and staff for all of your unconditional love and support.

This thesis is dedicated to the Bahai's of Iran who are systematically denied a right to higher education.

Abstract

Antibiotic Prescribing Practices in Periodontal Surgeries with and without Bone Grafting

Justine Hoda Hai

Background: The prevention of post-operative infection following periodontal surgery is often the basis for antibiotic prescription. The inherent risks of unwarranted antibiotic use and lack of guidelines for procedures involving bone grafts create additional difficulties in decision making for practitioners. This study aims to evaluate practitioners' self-reported practices in antibiotic prescribing for periodontal surgeries with and without bone grafting.

Methods: A 15-question anonymous survey using Qualtrics software was distributed to California periodontists via email. The survey included questions about prescribing practices for specific periodontal procedures, rationale questions for choosing to prescribe or not to prescribe antibiotics, demographic and dental practice information. Results were analyzed using McNemar tests and logistic regression.

Results: 100 practitioners responded to the survey. Practitioners were significantly less likely to report prescribing antibiotics for traditional periodontal surgeries involving no bone grafting compared to socket preservation, guided tissue regeneration (GTR), guided bone regeneration (GBR) and sinus augmentation ($p<0.0001$). Practitioners were significantly more likely to report prescribing antibiotics with more complex procedures involving bone grafting, such as GBR and sinus augmentation, when compared to socket preservation ($p<0.0001$). Seventy-five percent of practitioners responded that they would follow guidelines for antibiotic prescription with bone grafting procedures if they were developed and endorsed by the American Academy of Periodontology.

Conclusions: Practitioners are more likely to prescribe antibiotics when a bone graft is used and as the complexity of the bone-graft procedure increases. Based on these results and the willingness of practitioners to adopt evidence-based guidelines, the establishment of guidelines for practitioners on the appropriate use of antibiotics would be of benefit to the periodontal practicing community.

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I. Introduction

I. Introduction

In order to understand where the use of antibiotics in conjunction with surgical procedures began, it is important to review the history of infections in the pre-antibiotic era. Priest physicians dating back to ancient times in India and China had already presumed that pathogens could be transmitted between living beings.[1] This belief was adopted in other parts of the world at different times and by the late 1800's, a surgeon named Joseph Lister proposed that bacteria could be responsible for surgical infections. He was instrumental in pioneering the development of antiseptic surgery by using antiseptics such as phenol on operating equipment and in wounds.[1] Later in World War I, treatment strategies for preventing infections and decreasing mortality lead to significant progress in medicine. Since there was no time to conduct trials on the battlefield, decisions had to be made quickly to address the large number of wounded soldiers. In 1908, an Italian physician Antonio Grosich created the antiseptic compound known as Dakin-Carrel. This mixture of sodium hypochlorite and boric acid was widely used and noted to significantly reduce the number of deaths when applied to wounds.[2] Because of this success on the field, antiseptics continued to be widely used in wounds until the development of antibiotics and discovery of penicillin in 1928, which became the new "magic bullet".[3] It took another seventeen years for the purification and mass distribution of penicillin in hospital settings to take place.[3]

One of the first documented studies on the use of antibiotics in surgical procedures took place in Massachusetts Memorial Hospital. This was retrospective study that had some flaws by today's standards for study design.[4] According to one review of the English literature, 131 trials on the use of antibiotics in surgery were performed between the early 1960's to mid 1970's.[5] Of those, only 24 were found to meet the criteria for adequate study design; namely that therapy was instituted preoperatively or intraoperatively, the study was prospective, controlled and

randomized, there was a precise definition of wound infection, the spectrum of the antibiotic coverage included the anticipated contaminating organisms, the study was in humans, and the study excluded surgical procedures performed in patients with established infection including appendicitis.[5]

Whether or not use of antibiotics in surgery to prevent wound infection is efficacious or not is another contested topic. A prospective study evaluating decreased doses for prophylactic antibiotics prior to clean orthopedic surgery found that over a one year period, isolates of methicillin-resistant staphylococcus aureus significantly decreased in their hospital ward.[6] Numerous studies conducted at the beginning of the antibiotic era and thereafter found no benefit or even higher infection rate with the use of antibiotic prophylaxis.[4,7–10] This is not unusual given what is known about the mutualistic balance between bacteria and the host immune system. Even a single dose of antibiotic can reduce secretion of antimicrobial peptides and cause changes in T helper cell populations thereby increasing a patient's risk for developing an infection.[11] Although sometimes these effects are transient, effects on the gut microbiome, which plays a critical role in host immunity, can be permanent.[12,13] These effects include alterations in chemotaxis, changes in lymphocyte transformation, decreased ability for phagocytosis, bone marrow suppression, and decreased ability to produce antibodies.[14] Why is it then that giving antibiotics and predisposing a patient to superinfection is not considered as highly when considering a prescription of antibiotics with surgical procedures? One clue could be a landmark study conducted in the 1960's that reversed the notion that antibiotics with surgery increased infection rates and supported the use of antibiotics in clean surgical wounds to prevent infection.[15] Despite these early warnings about the risks of antibiotic resistance and the lack of good evidence that antibiotics in conjunction with surgery prevented post-surgical infections, use of antibiotics continued and increased into the next two decades with the emergence of newer and potentially

more powerful antibiotics.[1,5] While some specialties began to evaluate such practices and establish guidelines to prevent indiscriminate use of antibiotics with surgery, many others including the specialty of periodontics, have not.

The prevention of post-operative infection following periodontal surgery is often given as the basis for antibiotic use.[16–19] Procedures involving bone grafts are an additional factor for practitioners to consider when prescribing because no guidelines exist for the use of antibiotics with bone grafting. Practitioners are left to their own clinical experience and judgment to determine the need for antibiotics, which may be considered inadequate given the emergence of antibiotic resistance, antibiotic-associated allergy, ineffectiveness and suprainfections.[20] With higher numbers of patients enrolled in studies, greater number of studies and high-quality evidence, the medical community, unlike dentistry, uses GRADE to establish clinical practice guidelines to standardize healthcare administration at a national level. GRADE, otherwise known as Grading of Recommendation Assessment, Development and Evaluation, is a standard for developing trustworthy clinical guidelines that offers systematic and transparent guidance in moving from evidence to recommendations.[21] The GRADE strategy concentrates on four factors: balance between benefits and harms, the certainty of the evidence, values and preferences, and resource considerations.[21] GRADE distinguishes recommendations in guidelines as strong or weak.[21] Guidelines developed with this approach provide safety to patients as well as clinicians. Three guidelines that are of major importance are the recently revised Centers for Disease Control and Prevention Guideline for the prevention of surgical site infection, the World Health Organization recommendations on pre-operative measures for surgical site infection prevention, and the World Health Organization recommendations on intraoperative and post-operative measures for surgical site infection prevention.[18,22,23] According to the CDC guideline, ear, nose and throat (ENT) procedures have moderate level evidence that there is no greater reduction in

surgical site infection with a 3-5 day course of antibiotics compared to less than 24 hour dose.[22] Likewise, there is moderate level evidence that orthopedic surgery of fractures that often involve bone graft show no difference between groups treated with prophylactic antibiotics and those treated with no antibiotics.[22] The World Health Organization has given a strong recommendation from moderate level evidence against the further prolongation of antibiotic administration after wound closure regardless of patient's health status.[18] If antibiotic is to be given prophylactically, there is consensus that it should be given 60 minutes prior to incision and discontinued after wound closure.[24] Another clinical practice guideline for antimicrobial prophylaxis in surgery with moderate level evidence is the recommendation that no antibiotics be used in clean head and neck surgery with another guideline affirming this in dentoalveolar surgeries.[25,26] The Centers for Disease Control and Prevention surgical wound classification system provides useful information about infection rates and considerations based on type and location of wound.[27] Surgical procedures create clean or clean-contaminated wounds. Uninfected operative wounds not following blunt trauma that are primarily closed may be classified as clean while uninfected operative wounds that enter the respiratory, alimentary, genital or uninfected urinary tract may be classified as clean-contaminated.[27] Since most oral surgical wounds can be classified as clean or clean-contaminated, in the absence of specific guidelines for oral surgery procedures involving bone graft, one may consider the recommendations for procedures with similar surgical wound classification, such as those used in ENT and orthopedics, and thereby use evidence-based material in decision making. These guidelines also provide insight into considerations before, during and after surgery that are critical for decreasing surgical site infection beyond the use of antibiotics alone including the intensive protocols for preoperative blood glucose control, irrigation of the wound intraoperatively and laminar airflow ventilation systems to name a few.[18]

Unlike other medications that undergo FDA approval and testing for their potential harmful effect on the individual, antibiotics are unique in that their effectiveness, safety and global impact changes over time and these impacts can be at the level of the individual as well as at the level of society. Continuous evaluation of prescribing and efficacy must be done and changes in antibiotic use should subsequently follow if deemed advisable. Guidelines that are created should be regularly examined to determine if the risk-to-benefit ratio is current and if the anticipated target bacteria have remained sensitive to the antibiotic planned for use. Although the CDC is responsible for collecting data on bacterial resistance and categorizing the threats based on level of urgency, this review of guidelines takes place at the specialty level, which may have a disconnect at the public health level.[28] Antibiotics have been linked to numerous serious adverse events including life-changing alterations in gut microbiome, allergic reactions, disruption of contraceptive medication, mania, superinfections that are resistant to treatment and death.[29–33] According to the Centers for Disease Control and Prevention, at least 2 million people in the U.S. develop an antibiotic-resistant infection with at least 23,000 deaths from those infections every year and that number expected to rise.[28] Two of the largest reasons for this increase in antibiotic-resistant strains of bacteria are the overuse of antibiotics and inappropriate prescribing.[34] A systematic review on this topic evaluated shorter course (typically defined as 3 days) and longer course (7 days or longer) regimens of antibiotic use in infections and found no difference in microbiological outcomes, short-term mortality and long-term mortality.[35] Another systematic review evaluating antibiotic prophylaxis in clean-contaminated head and neck surgery also found no difference in 1 day vs. 5 day antibiotic regimens on wound infection.[36] Other studies evaluating shorter course antibiotics in outpatient settings also found that the effectiveness and safety of shorter courses of antibiotics was no different than longer courses.[37,38] Most antibiotic prescribing is done in outpatient settings with an estimated 30% of these

prescriptions being inappropriate.[39] One publication found that inappropriate antibiotic prescribing by dentists had broad variability by provider, geographic location and whether it was prophylactic or therapeutic in nature.[40] With dentists being the third highest prescribers of antibiotics in the U.S. by volume, their impact on developing antibiotic resistance is great and its evaluation is of importance.[41]

In randomized controlled trials comparing guided-tissue regeneration with and without antibiotics, no differences in healing or infection rates were found.[42,43] Some protocols including those from the 1990s for sinus augmentation recommend the use of antibiotics, but to date no randomized controlled trials have been performed to evaluate the incidence of graft infection with and without antibiotics.[44,45] Earlier studies evaluating the use of antibiotics for osseous surgery showed no benefit in using antibiotics and even reported infection in patients given antibiotics.[19,46] The incidence of infection for most periodontal surgeries ranges between 0% and 6% with or without the use of antibiotics.[47–50] In a study conducted by Powell et al, the rate of infection was as low as 0% and included a large variety of periodontal surgical procedures including bone grafting.[47] What most studies fail to address in antibiotic prescribing is the number needed to harm. The term ‘number needed to harm’ is an absolute measure of the potential harm of a drug.[51] The number needed to harm is a value that represents how many patients one would need to treat with an intervention vs. another intervention or vs. no intervention in order to encounter one harmful outcome.[51] Multiple studies including systematic reviews in the medical literature have looked into the number needed to harm with use of antibiotics. In most studies, the number of courses of antibiotic, specifically amoxicillin often used in dentistry, ranges between 8 to 12. [52,53] This means that for every 8 patients who are prescribed antibiotics, at least one will have an unfavorable outcome such as allergy, gastrointestinal issues or candidiasis.[52] Outcomes that are more difficult or perhaps not possible

to measure such as changes in gut microbiome and bacterial resistance are not included in this analysis, but nevertheless cause additional harm on an individual and global level. Some articles from other surgical specialties in medicine even found that the use of prophylactic antibiotics had increased the occurrence of post-operative sepsis.[8,16,17,54] The infrequency of infections with periodontal surgeries and frequency of causing harm to patients with an unnecessary antibiotic prescription underscores the need for avenues of research to investigate the appropriateness of systemic antibiotics for procedures involving bone grafting.

In 2004, the American Academy of Periodontology published a position paper outlining the efficacy and practical aspects of antibiotics in periodontal therapy.[55] This information has been used by clinicians in treating various forms of periodontitis, periodontal abscesses and in decision making for the most efficacious antibiotic to use, but without evaluation, it remains unknown if these evidence-based guidelines are adopted. The use of surveys in collecting data about antibiotic prescribing is not new or exclusive to the dental field.[56–59] Data from other surveys show an increasing use of antibiotics by dentists and reveal that knowledge about antibiotics, resistance and guidelines are inadequate in the dental profession and that these prescriptions are often made for social reasons (e.g. patient perception that the provider is giving them something to aid in healing).[20,41,57,59,60] These surveys help bring to light information that otherwise may not be evaluated systematically, to capture knowledge and attitudes, and fill gaps in knowledge. A gap in knowledge exists with the use of bone graft in periodontal surgery and its ramifications on further antibiotic coverage for patients. In addition, it is unknown if dentists are aware of and adopt guidelines in treating patients with antibiotics. This study aims to evaluate antibiotic prescribing practices and rationale for periodontal surgeries with and without bone grafting and the acceptability of guidelines.

II. Materials and Methods

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The survey and study number 17-22459 were approved under exempt status on October 25, 2017 by the institutional review board of the University of California, San Francisco. The survey instrument underwent face and content validity testing. Face and content validity testing were conducted with two periodontists who independently reviewed the content and deemed it appropriate for measuring the intended concepts. Face and content validity testing is at its nature context-specific and not meant to provide an absolute assessment.[61] Face validity is a measure of whether the items in an instrument or procedure are sensible, appropriate and relevant to the people who use the measure on a day-to-day-basis.[62] Content validity is a measure of the extent to which the set of items comprehensively covers the different components to be measured.[63] For this reason, it was deemed acceptable to have two periodontists who are trained in the field of the content being questioned to determine face and content validity. The reliability of the survey was tested by distributing the survey instrument to seven periodontal residents at UCSF who took the survey twice with two weeks between responses. Two weeks is deemed an appropriate amount of time to allow respondents to forget their responses at the first administration without having a meaningful change in knowledge or attitudes at the second administration.[61,64] Test-retest reliability was calculated using Cohen's kappa test and was found to range between 0.83 and 1.0 with a mean of 0.93 where kappa values between 0.8-1.0 are considered as almost perfect agreement.[65] A sample size calculation was conducted prior to distribution of the survey instrument assuming that approximately 10% of practitioners would prescribe antibiotics for all procedures, 60% of practitioners would prescribe antibiotics with bone graft but would not prescribe if no bone graft was used, 25% of practitioners would prescribe antibiotics in cases with no bone graft but would not prescribe if bone graft was used and 5% of practitioners would not prescribe antibiotics for any procedures. To obtain a power of 90% with 95% confidence to

detect a difference in prescribing habits between surgeries that do not involve bone grafting (e.g., traditional periodontal surgery) and those involving bone grafting (e.g., socket preservation, guided-tissue regeneration [GTR], guided-bone regeneration [GBR] and sinus augmentation), 69 participants were needed for a McNemar test.

The survey was distributed using Qualtrics software to the California Society of Periodontists listserv via two separate emails sent one week apart. The listserv included all 294 active members of the California Society of Periodontists. A $10 gift card to Starbucks or Amazon was available upon request to those who completed the survey. Responses were anonymous and in no way linked to the email address or any other identifying information of the respondent. A copy of the survey is included in the appendix summary. The survey consisted of 15 questions, of which six questions asked practitioners "In an otherwise healthy patient, would you prescribe antibiotics for X procedure," where X included acute periodontal abscess, traditional periodontal surgery, socket preservation, guided tissue regeneration, ridge augmentation (aka guided bone regeneration) and sinus augmentation. Response choices were limited to "In most cases no, in most cases yes, and I do not perform this procedure." Based on their response to prescribe or not to prescribe antibiotics, an appropriate follow up question was asked to obtain the rationale for their decision to prescribe through a multiple-choice series of questions with a free response option. Prescribers were able to select multiple responses if they were applicable to them. Figure 1 shows a summary of how the procedure questions with subsequent answer logic were presented. The remaining nine questions asked about demographic variables, overall antibiotic prescribing rationale, use of guidelines, dental training and practice information. McNemar tests were used to compare responses based on procedure and logistic regression was used to evaluate differences in antibiotic prescribing according to demographic and dental practice

characteristics.[66] Multiple logistic regression models were calculated with odds ratio and 95% confidence intervals with one fitted for each surgical procedure to evaluate if demographic, dental training, and dental practice characteristics were associated with the outcome variable of routinely prescribing antibiotics for the procedure. Covariates included gender, academic appointment, location of training, years of practice, race, private practice vs educational work setting, and private practice size. In some cases, there were not enough data points for regression analysis: for example, certain years of practice, race and practice size. Models for which variables were not analyzed are clearly demarcated with a - symbol.

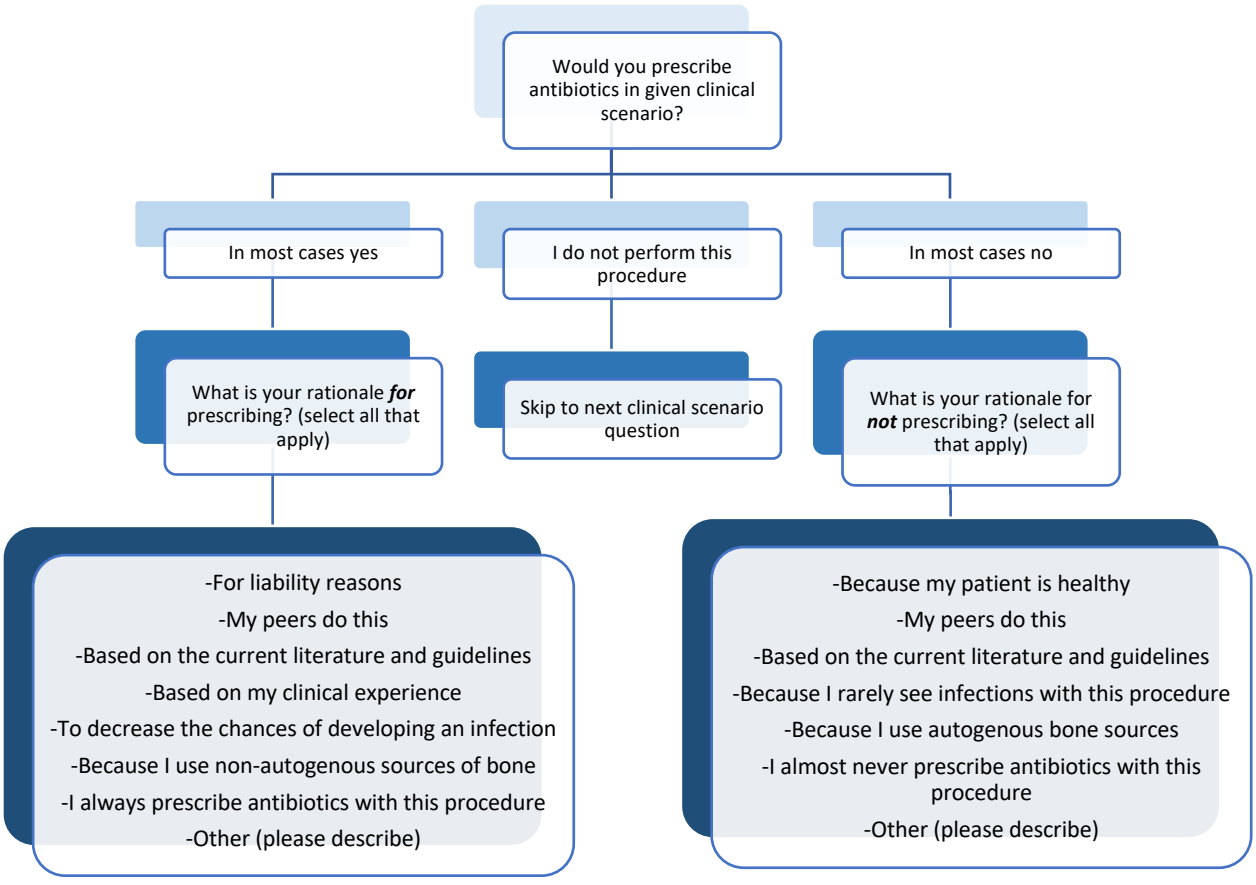

Figure 1. Procedure questions with subsequent rationale follow up questions

III. Results

III. Results

A total of 294 periodontists were contacted to participate in the study via an email containing a link to the survey. Of the 294 that received the email, 100 responded. The survey found an increased likelihood of reporting antibiotic use as bone graft is used and the complexity of the bone grafting procedure increases. Antibiotic use was significantly lower in traditional periodontal surgeries (e.g. those that require no bone grafting) with only 22% of practitioners prescribing antibiotics when compared with 71% for socket preservation ($p<0.0001$), 73% for GTR ($p<0.0001$), 91% for GBR ($p<0.0001$) and 92% for sinus augmentation ($p<0.0001$) as seen in Figure 2. More complex procedures involving bone graft, namely GBR and sinus augmentation had significantly higher antibiotic use even when compared with socket preservation ($p<0.0001$).

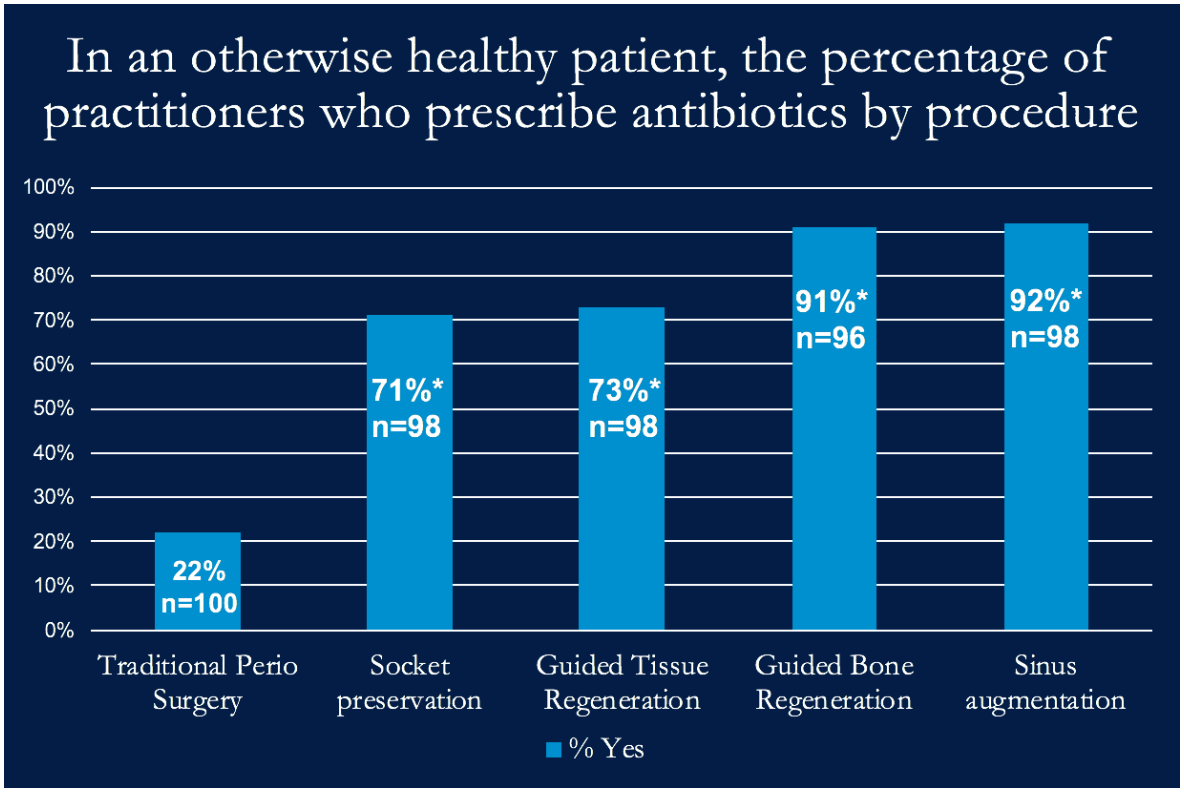

Figure 2. Percentage of practitioners who report prescribing antibiotics by procedure

Of the survey respondents, 22% of practitioners reported prescribing antibiotics with traditional periodontal surgery as seen in Figure 3. The most common reasons for prescribing antibiotics were based on clinical experience (n=14, 64%) and to decrease the chances of developing an infection (n=11, 50%). The most common reasons for not prescribing antibiotics were because I rarely see infections with these procedures (n=51, 65%) and based on current literature and guidelines (n=48, 62%).

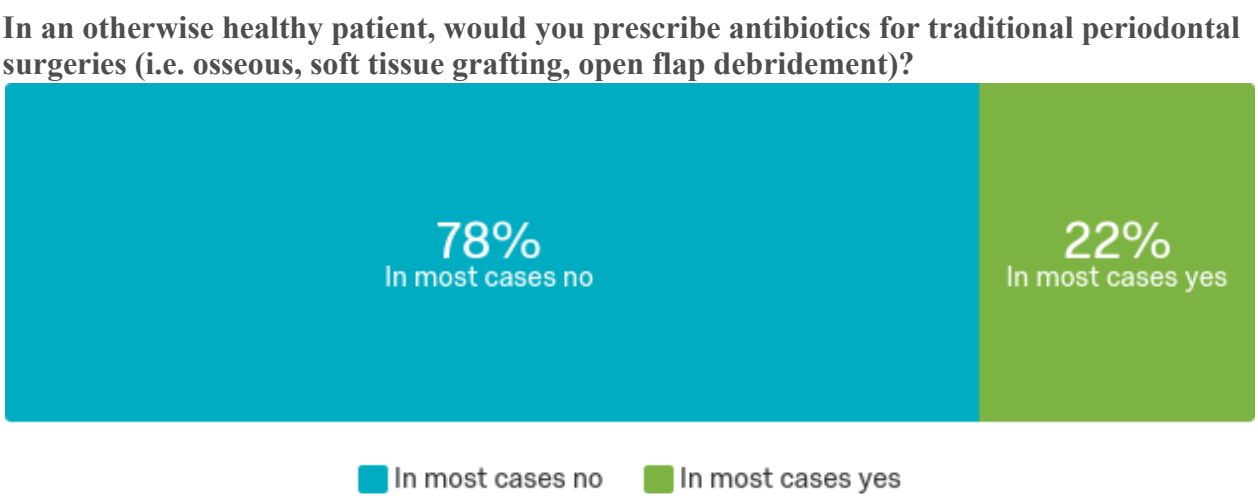

Figure 3. Traditional Periodontal Surgery Responses

Of the survey respondents, 71% of practitioners who perform socket preservation procedures involving bone grafting reported prescribing antibiotics as seen in Figure 4. The most common reason for prescribing antibiotics was to decrease the chances of developing an infection (n=52, 76%). The most common reason for not prescribing antibiotics was because I rarely see infections with this procedure (n=20, 67%).

In an otherwise healthy patient, would you prescribe antibiotics for socket preservation procedures involving bone grafting?

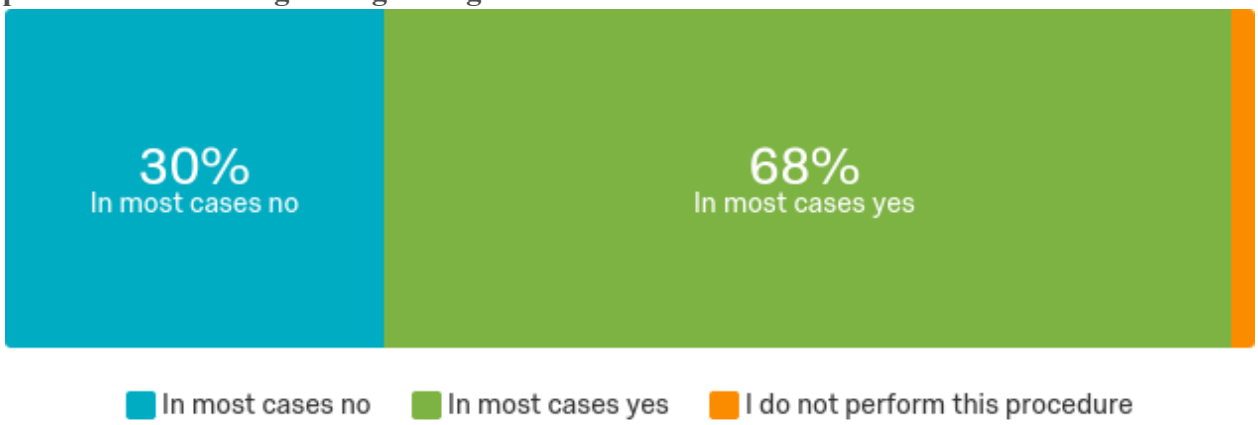

Figure 4. Socket Preservation Responses

Of the survey respondents, 73% of practitioners reported prescribing antibiotics with GTR around teeth as seen in figure 5. The most common reasons for prescribing antibiotics with this procedure were to decrease the chances of developing an infection (n=51, 71%) and based on my clinical experience (n=43, 60%). The most common reasons for not prescribing antibiotics were based on the current literature and guidelines (n=16, 62%) and because I rarely see infections with this procedure (n=15, 58%).

In an otherwise healthy patient, would you prescribe antibiotics for guided tissue regeneration procedures involving bone grafting around teeth?

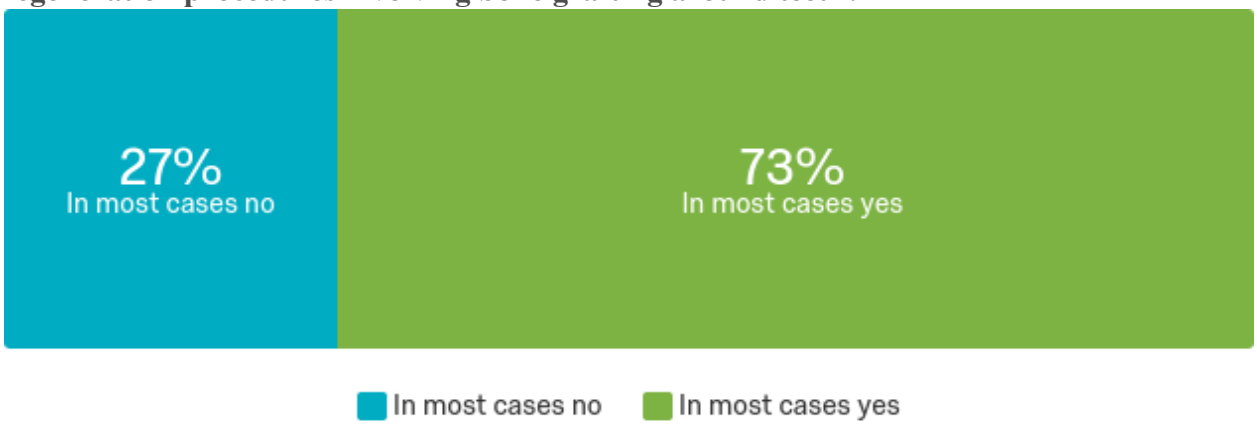

Figure 5. Guided Tissue Regeneration Responses

Of the survey respondents, 91% of practitioners who perform GBR procedures reported prescribing antibiotics as seen in figure 6. The most common reasons for prescribing antibiotics were to decrease the chances of developing an infection (n=70, 82%) and based on my clinical experience (n=55, 65%). The most common reasons for not prescribing antibiotics were because my patient is healthy (n=5, 56%) and because I rarely see infections with this procedure (n=4, 44%).

In an otherwise healthy patient, would you prescribe antibiotics for ridge augmentation procedures involving bone grafting?

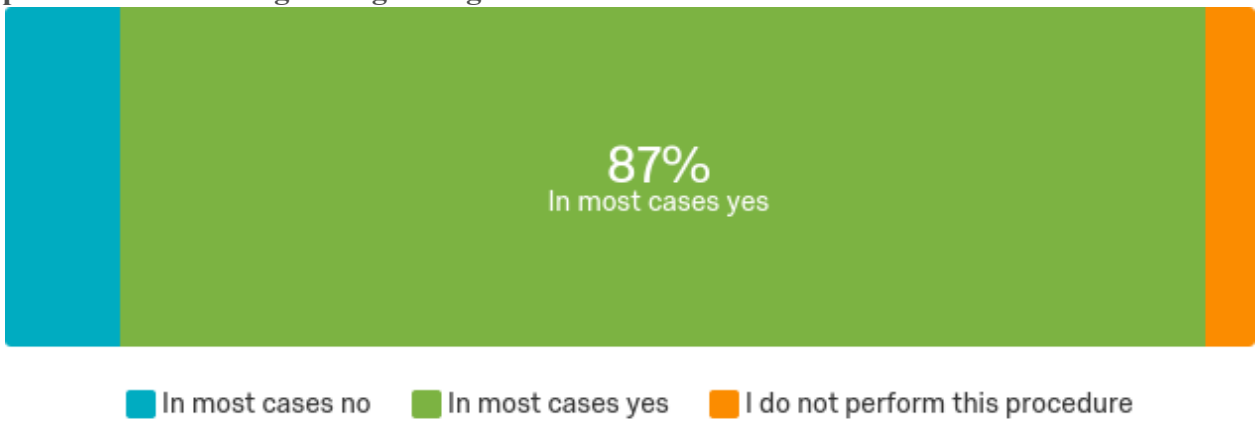

Figure 6. Guided Bone Regeneration Responses

Of the survey respondents, 92% of practitioners who perform sinus augmentation procedures reported prescribing antibiotics as seen in figure 7. The most common reason for prescribing antibiotics was to decrease the chances of developing an infection (n=72, 80%). The most common reason for not prescribing antibiotics was because I rarely see infections with this procedure (n=3, 38%).

In an otherwise healthy patient, would you prescribe antibiotics for sinus augmentation procedures involving bone grafting?

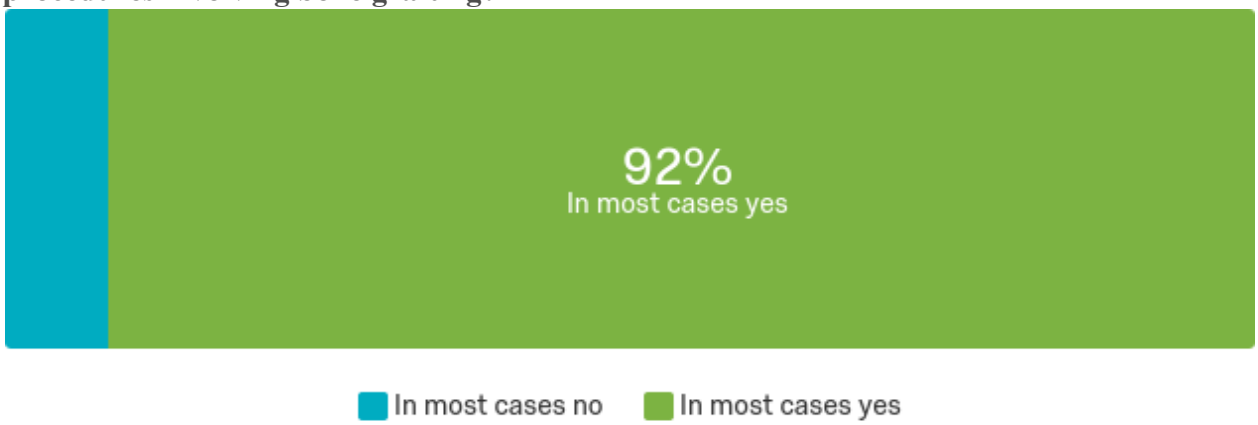

Figure 7. Sinus Augmentation Responses

The question, "If the American Academy of Periodontology developed and endorsed evidence-based guidelines for prescribing antibiotics for procedures involving bone grafting, would you follow them?" received 75% yes responses, 23% not sure and 2% no responses as seen in figure 8.

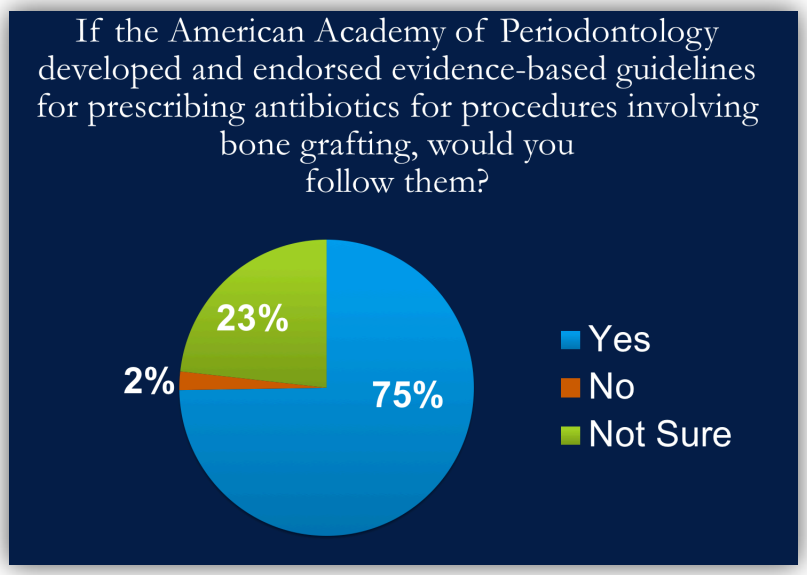

Figure 8. Percentage of practitioners who would adopt guidelines for antibiotic prescribing

In a stand-alone question regarding antibiotic prescribing rationale in conjunction with bone grafting procedures, the most common reasons for prescribing were to decrease the chances of developing an infection, due to patients having a condition that affects wound healing, based on clinical experience and because the patient's health status is immunocompromised as seen in Figure 9. Some common themes emerged in reviewing the free responses. Those themes *for prescribing* antibiotics are summarized in Table 1.

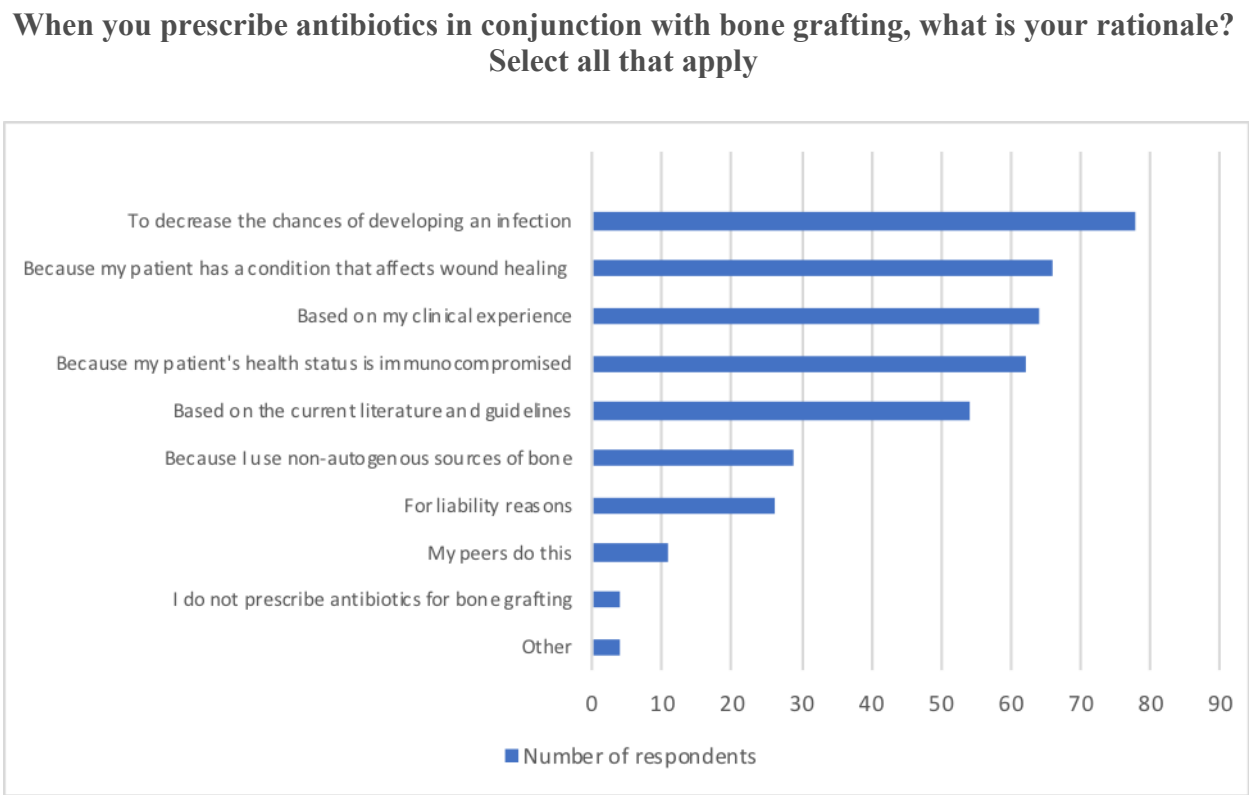

Figure 9. Overall antibiotic prescribing rationale with bone grafting

Table 1. Free Response Themes for Prescribing Antibiotics

Bone graft is a foreign body in the mouth
Bone graft material is more prone to infection
Patients will have poor plaque control post-surgery and antibiotics help
Antibiotics reduce post-operative pain
Patient perception that if no antibiotics are given and they have a failure, that it was due to not having taken antibiotics
Even a slightly lower chance of infection is worth prescribing antibiotics to prevent failure (reduces cost in re-treatment and increases patient perception that treatment was done correctly)
I give antibiotics after surgery even short course because I believe it reduces infection risk

Questions regarding demographics and dental practice included length of time practicing, location of highest level of training, practice setting for majority of the work week, specialty, size of practice, full or part time academic appointment, gender and race were evaluated. Logistic regression analysis was completed to determine which demographic parameters were associated with whether a practitioner was more or less likely to report prescribing antibiotics and these data were further analyzed by procedure. Statistically significant differences were noted only in prescribing habits between practitioners who work the majority of the week in private practice compared to those in an academic clinic as noted in Table 3 with an asterisk. Private practitioners were significantly more likely to prescribe antibiotics for guided bone regeneration and sinus augmentations, with an odds ratio of 84.5 and 12.2, respectively ($p<0.01$) when compared to practitioners who do not work in private practice. This difference should be interpreted with caution since the frequency of prescribing antibiotics for these procedures was so high that even a single non-prescriber response from a practitioner who does not work in private practice was sufficient to create a significant difference thereby artificially inflating the odds ratios.

Demographic and dental practice characteristic data are presented in Figures 11 through 18 and Table 2.

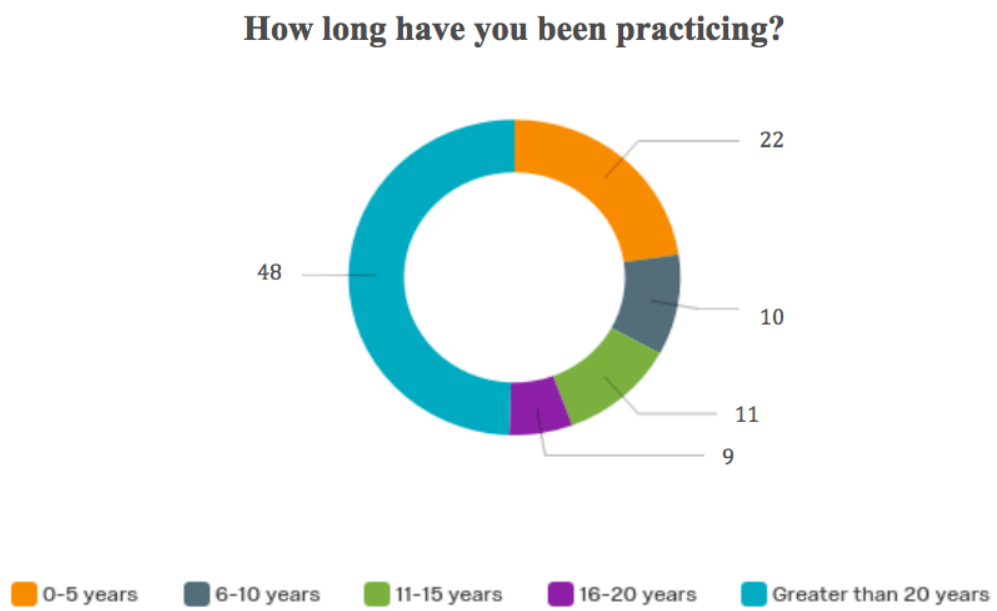

Figure 11. Years in Practice

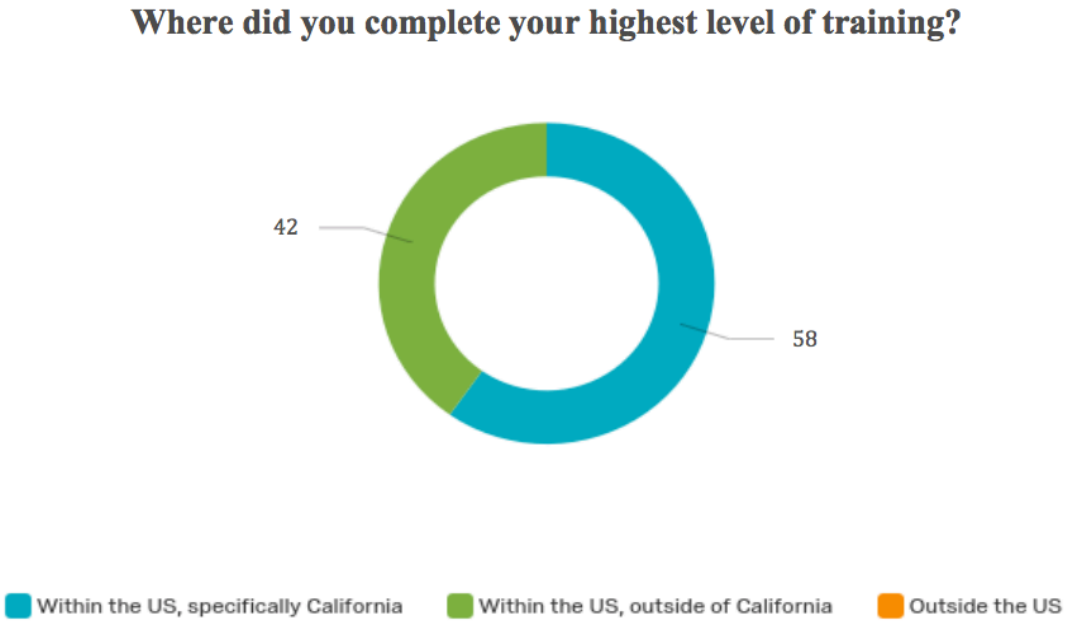

Figure 12. Highest Level of Training

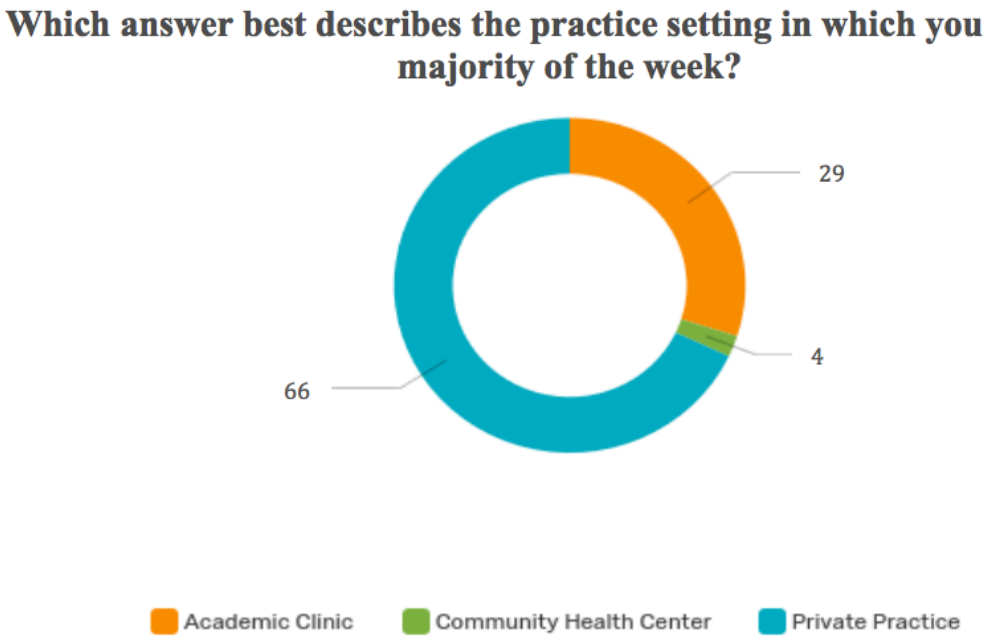

Figure 13. Work Setting

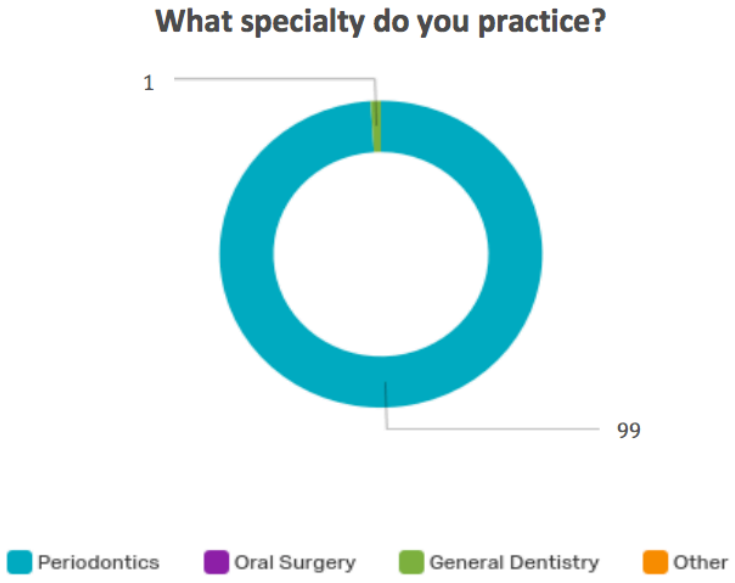

Figure 14. Specialty

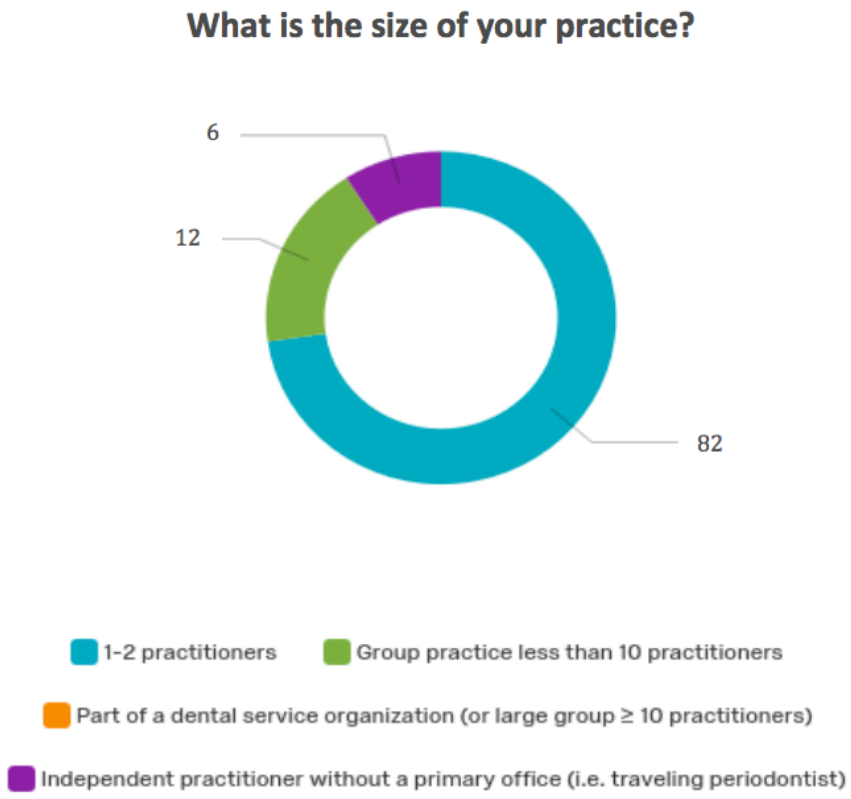

Figure 15. Size of Practice

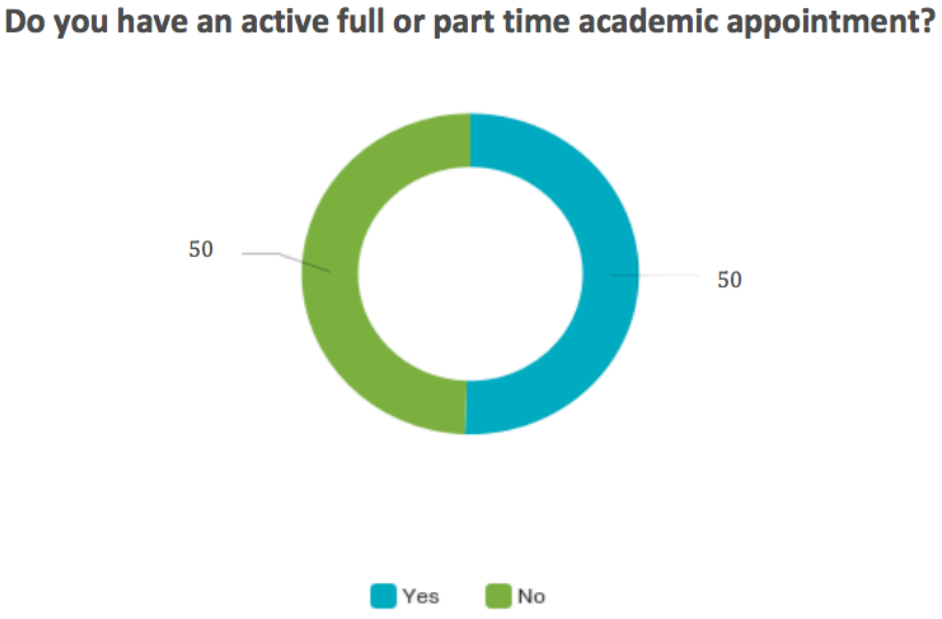

Figure 16. Academic Appointment

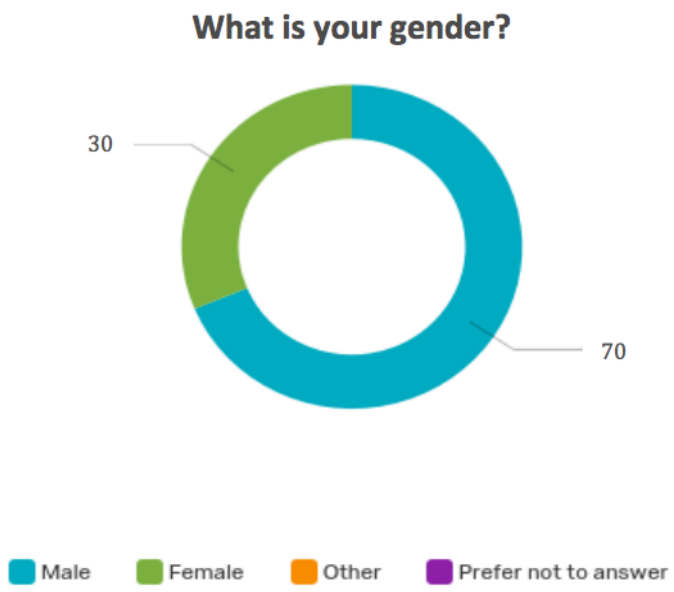

Figure 17. Gender

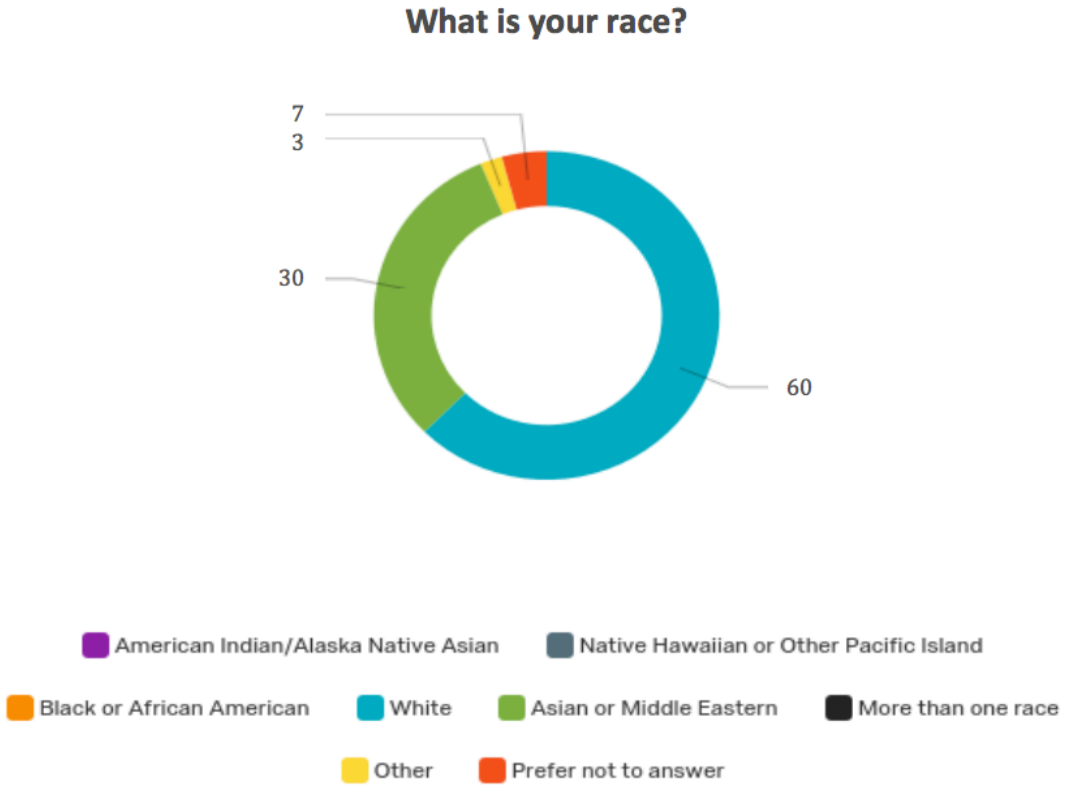

Figure 18. Race and Ethnicity

Table 2: Demographic and Dental Practice Characteristics of the Total Sample

	N	%
Gender		
Male	62	70%
Female	27	30%
Race		
White	56	63%
Asian or Middle Eastern	27	30%
Other	2	2%
Prefer not to answer	4	5%
Years of Practice		
0-5	20	22%
6-10	10	11%
11-15	10	11%
15-20	6	7%
20+	44	49%
Academic appointment		
Yes	45	50%
No	45	50%
Place of periodontal training		
Inside California	52	58%
Outside California	38	42%
Predominant work setting		
Private practice	63	28%
University	25	70%
Community health center	2	2%

Table 3: Demographic and Dental Practice Characteristics Breakdown by Procedure

Acute periodontal abscess	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Male Gender	0.779	0.209	2.901	0.523	-0.37	0.7090
Academic Appointment	0.376	0.111	1.268	0.232	-1.58	0.1150
CA Trained	0.479	0.133	1.727	0.313	-1.13	0.2610
Race (white comparison)						
Asian or Middle Eastern	1.343	0.333	5.418	0.956	0.41	0.6790
Other	1.000	-	-	-	-	-
Prefer not to answer	1.056	0.087	12.878	1.348	0.04	0.9660
Years of practice (1-5 years comparison)						
6-10 years	0.194	0.025	1.530	0.204	-1.56	0.1200
11-15 years	1.000	-	-	-	-	-
16-20 years	1.000	-	-	-	-	-
20+ years	0.471	0.100	2.212	0.372	-0.95	0.3400
Private Practice	4.019	0.989	16.331	2.875	1.94	0.0520
Practice size (partnership comparison)						
Group practice < 10	0.371	0.059	2.314	0.346	-1.06	0.288
Independent contractor	0.372	0.014	10.197	0.628	-0.59	0.558
_constant	3.802	0.518	27.921	3.868	1.31	0.1890

Traditional Perio	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Male Gender	2.227	0.462	10.723	1.786	1	0.318
Academic Appointment	0.687	0.173	2.726	0.483	-0.53	0.593
CA Trained	0.726	0.199	2.648	0.479	-0.48	0.628
Race (white comparison)						
Asian or Middle Eastern	1.446	0.250	8.363	1.295	0.41	0.681
Other	1.000	-	-	-	-	-
Prefer not to answer	1.204	0.064	22.615	1.801	0.12	0.901
Years of practice (1-5 years comparison)						
6-10 years	1.403	0.064	30.939	2.214	0.21	0.83
11-15 years	0.772	0.036	16.440	1.204	-0.17	0.868
16-20 years	1.000	-	-	-	-	-
20+ years	1.486	0.109	20.178	1.977	0.3	0.766

Traditional Perio continued	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Private Practice	1.000	-	-	-	-	-
Practice size (partnership comparison)						
Group practice < 10	0.353	0.059	2.100	0.321	-1.14	0.253
Independent contractor	1.000	-	-	-	-	-
_constant	0.356	0.016	7.967	0.564	-0.65	0.515

Socket preservation	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Male Gender	0.601	0.079	4.555	0.621	-0.49	0.622
Academic Appointment	0.374	0.079	1.760	0.295	-1.25	0.213
CA Trained	0.593	0.121	2.910	0.481	-0.64	0.52
Race (white comparison)						
Asian or Middle Eastern	1.881	0.295	11.979	1.777	0.67	0.504
Other	1.000	-	-	-	-	-
Prefer not to answer	0.265	0.011	6.164	0.425	-0.83	0.408
Years of practice (1-5 years comparison)						
6-10 years	1.000	-	-	-	-	-
11-15 years	1.000	-	-	-	-	-
16-20 years	0.514	0.033	8.004	0.720	-0.48	0.635
20+ years	2.125	0.188	24.052	2.631	0.61	0.542
Private Practice	1.000	-	-	-	-	-
Practice size (partnership comparison)						
Group practice < 10	0.203	0.034	1.217	0.185	-1.75	0.081
Independent contractor	2.483	0.143	42.977	3.612	0.63	0.532
_constant	6.272	0.198	198.587	11.057	1.04	0.298

GTR	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Male Gender	0.332	0.024	4.494	0.441	-0.830	0.407
Academic Appointment	0.694	0.086	5.615	0.741	-0.340	0.732
CA Trained	0.101	0.006	1.686	0.145	-1.600	0.110
Race (white comparison)						
Asian or Middle Eastern	1.087	0.105	11.258	1.296	0.070	0.944
Other	1.000	-	-	-	-	-
Prefer not to answer	0.067	0.001	3.098	0.131	-1.380	0.167
Years of practice (1-5 years comparison)						
6-10 years	1.000	-	-	-	-	-
11-15 years	1.000	-	-	-	-	-
16-20 years	0.151	0.006	3.993	0.253	-1.130	0.258
20+ years	5.898	0.393	88.615	8.154	1.280	0.199
Private Practice	1.000	-	-	-	-	-
Practice size (partnership comparison)						
Group practice < 10	0.646	0.042	9.866	0.898	-0.310	0.753
Independent contractor	11.092	0.407	302.590	18.710	1.430	0.154
_constant	28.916	0.378	2210.617	63.979	1.520	0.128

GBR	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Male Gender	0.601	0.065	5.586	0.684	-0.45	0.655
Academic Appointment	9.589	1.122	81.966	10.498	2.06	0.039*
CA Trained	0.657	0.078	5.502	0.712	-0.39	0.698
Race (white comparison)						
Asian or Middle Eastern	1.000	-	-	-	-	-
Other	1.000	-	-	-	-	-
Prefer not to answer	1.000	-	-	-	-	-
Years of practice (1-5 years comparison)						
6-10 years	1.000	-	-	-	-	-
11-15 years	1.000	-	-	-	-	-
16-20 years	1.000	-	-	-	-	-
20+ years	1.000	-	-	-	-	-
Private Practice	84.543	6.370	1122.029	111.531	3.36	0.001*

GBR continued	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Practice size (partnership comparison)						
Group practice < 10	1.000	-	-	-	-	-
Independent contractor	1.000	-	-	-	-	-
_constant	0.824	0.052	13.048	1.161	-0.14	0.891

Sinus augmentation	Odds Ratio	95% confidence interval	95% confidence interval	Standard Error	Z	P > |z|
Male Gender	0.546	0.079	3.776	0.539	-0.61	0.539
Academic Appointment	1.937	0.305	12.284	1.825	0.7	0.483
CA Trained	0.319	0.044	2.326	0.323	-1.13	0.26
Race (white comparison)						
Asian or Middle Eastern	1.000	-	-	-	-	-
Other	1.000	-	-	-	-	-
Prefer not to answer	1.000	-	-	-	-	-
Years of practice (1-5 years comparison)						
6-10 years	1.000	-	-	-	-	-
11-15 years	1.000	-	-	-	-	-
16-20 years	1.000	-	-	-	-	-
20+ years	1.000	-	-	-	-	-
Private Practice	12.155	1.717	86.039	12.137	2.5	0.012*
Practice size (partnership comparison)						
Group practice < 10	1.000	-	-	-	-	-
Independent contractor	1.000	-	-	-	-	-
_constant	6.979	0.545	89.435	9.082	1.49	0.135

IV. Discussion

IV. Discussion

The results of this study confirm that there is a greater tendency of prescribing antibiotics when bone graft is used. Given that the rate of post-operative infection defined as increasing and progressive soft tissue swelling with the presence of suppuration for periodontal surgeries is approximately 2% with and without antibiotics and that antibiotics do not necessarily prevent infections, it is surprising that practitioners continue to use antibiotics in conjunction with such procedures.[47] One possibility for the increased prescription of antibiotics when bone graft is used is the anticipation that the antibiotic will help to prevent graft failure. This may be gleaned from some of the free responses that stated the belief that bone graft is a foreign body or that bone graft is more prone to infection. Since the present study had a high prescription rate when asking providers to answer the scenarios in an otherwise *healthy* patient and a common rationale for these prescriptions was the presence of immune compromise or wound healing impairment in their patients, it may be noted that either practitioners treat a large number of unhealthy patients or that they commonly prescribe antibiotic regardless of patient's health status. The present study found that antibiotics were prescribed more often with more complex procedures namely with GBR and sinus augmentation. A motivation for this greater propensity to prescribe may be practitioners' concerns that the adverse outcome of an infection would be much more devastating when compared to less complex procedures. This was reinforced in the free response by respondents who stated that patients are spending a lot of money on procedures and it is hard to explain infection to them if they were not given an antibiotic. Since practitioners cannot see tangible changes in antibiotic resistance and alterations in individual microbiota, the weighing of potential risks and benefits is often done incorrectly.

An evidence-based set of guidelines would be of benefit to protect patients from the risks of unnecessary antibiotics. In medicine, guidelines are a mainstay of protocols and the adoption of a guideline-based practice would provide dentistry with many advantages. Over-prescription of antibiotics can have powerful impacts at the patient level and global level and as such, creating a standard resource for practitioners to use may help eliminate the threats imposed by unwarranted antibiotic use. Antibiotic stewardship, defined by the Society of Healthcare Epidemiology of America as the set of coordinated strategies to improve the use of antimicrobial medications with the goal of enhancing patient health outcomes, reducing resistance to antibiotics and decreasing unnecessary costs, is the responsibility of all practitioners and particularly surgeons. Antibiotic choice, time of administration, dose and duration are critical factors in increasing antibiotic stewardship.

A. Study Strengths

One of the strengths of the study was the ability to discern sizeable differences in self-reported prescribing behaviors with excellent reliability. The Cohen's kappa value for this study was between 0.83 and 1, which is regarded as almost perfect intra-rater agreement.[65,67] This level of agreement is synonymous with consistency of results and ability to retest the same group of individuals with the same survey and have similar findings. With the demographic questions, stratification of the data to look for differences between particular groups was also possible, albeit with limited statistical power. Although statistically significant differences were only found between periodontists in private practice and those who work in an academic setting, which should be interpreted with caution, the evidence obtained in the current study provides valuable insight into the diversity of reported antibiotic prescribing practices. This study also gauged not only if practitioners prescribe antibiotics in certain cases but their rationale and attitudes towards guidelines. The free response options allowed for an evaluation of specific

reasons for prescribing that may not have been noted in an otherwise standard response type question. Some surveys have been conducted on antibiotic prescribing habits in dentistry, but it is unknown if that information has affected changes in clinical practice without rationale questions.[20,41,58–60] Questions that determine practitioner rationale provide insight to address gaps in knowledge and understand the mindset of those who may be affected by the creation of guidelines. This along with the ability to determine attitudes towards the adoption of guidelines makes a practical next step for the profession possible and brings scientific data closer to promoting effective change.

B. Study Limitations

Some limitations of the study may be the number of participants. Most respondents of the survey were practitioners either practicing between 0-5 years or more than 20 years. The final number of participants did not afford a high degree of statistical precision or power, which limited the ability to detect statistically significant differences in the logistic regression models. Since only 100 people responded to the survey and those were all members of the California Society of Periodontists, this lack of diversity could be regarded as a drawback as it may not show the true antibiotic prescribing trends of the overall periodontist community especially those outside of California. The response rate of approximately 35% could also be seen as a point of bias as those who have stronger opinions about antibiotics may have been more likely to participate in the survey. Another limitation of the present study is that all non-bone grafting procedures were included together in one question. In a free response to the question about traditional periodontal surgery, a respondent included that he or she would have prescribed antibiotics when using non-autogenous tissue for grafting but not for traditional periodontal surgery (e.g. osseous surgery or open flap debridement). Separating these procedures more distinctly would have given more accurate self-reported antibiotic prescribing data. While the free response questions were helpful

in obtaining information about behavior and attitudes, all information was self-reported and may not have been the same as actual behavior. This study also did not consider implant related prescribing practices, which may have been useful for comparing further details of prescribing rationale.

C. Summary

In summary, practitioners are more likely to prescribe antibiotics with the use of bone graft and as the complexity of the bone grafting procedure increases. One of the most common reasons for antibiotic prescription was to decrease the chances of developing an infection. Based on the minimal risk for post-operative infection cited in the literature with such surgeries and the inherent risks of unnecessary antibiotic use, the establishment of evidence-based guidelines for practitioners on the appropriate use of antibiotics would be of benefit to the periodontics specialty and subsequently the dental profession. In the absence of such periodontal-specific guidelines, our recommendation is to follow a combination of the guidelines mentioned earlier in this review. In an otherwise healthy patient with a clean wound, such as in traditional periodontal surgeries, extraction with socket preservation, or GTR, no antibiotic augmentation is necessary. In the presence of a clean-contaminated wound such as GBR or sinus augmentation, a pre-operative dose of amoxicillin or clindamycin in penicillin-allergic patients may be given 60 minutes prior to incision. If the procedure is to last more than 3 hours, an additional dose may be given. No further prolongation of antibiotics should be given post-operatively regardless of patient's health status. If treating surgical site infection, a short course (3 day) of appropriate antibiotic should be given with re-evaluation of signs and symptoms of infection. In the persistence of infection, prolonging the course or switching the antibiotic is advised and should not exceed 7 days. Although the present study did not evaluate antibiotic use in implant surgeries, the authors recommend no additional antibiotic augmentation with uncomplicated

implant placement in otherwise healthy patients. A modification to include a prophylactic dose of antibiotic with no further prolongation of antibiotic after wound closure is left to the discretion of the practitioner in cases of immune compromise or impaired wound healing.

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E. Ethical Considerations

This survey and study were approved under exempt status by the institutional review board of University of California, San Francisco. Participants were provided $10 gift cards to Amazon or Starbucks (respondent preference) as an incentive to respond to the survey. At the end of the survey, an email address was shown on the screen for respondents to email if they desired a gift card. Gift cards were sent electronically via email response to any one who sent an email to the email address associated with the survey. Since the timing of the emails were separate from the time of the survey, there was no way to match responses to individuals protecting the anonymity of the study.

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Appendix Summary

Start of Block: Prescribing

Q1 In an otherwise healthy patient, would you prescribe antibiotics for an **acute periodontal abscess** that is not draining?

- ○ In most cases no (1)
- ○ In most cases yes (2)

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for an acute periodontal abscess... = In most cases no

Q1a What is your rationale for *not* prescribing antibiotics with this procedure? **Select all that apply**

- ☐ Because my patient is healthy (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Based on my clinical experience (4)
- ☐ I almost never prescribe antibiotics with this procedure (5)
- ☐ Other (please describe) (6)

_____

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for an acute periodontal abscess... = In most cases yes

Q1b What is your rationale for prescribing antibiotics with this procedure? **Select all that apply**

- ☐ For liability reasons (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Based on my clinical experience (4)
- ☐ To decrease the chances of developing an infection (5)
- ☐ I almost always prescribe antibiotics with this procedure (6)
- ☐ Other (please describe) (7)

_____

Q2 In an otherwise healthy patient, would you prescribe antibiotics for **socket preservation** procedures involving bone grafting?

- ○ In most cases no (1)
- ○ In most cases yes (2)
- ○ I do not perform this procedure (3)

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for socket preservation procedur... = In most cases no

Q2a What is your rationale for *not* prescribing antibiotics with this procedure? **Select all that apply**

- ☐ Because my patient is healthy (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Because I rarely see infections with this procedure (4)
- ☐ Because I use autogenous bone sources (5)
- ☐ I almost never prescribe antibiotics with this procedure (6)
- ☐ Other (please describe) (7)

_____

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for socket preservation procedur... = In most cases yes

Q2b What is your rationale for prescribing antibiotics with this procedure? **Select all that apply**

- ☐ For liability reasons (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Based on my clinical experience (4)
- ☐ To decrease the chances of developing an infection (5)
- ☐ Because I use non-autogenous sources of bone (6)
- ☐ I almost always prescribe antibiotics with this procedure (7)
- ☐ Other (please describe) (8)

_____

Q3 In an otherwise healthy patient, would you prescribe antibiotics for **traditional periodontal surgeries** (i.e. osseous, soft tissue grafting, open flap debridement)?

- ○ In most cases no (1)
- ○ In most cases yes (2)
- ○ I do not perform this procedure (3)

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for traditional periodontal sur... = In most cases no

Q3a What is your rationale for *not* prescribing antibiotics with this procedure? **Select all that apply**

- ☐ Because my patient is healthy (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Because I rarely see infections with this procedure (4)
- ☐ I almost never prescribe antibiotics with this procedure (5)
- ☐ Other (please describe) (6)

_____

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for traditional periodontal sur... = In most cases yes

Q3b What is your rationale for prescribing antibiotics with this procedure? **Select all that apply**

- ☐ For liability reasons (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Based on my clinical experience (4)
- ☐ To decrease the chances of developing an infection (5)
- ☐ I almost always prescribe antibiotics with this procedure (6)
- ☐ Other (please describe) (7)

_____

Q4 In an otherwise healthy patient, would you prescribe antibiotics for **guided tissue regeneration** procedures involving bone grafting around teeth?

- ○ In most cases no (1)
- ○ In most cases yes (2)
- ○ I do not perform this procedure (3)

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for guided tissue regeneration p... = In most cases no

Q4a What is your rationale for *not* prescribing antibiotics with this procedure? **Select all that apply**

- ☐ Because my patient is healthy (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Because I rarely see infections with this procedure (4)
- ☐ Because I use autogenous bone sources (5)
- ☐ I almost never prescribe antibiotics with this procedure (6)
- ☐ Other (please describe) (7)

_____

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for guided tissue regeneration p... = In most cases yes

Q4b What is your rationale for prescribing antibiotics with this procedure? **Select all that apply**

- ☐ For liability reasons (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Based on my clinical experience (4)
- ☐ To decrease the chances of developing an infection (5)
- ☐ Because I use non-autogenous sources of bone (6)
- ☐ I almost always prescribe antibiotics with this procedure (7)
- ☐ Other (please describe) (8)

_____

Q5 In an otherwise healthy patient, would you prescribe antibiotics for **ridge augmentation** procedures involving bone grafting?

- ○ In most cases no (1)
- ○ In most cases yes (2)
- ○ I do not perform this procedure (3)

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for ridge augmentation procedure... = In most cases no

Q5a What is your rationale for *not* prescribing antibiotics with this procedure? **Select all that apply**

- ☐ Because my patient is healthy (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Because I rarely see infections with this procedure (4)
- ☐ Because I use autogenous bone sources (5)
- ☐ I almost never prescribe antibiotics with this procedure (6)
- ☐ Other (please describe) (7)

_____

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for ridge augmentation procedure... = In most cases yes

Q5b What is your rationale for prescribing antibiotics with this procedure? **Select all that apply**

- ☐ For liability reasons (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Based on my clinical experience (4)
- ☐ To decrease the chances of developing an infection (5)
- ☐ Because I use non-autogenous sources of bone (6)
- ☐ I almost always prescribe antibiotics with this procedure (7)
- ☐ Other (please describe) (8)

_____

Q6 In an otherwise healthy patient, would you prescribe antibiotics for **sinus augmentation** procedures involving bone grafting?

- ○ In most cases no (1)
- ○ In most cases yes (2)

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for sinus augmentation procedure... = In most cases no

Q6a What is your rationale for *not* prescribing antibiotics with this procedure? **Select all that apply**

- ☐ Because my patient is healthy (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Because I rarely see infections with this procedure (4)
- ☐ Because I use autogenous bone sources (5)
- ☐ I almost never prescribe antibiotics with this procedure (6)
- ☐ Other (please describe) (7)

_____

Display This Question:

If In an otherwise healthy patient, would you prescribe antibiotics for sinus augmentation procedure... = In most cases yes

Q6b What is your rationale for prescribing antibiotics with this procedure? **Select all that apply**

- ☐ For liability reasons (1)
- ☐ My peers do this (2)
- ☐ Based on the current literature and guidelines (3)
- ☐ Based on my clinical experience (4)
- ☐ To decrease the chances of developing an infection (5)
- ☐ Because I use non-autogenous sources of bone (6)
- ☐ I always prescribe antibiotics with this procedure (7)
- ☐ Other (please describe) (8)

_____

End of Block: Prescribing

Start of Block: Rationale and Guidelines

7 If the American Academy of Periodontology developed and endorsed evidence-based guidelines for prescribing antibiotics for procedures involving bone grafting, would you follow them?

- ○ Yes (1)
- ○ No (2)
- ○ Not sure (3)

8 When you prescribe antibiotics in conjunction with bone grafting, what is your rationale? **Select all that apply**

- ☐ Because my patient's health status is immunocompromised (e.g. HIV, transplant patient) (1)
- ☐ Because my patient has a condition that affects wound healing (e.g. diabetes) (2)
- ☐ For liability reasons (3)
- ☐ My peers do this (4)
- ☐ Based on the current literature and guidelines (5)
- ☐ Based on my clinical experience (6)
- ☐ To decrease the chances of developing an infection (7)
- ☐ Because I use non-autogenous sources of bone (8)
- ☐ I do not prescribe antibiotics for bone grafting (9)
- ☐ Other (please describe) (10) _____

End of Block: Rationale and Guidelines

Start of Block: Demographics

9 How long have you been practicing?

- 0-5 years (1)
- 6-10 years (2)
- 11-15 years (3)
- 16-20 years (4)
- Greater than 20 years (5)

10 Where did you complete your highest level of training?

- Within the US, specifically California (1)
- Within the US, outside of California (2)
- Outside the US (3)

11 Which answer best describes the practice setting in which you work the majority of the week?

- Academic Clinic (1)
- Community Health Center (2)
- Private Practice (3)

Display This Question:

If Which answer best describes the practice setting in which you work the majority of the week? = Private Practice

11c What is the size of your practice?

- 1-2 practitioners (1)
- Group practice less than 10 practitioners (2)
- Part of a dental service organization (or large group ≥ 10 practitioners) (3)
- Independent practitioner without a primary office (i.e. traveling periodontist) (4)

12 Do you have an active full or part time academic appointment?

- Yes (1)
- No (2)

13 What is your gender?

- Male (1)
- Female (2)
- Other (3)
- Prefer not to answer (4)

14 What is your race?

- ○ American Indian/Alaska Native Asian (1)
- ○ Native Hawaiian or Other Pacific Island (2)
- ○ Black or African American (3)
- ○ White (4)
- ○ Asian or Middle Eastern (8)
- ○ More than one race (5)
- ○ Other (6)
- ○ Prefer not to answer (7)

15 What specialty do you practice?

- ○ Periodontics (1)
- ○ Oral Surgery (2)
- ○ General Dentistry (3)
- ○ Other (4)

End of Block: Demographics

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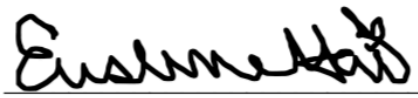

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