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- Oral Health Literacy in the Dental Office: The Unrecognized Patient Risk Factor
- Dental Diagnostics: Molecular Analysis of Oral Biofilms
- Diabetes and Oral Health: The Importance of Oral Health-Related Behavior
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The *Journal of Dental Hygiene* is the refereed, scientific publication of the American Dental Hygienists' Association. It promotes the publication of original research related to the profession, the education, and the practice of dental hygiene. The journal supports the development and dissemination of a dental hygiene body of knowledge through scientific inquiry in basic, applied, and clinical research.

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Editorial

Rebecca Wilder, RDH, BS, MS



Thank You!

A large number of individuals have contributed to making this past year a landmark year for the Journal of Dental Hygiene. We successfully made the transition to an online-only format and, once again, we have broken our previous record for the most submissions in a single year! We have a lot of people to thank for the success we have enjoyed this year. Of course, none of this would be possible without the energy, diligence, commitment and enthusiasm from a large number of ADHA members and other professionals who make the publication possible.

I wish to gratefully acknowledge the support and valuable contributions of the American Dental Hygienists' Association for their commitment to the Journal and for recognizing the value of scholarship to the growth of the profession. Specifically, I wish to thank our Journal Staff Editor, Josh Snyder for his attention to detail and pro-

fessional manner. Also, thanks to Ann Battrell, Executive Director, and Jeff Mitchell, Director of Communications, for their support and leadership at the ADHA.

We are proud of the peer review process and the quality publications that culminate from the efforts of the editorial review board and the other academicians who assist us with quality reviews. These volunteers, whether regular members or guest reviewers, make our publication one that all of us can be proud of as we strive to continuously grow our body of knowledge.

Thank You!

Sincerely,

Rebecca Wilder, RDH, BS, MS
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Linking Research to Clinical Practice

Treating Aggressive Periodontitis

Denise M. Bowen, RDH, MS

The purpose of Linking Research to Clinical Practice is to present evidence based information to clinical dental hygienists so that they can make informed decisions regarding patient treatment and recommendations. Each issue will feature a different topic area of importance to clinical dental hygienists with A BOTTOM LINE to translate the research findings into clinical application.

Griffiths GS, Ayob R, Guerrero A, et al. Amoxicillin and metronidazole as an adjunctive treatment in generalized aggressive periodontitis at initial therapy or re-treatment: a randomized controlled clinical trial. J Clin Periodontol. 2011;38(1):43–49.

Background: Previously, we showed that systemic metronidazole and amoxicillin significantly improved the outcomes of non-surgical debridement in generalized aggressive periodontitis patients. This study aimed to observe whether re-treatment with adjunctive antimicrobials would give the placebo group benefits comparable with the test group.

Methods: Thirty-eight of 41 subjects, from the initial 6 month trial, completed the second phase, the re-treatment of sites with remaining pockets of 5 mm. Subjects on placebo in phase 1 received adjunctive antibiotics for 7 days. Clinical parameters were collected at 2 months post-treatment (8 months from baseline).

Results: Patients who received antibiotics at initial therapy showed statistically significant improvement in pocket depth reduction and in the percentage of sites improving above clinically relevant thresholds, compared with patients who received antibiotics at re-treatment. In deep pockets (7 mm), the mean difference was 0.9 mm ($p=0.003$) and in moderate pockets (4 to 6 mm) it was 0.4 mm ($p=0.036$). Pockets converting from 5 to 4 mm was 83% compared with 67% ($p=0.041$), and pockets converting from 4 to 3 mm was 63% compared with 49% ($p=0.297$).

Conclusion: At 8 months, patients who had antibiotics at initial therapy showed statistically significant benefits compared with those who had antibiotics at re-treatment.

Commentary

Current classifications of periodontal diseases were developed at the 1999 World Workshop for the Classification of Periodontal Diseases and Conditions.¹ Aggressive periodontitis, formerly known as early-onset periodontitis/rapidly progressive periodontitis/juvenile periodontitis, was defined as rapid attachment loss and bone destruction in otherwise healthy individuals, with a familial pattern and microbial deposits that are inconsistent with severity of tissue destruction. The localized form occurs around puberty and affects incisors and first molars. The generalized form often affects people under 30 years of age, but patients may be older. In generalized aggressive periodontitis (GAgP), generalized interproximal attachment loss affects at least 3 permanent teeth other than the incisors and first molars. Invasive periodontal pathogens, neutrophil abnormalities and a poor serum antibody response to infecting agents are frequently identified. These characteristics provide the impetus for consideration of adjunctive antimicrobials in the treatment of aggressive periodontitis.²

In a previous study, these authors concluded that a 7 day regimen of systemic metronidazole and amoxicillin (500 mg each, 3 times per day) significantly improved clinical outcomes of non-surgical debridement in subjects with GAgP when administered in conjunction with initial therapy.

Those findings have been replicated in other studies of initial therapy for GAgP. The focus of this study was to assess whether systemic antibiotics in conjunction with full mouth root surface debridement (FMRSD) improve periodontal disease parameters better than FMRSD with a placebo in patients with GAgP when administered at re-treatment.

Several questions arise about this design. Why would the researchers want to test the antibiotics at re-treatment if they knew that the regimen was effective in initial therapy? Why are antibiotics considered in treatment of GAgP and not for treatment of chronic periodontitis? How does a clinician know when to include systemic antibiotics in a treatment plan for nonsurgical periodontal therapy?

Research findings indicate that FMRSD for chronic periodontitis is effective without prescribing antibiotics as adjuncts. Unnecessary use of antibiotics is also discouraged due to concerns about development of resistant strains of pathogens rendering drugs ineffective, risks and adverse reactions and cost. As a result, most clinicians attempt initial therapy for periodontitis without antibiotics and consider their use at re-evaluation if it is determined that FMRSD was ineffective.

The researchers had previously treated one group of subjects without antibiotics. These individuals could serve as the group receiving antibiotics at retreatment in phase 2, and those subjects who received antibiotics in the first trial would receive FMRSD alone. Although there was improvement in most subjects after phase 1, sites with ≥ 5 mm pockets remained. The first phase of the study included initial therapy with 2 and 6 month follow-ups, and this study was implemented 2 months later at reevaluation. Nineteen subjects in each group entered the second phase of the study. The authors reported, based on a power analysis, that 17 subjects in each group would be an adequate sample size for power needed to detect a difference of 1 mm in pocket depth (in deep pockets ≥ 7 mm), assuming 1 mm variation is normal. The sample size is only one of several factors in assuring there is enough power to detect a difference in outcomes if one exists, and generally a larger sample increases statistical power. Current guidelines for reporting clinical trials require authors to report this information.

Results indicated that antibiotics administered at initial therapy were more effective than administration of the same antibiotics at re-evaluation based on pocket depth reduction and percentage

of sites that improved above clinically relevant thresholds. In periodontal therapy studies, it is important to determine whether results are clinically relevant or just statistically significant. For example, a statistically significant reduction of 0.5 mm in pocket depths from 7 mm to 6.5 mm would not provide a good prognosis for health. A clinician would not want to adopt the intervention for their patients, even though a study may have found a significant difference. These researchers conducted an analysis to identify reductions in pockets by ≥ 2 mm or reductions in the number of pockets that would require additional treatment (≥ 5 mm to ≤ 4 mm or ≥ 4 mm to ≤ 3 mm). These parameters represent criteria used in practice to assess success of periodontal therapy at re-evaluation. Findings from a comparison of both groups indicated that, in deep pockets (7 mm), the mean difference in probing depth reduction was 0.9 mm ($p=0.003$), and in moderate pockets (4 to 6 mm) it was 0.4 mm ($p=0.036$). For pockets converting from ≥ 5 mm to ≤ 4 mm, the group receiving antibiotics at initial therapy had 83% of sites improved compared with 67% ($p=0.041$) at reevaluation. For pockets converting from ≥ 4 mm to ≤ 3 mm reduction, the percentage was 63% compared with 49% ($p=0.297$). The authors also reported a high incidence (42%) of adverse effects from the medication with the majority being minor such as mild nausea, vomiting, diarrhea, metallic taste or headache. These risks need to be weighed against the advantages of using systemic antibiotics in periodontal therapy, thereby reinforcing their potential use in GAgP cases and not in chronic periodontitis cases. It is interesting to note that none of the possible side effects of 0.2% chlorhexidine mouthrinse were reported, possibly because the subjects only were required to use it for 2 weeks following the debridement.

Although a statistically significant difference in pocket depth reduction was found from 0 to 8 months, it was found in both groups, perhaps because both groups had been exposed to antibiotics at some point in therapy. The main effect was found in phase 1 (0 to 6 months) when antibiotics were administered with initial therapy. These findings would not support the common approach of delivering initial therapy and waiting to see if it worked before prescribing antibiotics in patients with GAgP. Prescribing amoxicillin and metronidazole (500 mg each, 3 times a day) with FMSRD is more effective when administered with initial therapy. A careful periodontal assessment with consideration of all criteria for an accurate periodontal disease classification is indicated for appropriate care planning.

Varela VM, Heller D, Silva MX, Torres MC, Colombo AP, Feres-Filho EJ. Systemic antimicrobials adjunctive to a repeated mechanical and antiseptic therapy for aggressive periodontitis: a 6-month randomized controlled clinical trial. J Periodontol. 2011;82(8):1121-1130.

Background: The purpose of this study is to compare the additional benefit of systemic antimicrobials versus placebos to a repeated mechanical instrumentation combined with comprehensive local chemical plaque control for the periodontal treatment of GAgP.

Methods: This was a 6 month, randomized, double-masked, placebo-controlled clinical trial. All GAgP patients received full-mouth disinfection followed by staged scaling and root planing without (placebo group, n=17) or with (test group n=18) systemic antimicrobials (500 mg amoxicillin [AMX] + 250 mg metronidazole [MET], 3 times a day for 10 days). Clinical parameters were measured at baseline and 3 and 6 months post-therapy. Significant differences between groups at baseline were sought by using the Mann-Whitney U test, whereas comparisons over time were examined by using a general linear model repeated measures procedure.

Results: Both groups demonstrated similar improvements in most parameters over time. The test group presented a greater mean probing depth reduction and clinical attachment level (CAL) gain at sites with initially moderate probing depth at 6 months ($p<0.03$). No differences were seen between groups regarding mean reductions and mean gains, respectively, for probing depth and CAL initially ≥ 7 mm. The test group presented a higher percentage of sites that improved ≥ 2 mm and ended up with a probing depth ≤ 4 mm, or a lower percentage of sites that worsened ≥ 2 mm and remained with probing depth >4 mm at 3 months ($p<0.01$). No differences were noticed between groups for these parameters at 6 months.

Conclusion: AMX and MET brought additional clinical effects to the repeated mechanical and antiseptic treatment of GAgP in a very short time (3 months), which tended to fade away over time (6 months).

Commentary

This study assessed the adjunctive use of systemic antibiotics (500 mg amoxicillin [AMX] + 250 mg metronidazole [MET], 3 times a day for 10 days) in conjunction with full mouth disinfection followed by quadrant scaling and root planing for patients with GAgP. As mentioned in the discussion of the

preceding abstract, systemic antibiotics are considered in periodontal therapy for treatment of GAgP and not typically included in care plans for chronic periodontitis. All subjects received full-mouth ultrasonic debridement complemented by 0.2% chlorhexidine (CHX) irrigation in a 24 hour period, and home care instructions including daily use of 0.12% CHX twice a day as a mouthrinse and for tongue brushing. The test group received the antibiotics, and the control group was given a placebo to take for 10 days immediately following. Within a week, all subjects began quadrant scaling and root planning sessions with Gracey curets and 0.2% CHX irrigation of all pockets, with all quadrants completed within 4 to 6 weeks.

The sample included 17 control group subjects and 18 test group subjects. The authors reported that a power analysis indicated 17 in each group provided adequate power to detect differences of 1 mm in pockets ≥ 7 mm.

Probing depth and CAL were measured pre-intervention and post-intervention at 3 and 6 months. Although both groups showed improvement, the group taking the antibiotics with initial periodontal therapy showed a significantly greater average reduction in probing depth and gain in CAL at sites with initially moderate probing depth (≤ 6 mm) at 6 months. These pockets would be most appropriate for nonsurgical periodontal therapy. This same improvement in probing depth and CAL was found in deeper pockets (≥ 7 mm) at 3 months, but there was no difference between subjects receiving the antibiotic and those who did not at 6 months. These areas would normally require periodontal surgery for adequate response and long-term stability. When comparing both groups' improvement in percentage of sites reduced by ≥ 2 mm or reduced to ≤ 4 mm, the test group had more sites showing these clinically relevant changes than the control group at 3 months. However, these changes were not found at 6 months. This finding combines clinical results of treating moderate and deep pockets. The fact that those changes were not sustained over time might have been related to the need for surgical correction of the deeper pockets (≥ 7 mm).

The regimen for antibiotics differed in this study from the standard protocol used in the previously discussed study. These subjects were prescribed 500 mg AMX and 250 mg MET, 3 times a day for 10 days. The standard protocol is 500 mg AMX and 500 mg MET, 3 times a day for 7 days. The side-effects reported in this study were more varied, possibly due to the longer regimen prescribed or perhaps due to the requirement in this study that subjects complete a compliance document daily and record

any adverse effects. Several of the side-effects also could be attributed to the long-term CHX use in this study as compared to the 2 week regimen used post-therapy in the former study. Side-effects included oral ulcerations, metallic taste, dizziness, nausea, diarrhea, tongue staining, teeth staining, taste alterations and mouth burning. The lower dose of MET was intended to reduce side effects; however, the authors note that it is possible that the 250 mg of MET 3 times a day is less effective than at a higher dosage, and could explain the minimal effect in the test group in this study.

The conclusion drawn by the authors was that the use of AMX and MET brought some additional clinical benefits to repeated SRP and antiseptic therapy for GAgP in the short term (3 months), which had a tendency to disappear at 6 months. This conclusion is related to the authors' identified primary outcome measure of deep pockets (≥ 7 mm) and the clinically relevant measures which included the percentage of sites reduced by ≥ 2 mm or reduced to ≤ 4 mm. It does not draw a conclusion about the moderate pockets (4 mm to 6 mm) which did maintain successful reductions at 6 months.

The Bottom Line

Each of these studies addressed the adjunctive use of antibiotics in patients with GAgP. Although this classification of periodontitis is less common than chronic periodontitis, prevalence has been estimated to be 2% for GAgP and 4% for localized aggressive periodontitis in individuals between the ages of 18 and 30 years.³

Both of these studies provide support for use of systemic antibiotics in the initial nonsurgical treatment of GAgP. Both authors also emphasize the importance of prudent use of antibiotics in periodontal therapy because of concerns about side effects/adverse reactions, development of resistant strains rendering the antibiotics ineffective and cost. Based on the findings of these studies, the following conclusions can be drawn:

- For patients with GAgP, adjunctive therapy with systemic antibiotics (500 mg amoxicillin and 500 mg metronidazole, 3 times a day for 7 or 10 days) with nonsurgical periodontal therapy (full mouth debridement, scaling and root planing) results in greater reduction of pocket depths and clinical attachment gains in moderate pockets (4 to 6 mm) when compared to nonsurgical periodontal therapy alone. For pockets ≥ 7 mm, this improvement was found at 6 months in one study, and detected only at 3 months in another. Deep pockets should be referred for periodontal

surgery. Systemic antibiotics added a benefit, especially in the moderate categories of probing depth and CAL.

- Adjunctive systemic antibiotic therapy is more effective when administered with initial nonsurgical periodontal therapy than when administered at reevaluation.
- A thorough periodontal examination with consideration given to characteristics of aggressive periodontitis should be performed for all patients between the ages of 18 and 30 years. Bone and attachment loss in the mandibular incisors and first molars, as well as 3 other sites, presence of deposits inconsistent with degree of attachment loss and a familial pattern suggest a classification of GAgP. When GAgP is found, consultation with the dentist or periodontist and the adjunctive use of antibiotics should be considered in conjunction with initial nonsurgical periodontal therapy rather than waiting to see if periodontal debridement/scaling/root planing alone will be effective at reevaluation.

Summary

Evidence presented in this column indicates that adjunctive antibiotics should be considered in treatment plans for GAgP, despite the fact that they are not recommended for initial treatment of chronic periodontitis. Both of these studies were well-designed and provide support for dental hygienists to alter normal care planning and treatment considerations for GAgP cases.

Denise M. Bowen, RDH, MS, is Professor Emerita in Dental Hygiene at Idaho State University. She has served as a consultant to dental industry, as well as numerous government, university and private organizations and presently is a member of the National Advisory Panel for the National Center for Dental Hygiene Research in the U.S.

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Critical Issues in Dental Hygiene

Oral Health Literacy in the Dental Office: The Unrecognized Patient Risk Factor

Julie H. Schiavo, MLIS, AHIP

Introduction

Dental hygienists devote a large portion of their time to educating patients about their oral health, dental procedures and preventive measures to encourage better habits, increase treatment success and assuage patient fears. Clear communication is a vital factor in patient education, but a patient's health literacy is also important and often overlooked by dental health care professionals. Adequate health literacy enables patients to become an active part of the dental health care process and to act in their own best interests. Millions of American adults, who are unable to read dental patient health or insurance information, are unable or unwilling to admit this deficit. A patient's health literacy level can have far-reaching and often surprising consequences. Research has shown that literacy skills predict an individual's health status more strongly than age, income, employment status, education level and racial or ethnic group.¹ The modern health care system makes an unprecedented demand on patients' literacy skills. To successfully negotiate through the system, patients are expected to find more information on their own, understand and accept new rights and responsibilities and make decisions for themselves and others.² Dental hygienists are in a unique position to help patients with low oral or general health literacy, thus empowering them to take an active role in their oral health care.

Health literacy is not only the ability to read but includes the skills necessary to decipher dosage charts, understand appointment slips, understand doctor's directions and complete medical, dental or insurance forms. Improved consumer health literacy

Abstract

Purpose: According to the report Healthy People 2010, oral health literacy is the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate oral health decisions. Studies have linked a patient's health literacy to a variety of significant health behaviors, statuses and outcomes. This article provides an overview of the literature concerning the levels of health literacy among adults in the U.S., the effects of literacy levels on treatment and patient outcomes, literacy assessment in the practice setting and the effects of a patient's literacy on communication with a dental health provider. The implications of inadequate patient oral health literacy on the practice of dental hygienists and communication recommendations are discussed, as is the need for future research specifically on oral health literacy.

Keywords: Communication Barriers, Dental Health Education, Health Knowledge, Attitude, and Practice, Health Promotion, Literature Review, Oral Health, Oral Health Literacy, Patient Acceptance of Health Care, Patient Participation, Professional-Patient Relations

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Assess strategies for effective communication between the dental hygienist and client.

is deemed so important that it was included as an objective in the U.S. Department of Health and Human Services' Healthy People 2010, and is a part of the Surgeon General's 2000 report, Oral Health in America.^{3,4} Oral health literacy, as defined by Healthy People 2010, is "the degree to which individuals have the capacity to obtain, process and understand basic health information and services needed to make appropriate oral health decisions."^{3,4} As a result of its inclusion in Healthy People 2010, health literacy research has greatly increased over the last decade. Researchers are studying the effects of low health literacy on patients in different settings and developing instruments to aid in the identification of those who struggle with literacy.

Patient health literacy is considered to be an important aspect of patient care by the American Dental Hygienists' Association (ADHA). The ADHA has presented to the Institute of Medicine (IOM) committees on oral health, including An Oral Health Initiative, a study convened by IOM in 2010. The study, comprised of dental hygienists, dentists, nurses, physicians, epidemiologists and health promotion experts, examined oral health literacy from a broad perspective with a goal to increase oral health literacy in Americans.^{5,6} ADHA has concluded that a patient's literacy is a factor to be evaluated to determine a patient's level of general or oral health risk in the Standards of Clinical Dental Hygiene Practice.⁷

In 2008, the American Dental Association (ADA) House of Delegates passed the following 3 resolutions to promote communication in the profession:

1. The need for dental professionals to communicate in a clear, accurate and effective manner
2. Continued funding through National Institutes of Health, including the National Institute of Dental and Craniofacial Research, to encourage research in health literacy
3. Strategic plan development through the ADA Council on Access, Prevention and Interprofessional Relations and other agencies to improve the oral health literacy of the public⁸

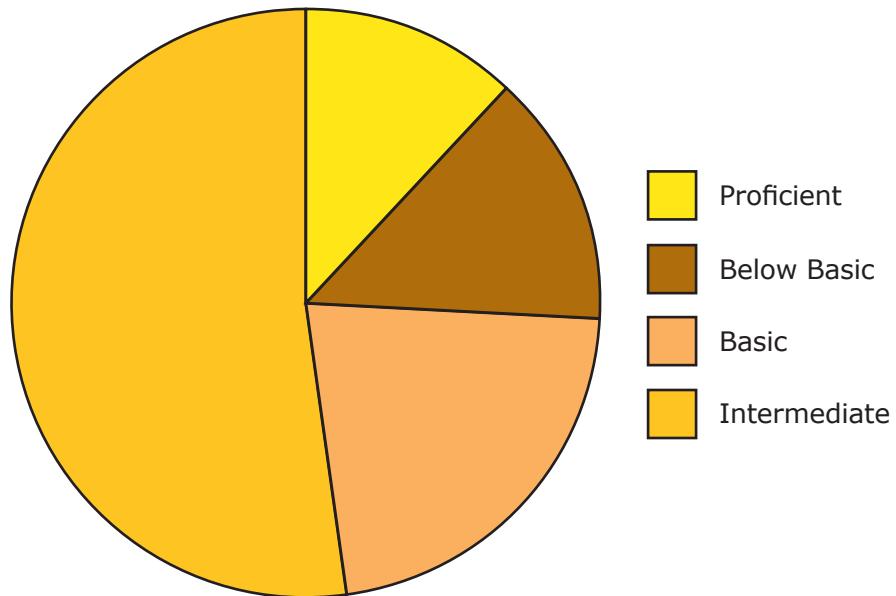
In 2009, ADA's Council on Access, Prevention and Interprofessional Relationships published Health Literacy in Dentistry Strategic Action Plan 2010–2015 to provide guidance to the ADA, dental professionals and policy makers to improve patient health literacy by developing a set of principles, goals and even some specific strategies.⁹

This literature review discusses the levels of health literacy among adults in the U.S. and the effect of literacy levels on dental treatment and patient outcomes. Suggestions for health literacy assessment in the practice setting are discussed as are recommendations for effective communication between the dental team and the patient who struggles with literacy.

Adult Literacy in America

The National Center of Educational Statistics conducted the National Assessment of Adult Literacy

Figure 1: Adult Health Literacy Levels: Results from the National Assessment of Adult Literacy, 2003



(NAAL) in 2003 to assess the literacy of U.S. adults.¹⁰ The NAAL was administered to approximately 30,000 adults: 18,000 adults living in households and 12,000 prison inmates. The following results are based on the household sample. Participants in the NAAL survey were grouped in 1 of 4 literacy levels: below basic, basic, intermediate and proficient, depending on their responses to the questions. The results of the assessment give an accurate snapshot of adult health literacy in America (Figure 1).¹⁰

Effects of Health Literacy on Treatment

The link between a patient's health literacy level and dental or medical prognosis has been demonstrated by current research. Patients who have insufficient health literacy levels have less knowledge about their chronic medical conditions and are less able to manage the conditions.^{11–13} They are at a higher risk of being hospitalized and tend to remain in the hospital longer than patients with higher health literacy rates. Patients with low health literacy levels are more prone to make medication errors due to misinterpretations of drug label instructions or a lack of knowledge of dosing methods or measurements.^{14,15} Researchers have also concluded that inadequate health literacy has a strong association with mortality in elderly persons.¹⁶ Parental health literacy can affect the health of a child. Children with parents or caregivers who have low health literacy scores are more likely to be hospitalized, engage in more risky health behaviors and have less desirable health outcomes both in dental and medical situations. Studies have shown that when parental literacy is improved, children benefit.^{17–19}

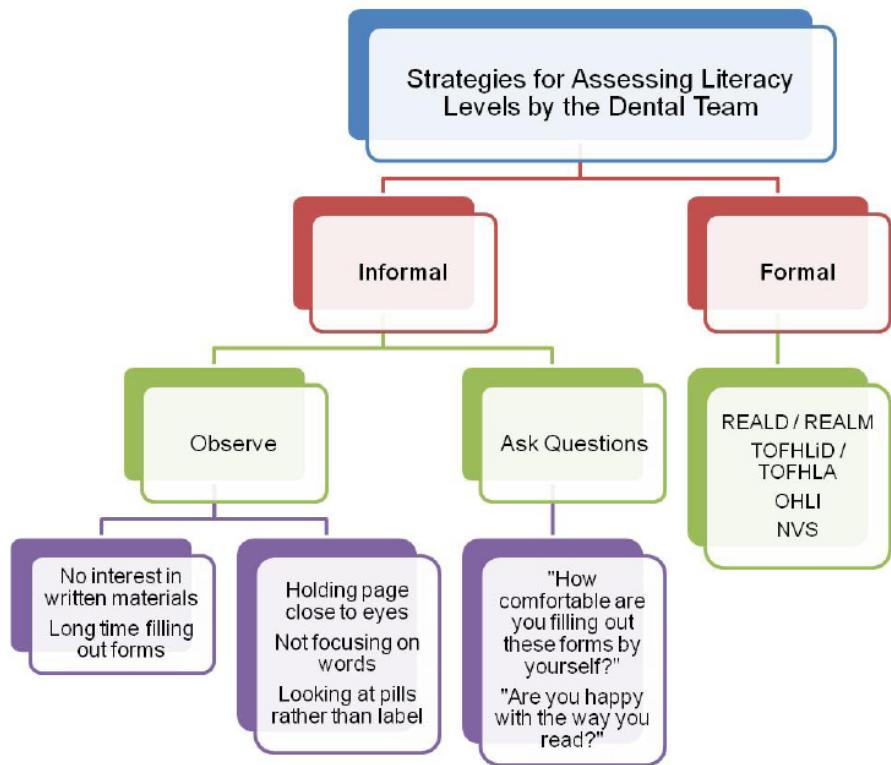
Health professionals tend not to recognize the signs of low health literacy and are not aware of their patients' reading levels. Studies have found that both physicians and residents consistently overestimate their patients' literacy levels and fail to recognize patients at risk of low literacy.^{20,21} A health professional's overestimation of a patient's literacy level can present a barrier to effective communication and be detrimental to a positive treatment outcome.

Assessing Literacy in the Practice Setting

Patients with limited health literacy can be difficult to identify, as the problem is spread across social, racial and economic borders. In 2007, Jones et al concluded that a significant number of dental patients have low health literacy. These patients exhibit a lower level of dental knowledge, less recent dental care and worse self-perceived oral health status.²²

The dental hygienist can look for signs that a patient has a low literacy level. Patients with a low literacy level will often show little or no interest in written documentation, such as pamphlets or health history forms, and will often express frustration or impatience when encouraged to use printed materials. A patient with low health literacy will take a long time filling out forms and will return them incompletely or incorrectly completed. A patient may make excuses to avoid reading or completing a form, saying "I forgot my glasses at home," or "I'm too tired to read right now, I'll take it home and do it later." Poor readers may show signs of nervousness, confusion, frustration or even indifference and withdraw from situations where their reading difficulties may be noticed. Patients may also give the wrong answers to questions about something they have just been given to read. A dental hygienist can often spot a patient who is having problems reading by simply watching the patient's eyes. If a patient's eyes wander over the page, do not focus on one area and then move on, he or she is most likely not actually reading. Poor readers may also hold the paper close to their eyes or follow the words with their finger while reading. Another sign of low literacy is when the patient looks at the pills inside a bottle rather than reading the label when describing the purpose of the medication. Such a patient has associated the size, shape and color of the pill with its intended purpose rather than actually reading the label.^{23,24}

Figure 2: Strategies for Assessing Literacy Levels by the Dental Team



The dental hygienist can take a proactive approach to health literacy assessment. If low literacy is suspected, a casual conversation on the subject can often reveal valuable insight into a patient's level of literacy. Simply asking a patient "What do you like to read?" "Are you happy with the way you read?" or "How often do you read?" can begin a conversation on the subject. A study by Wallace et al in 2006 determined that clinicians can identify patients with low literacy levels by asking them the simple question, "How confident are you filling out medical forms by yourself?" The answers patients gave to this question corresponded well to their performance on formal literacy assessments.²⁵ Approaching a patient with low reading ability with a simple, non-judgmental question may allow the hygienist to offer the assistance a patient needs without causing any shame or discomfort.

If a more formal assessment of health literacy is desired, there are several options available, such as the Rapid Estimate of Adult Literacy in Dentistry (RE-ALD), the Test of Functional Health Literacy in Adults or the Oral Health Literacy Instrument (Figures 2, 3).²⁶⁻³² Although health literacy assessments can be an important tool for the dental team, a formal assessment, however brief, may not be ideal in an office practice setting. There is a possibility of causing the patient discomfort, alienation and shame when a literacy assessment becomes a part of an exam. Persons who live with the daily struggles resulting

from an inability to read well develop elaborate coping skills to hide their deficiency, even from those to whom they are closest. If a literacy assessment becomes a regular part of a dental exam, patients with low literacy skills may begin to avoid offices that administer such tests and not receive needed treatment. Formal health literacy assessments can be safely administered in research settings in which the patients are informed of the purpose of the study and give consent but are not currently recommended as regular screening techniques.³³

Communication

Many factors can affect a person's ability to read, comprehend and use information. This is true for all persons, regardless of their literacy level, but a low literacy level can compound simple problems. Conditions that are inherent in dental treatment can often make a patient's literacy ability decrease. Stress and illness are often the largest contributors to a patient's inability to read, understand or remember a health provider's advice. Even those with good general literacy skills may find dental and general health care information difficult to understand, and as a result, be hesitant to ask questions.²⁴ Patients with low health literacy scores do not ask as many questions as those with sufficient health literacy scores. They are less likely to ask a health care provider to repeat a concept they do not understand. Dental health care providers must be aware of this and take measures to make themselves clear to the patient.³⁴

A patient's age and the normal aging process can affect health literacy levels. Among the many factors are the generational culture of a patient and physical or mental health conditions. An elderly patient's background can affect interaction with a health provider. Many elderly patients grew up in a culture where one did not question the recommendations of a health care provider. The patient was to do as told regardless of their understanding of the treatment. Factors such as a loss of visual, auditory or mental acuity in the aged population also change a patient's health literacy levels. Reading ability scores tend to decline dramatically after the age of 55.²³

Figure 3: Popular Formal Health Literacy Assessment Tools

Medical			
REALM (Rapid Estimate of Adult Literacy in Medicine)	1991	Word recognition test	5min
REALM	1993	Shortened version of REALM	2min
Test of Functional Health Literacy in Adults	1995	Reading comprehension and numerical ability	22min
NVS (Newest Vital Sign)	2005	Literacy and numeracy skills	3min
Dental			
REALD-30	2007	Word recognition test	5–10min
REALD-99	2007	Longer version of REALD-30	5–10min
Test of Functional Health Literacy in Dentistry	2007	Reading comprehension and numerical ability	30min
Oral Health Literacy Instrument	2009	Comprehension, numerical ability, and general oral health knowledge	45min

Language barriers can be a contributor to a patient's low health literacy level. When a person is under stress, comprehension and communication are inherently easier in a patient's native language. If that language is not the language of the health provider, communication will be hindered. Spoken language skills and reading skills can be drastically different within the general population, and these differences can be greatly magnified in persons who are communicating in a language that is not native to them.

Cultural differences must also be considered under the scope of a patient's health literacy. Many cultures give the family priority over the individual, and as a result, health-related decision making is done as a family unit – the patient may not be the person responsible for making the decisions for the family. A patient may not be comfortable asking questions of a health professional of a different gender or status. Some cultures advocate showing deference and politeness to those who are perceived as authority figures, such as health care providers. Often, in an attempt to not offend or appear confrontational, a patient from such a culture will not ask questions. Such differences can make communication difficult for the patient and the provider must insure the patient understands the diagnosis, treatment plan and ramifications of not following the treatment plan.³⁵

It is important for the dental hygienist to use good communication skills when treating patients who have low health literacy. The amount of information initially given should be limited to what the patient needs to know as opposed to what is good to know. The provider should focus on 3 to 5 main points the patient should know to aid in comprehension. Re-

Figure 4: Medical Terms and Plain Language Alternatives

Medical Term	Plain Language alternative	Medical Term	Plain Language alternative
Abscess	Pocket of infection	Halitosis	Bad breath
Allergen	Something you are allergic to	Hypertension	High blood pressure
Amalgam	Filling material	Immediate	Right away
Analgesic	Pain killer	Inflammation	Pain, swelling, heat, redness
Anti-inflammatory	Lessens swelling, fever, or pain	Intake	What you eat or drink
Benign	Not cancer	Migraine	Very bad headache
Bridge	False teeth	Neglect	Don't take care of
Bruxism	Grinding your teeth	Non-Prescription	You can buy it without a prescription
Carcinoma	Cancer	Occlusion	Way teeth fit together when you bite
Cardiac problems	Heart problems	Oral	Mouth
Caries	Cavities; tooth decay	Orthodontics	Braces
Chronic	Constant; life-long condition	Palate	Roof of your mouth
Confidential	Private, secret	Periodontal disease	Gum disease
Crown	Cap or cover over your tooth	Permanent	Lasting forever
Deciduous teeth	Baby teeth; first set of teeth	Pulp	Tooth nerves
Denture	False teeth	Refrain	Stay away from; stop doing
Diagnosis	Cause or name of your illness	Root Canal	Removal of damaged tooth nerve
Drug interaction	One drug's effect on another drug	Severe	Very bad; dangerous
Enlarge	Get bigger	Side effect	Effect caused by a medicine you take
Extraction	Pull a tooth	Symptoms	What you are feeling; signs
Function	Does the job; action	Toxic	Poisonous
Gingivitis	Gum disease	Xerostoma	Dry mouth
Sealants	Coating painted on teeth to prevent cavities	Tempromandibular Joint	Joint that attaches jaw to skull

Adapted from: Clear Health Communication: Media – Words to Watch.³⁸

search has concluded that less than 50% of the information conveyed to a patient during the course of an appointment will be retained.³⁶ Dental offices should strive to maintain a “shame-free” environment. All patients should be offered assistance and staff should never try to single out patients they believe have low health literacy skills.^{2,37}

Using plain language that is simple, easily understood and jargon-free is important in ensuring the patient understands. Dental hygienists are surrounded by technical terms and jargon as part of their education and daily practice – the language used by providers is often not easily understood by the dental patient and their family. Using everyday language to convey meaning is much easier on both the provider and the patient. Terms such as cavities as opposed to caries, or gum disease as opposed to periodontal disease can improve patient/provider communication (Figure 4).

Dental hygienists should always explain the rea-

sons why a treatment has been recommended and emphasize the benefits of complying with the treatment plan. It is important to be clear and concise when explaining how a patient should comply. Patients can easily become confused with dental care devices, oral rinses or medication if their use is not sufficiently explained. Drawing pictures, using visual aids or active demonstrations will aid in the comprehension of directions. Dental hygienists should also remember to speak slowly and allow for ample time for the patient to voice any questions. Although the urge to repeat directions in a louder voice when not understood is strong, research has shown it actually distracts from the understanding of the message. Communication is more likely if the hygienist rethinks the words and manner used to convey the message.³⁹

Patients with low literacy levels often have highly developed coping systems that have allowed them to function in society. If asked by a health provider if they understand the information that they have been

given to read, patients will almost always reply in the affirmative in an attempt to not admit their deficiencies. A health provider should seek this information in a non-judgmental and casual manner. Telling patients that many people have problems with these instructions will give patients an opportunity to admit their ignorance and still keep their pride.²³

The Teach-Back Technique can be a useful tool to ensure that a patient understands the instructions from a health care provider. By using this technique, the provider asks the patient to repeat the instructions in their own words or demonstrate the concept. This can be accomplished in several non-threatening and non-judgmental ways. Patients should not be asked questions that can be answered with a yes or no response – learning will be reinforced if patients are asked to supply information or demonstrate and restate concepts.⁴⁰ Another tool is the Ask Me 3 education program developed by the Partnership for Clear Health Communication. Ask Me 3 is an office philosophy that seeks to communicate to the patient that the dental team in that office want to answer 3 main questions: What is my main problem? What do I need to do? Why is it important for me to do this? Patients are encouraged through posters, brochures and flyers placed throughout the office or clinic to ask these questions, write down the answers and bring the information home with them.⁴¹

Patient education pamphlets, booklets or other written material are useful in providing patients the information they need about privacy, dental conditions, procedures or treatment options. However, reading level must be considered when choosing the material. If a dental hygienist provides patients with pamphlets or other health information in print form, they should be written in no higher than a fifth or sixth grade level. The average American reads at a seventh to ninth grade level – health related materials are often written at a much higher level.⁴² If possible, written material should be illustrated with clear graphics.⁴³ Pamphlets should focus on a few main important facts stated as clearly as possible. Health Insurance Portability and Accountability Act notices and informed consent paperwork are even more difficult for a patient with literacy concerns as the nature of the documents require them to be written at a higher reading level.^{42,44,45}

Conclusion

Through awareness of oral health literacy, dental hygienists can enhance the patients' role in their own health care. Millions of American adults have health literacy problems which are not related to intelligence or education – many factors play a role in how a patient can understand and process health information at any time. Patients' health literacy rates have been linked to prognosis, compliance and even mortality, yet many dental health professionals may not even be aware the patient is having a problem. Oral health literacy can be determined in many different ways. Formal assessments can be conducted or informal, conversational, questions may be asked of the patient. With this information, a dental hygienist can tailor oral health information to the patient's needs. Plain language and assurance that questions are welcomed and assistance is available will give a patient confidence in the dental hygienist and the office or clinic.

Health literacy is a relatively new subject in the medical and dental literature. Research is growing rapidly, but has been dominated by studies held in medical settings. Although some research has been done on the implications of inadequate oral health literacy in specifically the dental setting, more research is needed.

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Review of the Literature

Dental Diagnostics: Molecular Analysis of Oral Biofilms

Sarah Hiyari, MS; Katie M. Bennett, PhD

Introduction

Some of the first microorganisms studied in the dawn of microbiology originated from dental plaque. Dutch scientist Antonie van Leeuwenhoek performed some of his initial experiments on scrapings of plaque from his teeth, and these studies would establish the foundations for modern microbiology. In one of his studies, he described scraping the white material lodged between his gums and teeth, in which he observed "moving animalcules."¹ At the time, Leeuwenhoek only had the aid of a microscope to analyze the microorganisms he observed from the teeth scraping samples. Some of the organisms described by van Leeuwenhoek, though unknown at the time, were the most abundant microorganisms present in the oral cavity.

W.D. Miller, a practicing dentist in the 1890s, spent much of his time analyzing the microbes found in the oral cavity. He later wrote a book called *Microorganisms of the Human Mouth*, which discussed the theory that microorganisms present in the mouth were a group of bacteria working together.² These initial studies on dental biofilms have inspired further studies of the organisms that live in the oral cavity. Today, dental biofilms are defined as a diverse community of microorganisms living as a structural unit, with complex communication pathways between species.³ These microbial colonies have also been found to cause dental caries and periodontal disease.⁴

Dental plaque is a well organized biofilm that attaches to the tooth surface. Its location in the mouth allows for a constant source of moisture, nutrients, warmth and surface, all of which contribute to its growth. The inhabitants of the mouth are incredibly diverse, and mutualistic relationships often take place. While some microbes occupy the niche pro-

Abstract

Purpose: Dental biofilms are complex, multi-species bacterial communities that colonize the mouth in the form of plaque and are known to cause dental caries and periodontal disease. Biofilms are unique from planktonic bacteria in that they are mutualistic communities with a 3-dimensional structure and complex nutritional and communication pathways. The homeostasis within the biofilm colony can be disrupted, causing a shift in the bacterial composition of the colony and resulting in proliferation of pathogenic species. Because of this dynamic lifestyle, traditional microbiological techniques are inadequate for the study of biofilms. Many of the bacteria present in the oral cavity are viable but not culturable, which severely limits laboratory analysis. However, with the advent of new molecular techniques, the microbial makeup of oral biofilms can be better identified. Some of these techniques include DNA-DNA hybridization, 16S rRNA gene sequencing, denaturing gradient gel electrophoresis, terminal restriction fragment length polymorphism, denaturing high-performance liquid chromatography and pyrosequencing. This review provides an overview of biofilm formation and examines the major molecular techniques currently used in oral biofilm analysis. Future applications of the molecular analysis of oral biofilms in the diagnosis and treatment of caries and periodontal disease are also discussed.

Keywords: dental biofilm, dental plaque, oral health, PCR, bacteria, molecular techniques, 16S rRNA, sequencing

This study supports the NDHRA priority area, **Clinical Dental**

Hygiene Care: Assess how dental hygienists are using emerging science throughout the dental hygiene process of care.

vided by the host, other species may only thrive in the presence of the primary colonizers. Further, the developing colony may prevent competing species of bacteria from colonizing by monopolizing space and resources. This mutualistic relationship is an important aspect in the development of biofilms in general, and modern research techniques have expanded our understanding of the ecology of oral bacterial communities.

Dental plaque formation is unique from typical biofilm formation due to the nature of the oral environment. Tartar, or calculus, is a calcified deposit on the teeth that is formed by the continuous presence of plaque. The rough surface of the tartar pro-

vides an ideal place for plaque to accumulate. Almost immediately, a salivary glycoprotein film called a pellicle coats a clean tooth. The pellicle allows for the adherence of gram positive primary colonizers, which include *Streptococcus mutans*, *Streptococcus anguis* and Actinomycete species.^{5,6} The biofilm mass continues to increase due to the multiplication of the primary colonizers, which provides a place for other organisms to subsequently attach. In a span of 1 to 3 days, the secondary colonizers adhere to the gram positive primary colonizers. These secondary colonizers are generally gram negative species and typically include *Fusibacterium nucleatum*, *Prevatella* species and *Capnocytophaga* species.⁶ In the final stage of dental biofilm formation, the tertiary colonizers attach, and there is an overall shift from gram positive facultative microbes to gram negative anaerobes.⁴⁻⁶

The thriving biofilm may result in cariogenic conditions that can lead to caries, or affect the adjacent soft tissue and result in periodontal disease. Further, chronic oral infections have also been associated with systemic diseases, such as diabetes and heart disease, due to the spread of oral microbes into the blood stream, and to certain lung diseases due to the aspiration of the plaque into the respiratory system.^{7,8} Thus, oral biofilms have health consequences beyond infections of the mouth, and novel methods for eradication or control of these colonies are needed.

In traditional microbiology, the individual cell unit is typically the focus. However, in the case of biofilms and dental biofilms in particular, the whole organism is working together and each bacterium is dependent on the other species present.³ Therefore, typical microbiological approaches may not be sufficient for the identification or study of biofilm-forming bacteria. Treatment strategies must incorporate a more holistic, ecological approach to the control of the dental biofilm. An understanding of the etiology of diseases caused by oral biofilms first requires identification of the bacterial species involved, which is best accomplished using molecular genetic techniques. This review summarizes many of the molecular techniques that may be utilized in the detection of bacterial species in dental biofilms and discusses the future of molecular diagnostics in dental hygiene practice.

Methods used for Study of Biofilms

Due to the complex multispecies lifestyle of dental biofilms, unique research methods have been developed for the study of these organisms. Traditional culturing methods of bacteria are often insufficient for the analysis of biofilms, because many bacteria

that are present in the oral cavity are considered viable but not culturable.⁹ It has been suggested that less than 1% of microorganisms can be cultured in the laboratory, meaning that the vast majority of oral bacteria evade standard microbiological detection methods.⁹ This has led to the development of alternative methods to assess dental biofilms based on DNA analysis or other molecular techniques. By learning more about the genetics and biochemistry of the organism, we can derive better strategies for treating infection. Biofilm colony homeostasis is a delicate balance, and when disrupted, pathological species can predominate.⁵ DNA analysis can allow identification of all of the species present in an oral biofilm, of which only 1 or 2 species may be the pathological culprits. By knowing which species of bacteria are present in the oral cavity, new treatment options can be developed that would, in turn, provide better dental care. Table I summarizes each molecular technique discussed below.

Checkerboard DNA–DNA Hybridization

DNA–DNA hybridization is considered the gold standard of oral biofilm analysis. It was developed by Socransky et al for the synchronized processing of large numbers of samples and the profiling of multiple species within the same sample in a semi-quantitative manner.¹⁰ The technique relies on the binding of DNA isolated from bacterial samples to a membrane, followed by hybridization with DNA probes specific to at least 40 different bacterial species.¹⁰ This method is very useful for analyzing dental plaque because of the simultaneous processing of large numbers of samples.¹¹ The technology has been able to detect microbes present on oral surfaces, biofilm composition in periodontal disease and bacterial prevalence in specific oral communities.¹²⁻¹⁵ Furthermore, this technique has been used to assess the outcome of therapeutic treatment.¹⁶

Because of the use of whole genome probes, DNA–DNA hybridization was originally limited only to the identification of species that can be cultured. However, a reverse capture checkerboard hybridization method was developed.¹⁷ In this modification of the traditional method, PCR-amplified 16S ribosomal RNA genes of up to 30 known bacterial species are spotted onto blots. The membrane is then hybridized with PCR-amplified 16S rRNA genes from unknown plaque samples. The primers for these targets are labeled with universal probes which are detected by chemiluminescence. This reverse capture hybridization method allows for 1,350 hybridizations simultaneously on 1 membrane.¹⁷ A disadvantage of these slot-blot methods is that they are rather laborious, and non-hybridization PCR methods are now more commonly used.

Table I: Summary of molecular techniques for dental biofilm analysis

Molecular Method	Pros	Cons	References
Checkerboard DNA-DNA Hybridization	<ul style="list-style-type: none"> • Simultaneous profiling of multiple species • Large number of plaque samples can be processed simultaneously 	<ul style="list-style-type: none"> • Traditional methods limited to culturable species of bacteria • Labor intensive 	10–17,37
16S rRNA Gene Sequencing	<ul style="list-style-type: none"> • High-throughput • Identifies uncultivable species 	<ul style="list-style-type: none"> • Low resolution at species level • No standardized threshold for distinguishing new species 	18–20
DGGE	<ul style="list-style-type: none"> • Each band pattern represents different bacterial population • Shows relative abundance of each species collected 	<ul style="list-style-type: none"> • Difficulty maintaining reproducible results • Multiple species sequences may co-migrate 	26,27,30
T-RFLP	<ul style="list-style-type: none"> • Quick detection of genetic diversity 	<ul style="list-style-type: none"> • High computational power needed • Novel software and database required 	31–33
DHPLC	<ul style="list-style-type: none"> • Detect point mutations 	<ul style="list-style-type: none"> • In its infancy stages with assessment of dental biofilms • Fairly new technology, needs more optimization 	36–38
Pyrosequencing	<ul style="list-style-type: none"> • Rapid results • Identify microbes and determine antibiotic resistance genotype 	<ul style="list-style-type: none"> • Cannot sequence full-length 16S rRNA gene 	39–41

16S rRNA Gene Sequencing

The 16S ribosomal RNA gene is highly conserved and can be used in the formation of phylogenetic trees or genetic relationships.^{18,19} This discovery, along with the advent of PCR techniques, has allowed the analysis of oral biofilms on a genetic level. 16S RNA is present in almost all bacterial species, with unique sequence differences allowing discrimination between species.²⁰ Amplification methods, such as 16S rRNA sequencing, have eliminated the requirement for culture based techniques, allowing the identification of uncultivable species. Identification of the species present is determined by comparing the 16S rRNA sequence derived from the unknown sample to databases of known species. Figure 1 summarizes the process of 16S rRNA sequencing.

There is some disagreement on the similarity threshold necessary to verify a species.²⁰ A reasonable criterion for genus identification is a 97% similarity score to a known database sequence, while 99% similarity was determined sufficient to identify at the species level.²¹ A limitation of this method is low resolution in distinguishing between bacteria at

the species level. Species may share identical 16S rRNA sequences or the differences between related species may be very small (less than 0.5%).²⁰ Despite these limitations, 16S rRNA sequencing has yielded a wealth of new information about dental biofilms. 16S rRNA analysis has shown that there are over 300 bacterial species present in the oral cavity that were not initially identified by typical culturing methods.^{22,23} Furthermore, it was found that there are differences in bacterial flora present in the oral cavity of individuals with immunosuppressive diseases such as HIV.²⁴ A total of over 700 bacterial species have been identified in the oral cavity, many of which are specific to a particular oral surface.²⁵

Denaturing gradient gel electrophoresis

Denaturing gradient gel electrophoresis (DGGE) is a PCR and electrophoresis-based approach for analysis of microbial communities. Various marker genes, including 16S rRNA, are amplified using PCR and then analyzed on a denaturing gel. A banding pattern develops based on the denaturation characteristics determined by the sequence composition of each amplified DNA. Each band observed on a DGGE gel theoretically represents a different bacte-

rial population within a community.²⁶ Thus, DGGE band patterns can illustrate the complexity and diversity of a biofilm sample, and individual bands can be subsequently excised and sequenced to determine species identity. Figure 2 shows a schematic example of a DGGE gel. DGGE has been applied in the analysis of oral microbial communities in conditions such as periodontitis and severe childhood caries.²⁷⁻²⁹ A limitation of DGGE is that sequence differences greater than 1 base pair may fail to separate on a denaturing gel because of similarities in nucleotide proportions that result in identical denaturing characteristics of 2 different sequences. Therefore, excision and sequencing is necessary to confirm the identification of species present within an individual band.³⁰

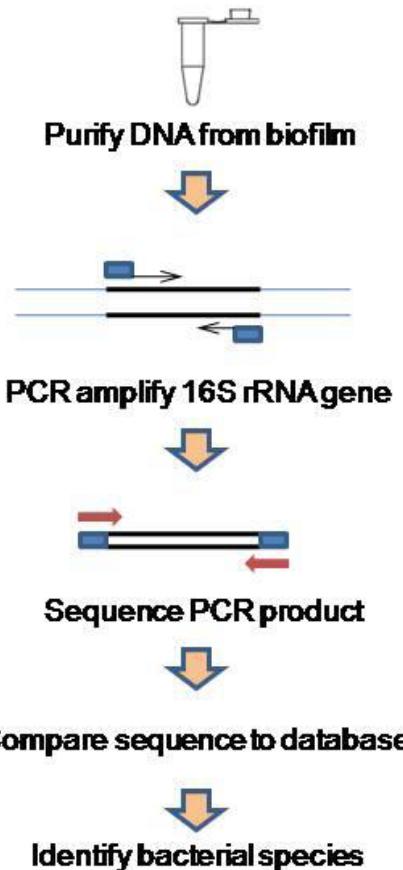
Terminal Restriction Fragment Length Polymorphism

Terminal restriction fragment length polymorphism (T-RFLP) is another PCR-based technique that can be applied to the study of oral biofilms. This technique originated from the study of bacterial diversity in environmental samples, and was later used for the analysis of oral microbial communities.³¹⁻³⁴ T-RFLP is similar to DGGE in that certain gene markers, including 16S rRNA, are amplified by PCR using gene-specific primers labeled with a fluorescent probe. The amplified products are then digested with restriction endonucleases, and the fragments are separated by capillary electrophoresis. The fragments with the attached fluorescent probes are detected by the instrument and analyzed using fragment analysis software. When the samples are analyzed by gel electrophoresis, specific banding patterns can be assessed which represent complex microbial communities.³⁵ This technology has been used to assess different microbial profiles in human saliva, changes in microbial communities in the oral cavity after treatment and bacteria present in infected root canals.³²⁻³⁴ The applications of T-RFLP are promising, but the technique is still in its infancy stages. T-RFLP requires expensive instrumentation, high computational power and very large databases to compare the genetic sequences.¹¹

Emerging Technologies

A number of recently developed techniques have been implemented for microbial identification, and these methods show potential for future applications in the study of oral biofilms. Denaturing high-performance liquid chromatography (DHPLC) is a PCR-based method which is followed by separation based on partial denaturation of the amplified DNA. This technique can be used to detect DNA sequence changes, such as point mutations.³⁶ DHPLC has

Figure 1: 16S rRNA Gene Sequencing Flowchart



This figure shows a general schematic of the process of 16S rRNA sequencing. DNA is first purified from the biofilm sample or bacterial isolate. The 16S rRNA gene is amplified from the genomic DNA using gene-specific primers. Either the entire 16S rRNA gene or a smaller hypervariable region of the gene may be amplified. The PCR product is then sequenced, and the sequence is compared against a database of known bacterial species. Exact or nearly exact (>99%) sequence alignment between known and unknown sequences can identify a microbe at the species level. Bacteria may only be identifiable at the genus level (>97% sequence identity).

been previously utilized in other areas of research, such as intestinal microbiota, and has more recently been applied for analysis of dental biofilms and bacteria.^{37,38} Techniques used in chronic wound biofilm analysis may also become useful for oral biofilm research and diagnosis. Pyrosequencing, a rapid sequencing method that can simultaneously identify microbes and detect antibiotic resistance, has been applied for the determination of bacterial diversity in chronic wound biofilms such as in diabetic foot

ulcers, venous leg ulcers and pressure ulcers.³⁹⁻⁴⁰ Recently, the pyrosequencing method was applied to the analysis of saliva and supragingival plaque samples, and it was estimated that 19,000 different microbial species are present in the mouth.⁴¹ Studies which utilize these next-generation methods are revealing that original approximations of oral microbial diversity were highly underestimated.

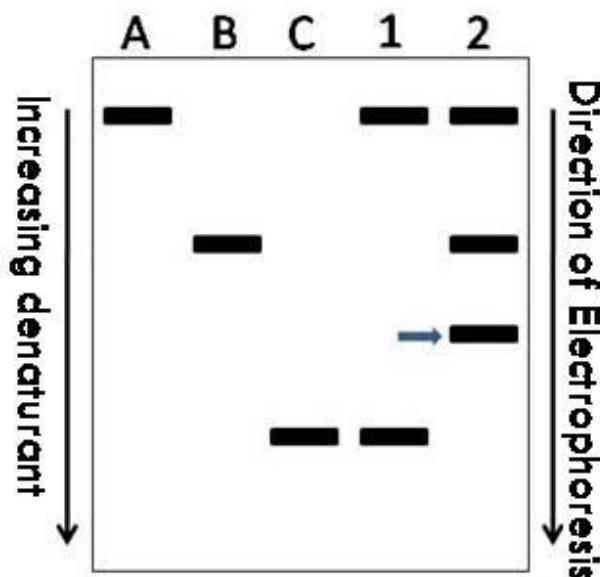
Discussion

The mainstream application of molecular methods in both research and clinical settings has allowed for a rapid expansion of our understanding of the oral microbial environment. As in other fields, such as chronic wound care, the future management of oral disease will benefit from adoption of molecular biofilm analysis methods. While the identification of species present within a plaque biofilm is essential for focused treatment, the understanding of the unified communication and adaptive changes that occur within the microbial community as a whole is equally important. Some future directions should include the assessment of gene expression levels in the oral biofilm. The analysis of gene expression within a biofilm can help aid in the identification of virulence factors that might make the biofilm more resistant to antibiotics or other treatment, similar to studies performed on methicillin-resistant *S. aureus*.⁴² Methods such as real-time PCR or microarray can analyze the gene expression patterns that may make a particular biofilm population inclined to cause disease. Expression data derived by such methods can be applied to analyze oral biofilms under conditions such as inflammation or immune suppression, or can be used to evaluate dental bacteria behavior before and after antibiotic treatment. This can provide insight into how the oral biofilm communicates and behaves as a whole unit.

As molecular techniques become mainstream and more widely available in clinical laboratories, the capability to obtain individual patient biofilm profiles is becoming attainable. By identifying the pathogenic bacteria in a patient, treatment can be personalized to the infection. A recently launched clinical diagnostic laboratory (OralDNA Labs) now offers molecular testing to dental practitioners for the diagnosis of periodontal disease, using PCR-based tests to identify pathogenic oral bacteria.⁴³ Such services may help avoid the generalized use of antibiotics that are ineffective or encourage antibiotic resistance. The traditional empirical method of prescribing antibiotics in dentistry has been questioned because of unnecessary or inappropriate use of antibiotics that can lead to antibiotic resistant organisms.^{44,45}

There are a number of obstacles preventing the

Figure 2: Schematic of a DGGE Gel



Various marker genes, such as 16S rRNA, are amplified by PCR and analyzed by denaturing electrophoresis. The polyacrylamide gel consists of a gradient of denaturant, typically urea and formamide. PCR products which are similar or identical in molecular weight are separated based on differing denaturing characteristics determined by the unique nucleotide sequence. Distinct bands represent different sequences of DNA from different bacteria present in the sample. For example, lanes A, B and C represent known bacterial samples. Lanes 1 and 2 are biofilm samples of unknown bacterial composition. Bands that migrate similarly in the unknown lanes are compared to the known bands. The biofilm sample in lane 1 includes Microbe A and Microbe C, while the sample in lane 2 includes Microbe A, Microbe B and an unknown species. The unknown band, indicated with an arrow, can be excised from the gel and sequenced for identification.

immediate marriage of dentistry and molecular diagnostics. Rapid treatment and relief for the patient is a primary concern for the dental practitioner. A patient with a critical oral infection should not be denied treatment for the 48 hours or more that is required for traditional microbiological tests, thus empirical treatment has been traditionally utilized in the absence of a better option. However, the rapid nature of most molecular assays provides a vast improvement over lengthy culture methods, with many molecular techniques providing identification of organisms in a matter of a few hours. Even a turnaround time of 24 hours for reliable identification of pathogenic bacteria can allow for customized modification of the initial empirical antibiotic treatment of very ill patients, particularly for refractory forms of oral disease. There is underuse of diagnostic microbiology laboratories by dental practitioners,

which may be mitigated by a greater awareness of the services provided by such laboratories.⁴⁴

Other considerations for implementation of molecular diagnostics in dental practice are that of practicality and cost.⁴⁶ Some of the techniques discussed above are currently cost prohibitive for routine use in the diagnosis of oral infection. The reimbursement of molecular assays by third-party payers is also complicated by lacking or ambiguous Current Procedural Terminology codes for some molecular tests. However, molecular assays are rapidly becoming higher-throughput and more standardized, and some molecular tests are kit-based and relatively inexpensive. Nonetheless, while molecular diagnostics are quickly becoming a feasible approach, laboratory diagnosis of oral disease will likely remain reserved for patients with severe periodontal disease or those who have been unresponsive to traditional treatment. Although molecular diagnostics will not take the place of the primary clinical methods of prevention and debridement, it does offer a beneficial complement to the practice of dental hygiene.

Conclusion

Understanding the complex interactions between bacteria that occur within an oral biofilm will provide insight necessary for improving diagnosis, treatment and prevention of periodontal disease. Dental practitioners should be aware of emerging diagnostic techniques and should strive to work in concert with researchers to harness new technologies for improving biofilm management. Molecular diagnostics of dental biofilms will allow for rapid, focused and personalized treatment, enhancing the traditional methods used by dental hygienists to control and prevent periodontal disease.

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Diabetes and Oral Health: The Importance of Oral Health–Related Behavior

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Introduction

Diabetes mellitus is a chronic debilitating disease that is gaining ground as a global epidemic, and is a major public health concern and economic burden in the U.S.^{1,2} According to the statistics provided by the National Institute of Diabetes and Digestive and Kidney Diseases, 23.6 million U.S. citizens have diabetes and 57 million adults aged 20 years and older have pre-diabetes, resulting in a total of 80.6 million U.S. citizens who were either diagnosed as diabetic or pre-diabetic.³ Given the potential for severe oral health complications of diabetes and the steady increase in the incidence of the disease, it is crucial to understand the role of dental hygienists in this context.^{4,5} This study shows that patients diagnosed with diabetes do indeed have poorer oral health than patients that were not diagnosed with diabetes, and investigates whether there are differences in the oral health-related behavior of these 2 groups of patients. Finally, this study demonstrates the importance of oral health promotion efforts for the oral health of patients with diabetes by comparing the oral health status of patients with diabetes and of patients not diagnosed with diabetes.

Review of the Literature

The complications of diabetes are numerous and include nephropathy, retinopathy, neuropathy, peripheral vascular disease, coronary artery disease and severe oral health complications.⁴⁻⁶ Research has documented relationships between diabetes and oral health diseases such as periodontitis, den-

Abstract

Purpose: The objective of this study was to explore oral health-related behavior, how patients with diabetes differ from patients not diagnosed with diabetes in their oral health and whether oral health-related behavior moderates the oral health status of patients with diabetes.

Methods: Survey and chart review data were collected from 448 patients (52% male, 48% female, average age: 57 years) of which 77 were diagnosed with diabetes (17%).

Results: Patients with diabetes had a higher percentage of teeth with mobility than those not diagnosed with diabetes (14% vs. 8%, p=0.023), as well as gingival recession (16% vs. 12%, p=0.035) and more teeth with recession in the esthetic zone (1.17 vs. 0.88, p=0.046). They also had more decayed, missing and filled surfaces due to caries (101 vs. 82, p<0.001) and more missing teeth due to caries (11 vs. 7, p<0.001). Patients with diabetes brushed and flossed less frequently. Patients with diabetes who did not brush regularly had poorer periodontal health (percentage of teeth with probing depth of <4 mm: 82% vs. 60%, p=0.039, 4 to 6 mm: 34% vs. 17%, p=0.059) and more caries (percentage of decayed teeth: 32% vs. 15%, p=0.033) than regularly brushing patients with diabetes.

Conclusion: Educating patients with diabetes about the importance of good oral self care needs to become a priority for their oral health care providers.

Keywords: Diabetes, periodontal disease, caries, tooth brushing, oral hygiene, oral hygiene education

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Investigate the effectiveness of oral self-care behaviors that prevent or reduce oral diseases among all age, social and cultural groups.

tal caries, oral mucosal lesions, burning mouth syndrome, xerostomia and tooth loss.^{5,7-12} Concerning the effects of diabetes on the periodontium, Tsai et al showed in 2002 that there is a strong relationship between periodontal health and glycemic control.¹³ On one hand, poor glycemic control in patients with diabetes is related to increased severity of periodontal disease.^{11,14} On the other hand, severe periodontal disease can result in poor glycemic

control and other complications.¹⁵⁻¹⁷ These relationships have been widely investigated and the consensus is that there is a bidirectional relationship between these chronic conditions.^{16,18}

In addition to the findings concerning the relationship between diabetes and periodontal disease, research also shows that patients with diabetes have a tendency for increased caries activity.^{18,19} While the relationship between caries and diabetic control has not been as clearly established as the relationship between diabetes and periodontal disease, research showed that patients with diabetes have an increase in cariogenic bacteria, higher plaque levels, increased root surface caries and higher numbers of decayed, missing and filled teeth (DMFT) due to caries, compared to patients without diabetes.^{18,20,21}

Additional research shows that patients with diabetes have increased tooth loss,^{11,12} most likely due to multiple causes, such as increased periodontal disease and caries, as well as delayed wound healing due to macrovascular and microvascular changes and taste alterations.^{21,22} Other neurosensory disorders, like dysphagia and burning mouth syndrome, have been reported and could be related to salivary flow, change in food intake and neuropathy.⁹ Patients with diabetes also reportedly have an increase in the incidence of fungal lesions, which may be explained by the immunocompromised state and reduced salivary flow.²³ These findings underline the fact that patients with diabetes tend to be systemically compromised and that their oral environment is also compromised due to the reduction in the buffering capacity and volume of their saliva and the change in bacterial flora.²⁰

When considering the complications of diabetes, it is crucial to acknowledge that lifestyle changes and long term behavior modification strategies can significantly reduce the morbidity and mortality of these patients.⁵ Concerning oral health-related consequences, research shows that a lack of knowledge about the relationship between diabetes and oral health can lead to poor oral health-related behavior.²⁴ For example, there is evidence that patients with diabetes may have a lower utilization rate of dental care services.¹⁵ In addition, Syrjala et al reported that patients with diabetes might have poorer oral health-related behavior compared to patients without diabetes, and suggested that oral health care and diabetic care are related.²⁵ Research also suggests that patients with diabetes who have better oral self care also have better glycemic control.^{14,2}

This study explores whether good oral hygiene

efforts in patients with diabetes also result in significantly improved oral health.

Based on the findings of earlier research, the current study has 3 objectives:

1. To investigate whether patients diagnosed with diabetes have poorer oral health than patients not diagnosed with this disease
2. To investigate the differences in oral health-related behavior between these 2 groups of patients
3. To analyze whether there are differences in the oral health of patients with diabetes who engage in good oral hygiene efforts versus patients with diabetes with poor oral self care behaviors

If such differences can be demonstrated, they would provide a strong basis to argue that dental hygienists must take on the responsibility of educating patients with diabetes about the importance of sound oral hygiene practices for the oral health of these patients.

Methods and Materials

This study was approved by the Institutional Review Board for the Health Sciences of the University of Michigan, in Ann Arbor, Michigan. Table I provides an overview of the respondent characteristics. Data were collected from 443 adult patients (male: 229, 52%, female: 213, 48%) at the pre-doctoral dental clinics at the University of Michigan School of Dentistry. The patients ranged in age from 18 to 72 years (mean=56.52, SD=16.584), were predominantly European American (72.6%), African American (9.3%), Hispanic (1.6%) and Asian/Pacific Islanders (1.6%), and had, on average, 13.91 years of schooling (SD=2.841). A total of 77 patients self-reported that they had been diagnosed with diabetes. The remaining 366 patients were included in this study as the control group subjects.

When the patients arrived for a regularly scheduled dental appointment, they were informed in the waiting area about the study. They were required to provide written consent and sign a Health Information Privacy Act Agreement to be able to participate in the study. They either self administered the questionnaire or the survey questions were asked in a face-to-face interview if the patients were unable to read the questions. If the questions were read to the patients, no explanations were provided. The clinical charts of the patients were reviewed to collect objective oral health data.

The survey included questions concerning the patients' socio-demographic background (gender, age,

ethnicity/race and years of schooling), oral health-related behavior (frequency of brushing, flossing and whether the patients had visited the dentist during the past year) and whether the patients had been previously diagnosed with diabetes. The questions concerning the frequency of brushing and flossing were taken from the National Health and Nutrition Survey.²⁷

The oral health data was collected in a chart review. All exams reported in these chart reviews were conducted by dental students in the same institution who were all educated in the same manner and were all closely supervised by dental school faculty. The chart review data included indicators of the degree of periodontal disease, of caries and the number of missing teeth. The first periodontal indicator was a global rating of the patients' gingival health with the 3 categories (good, fair and poor). These assessments were made by the providers according to their instruction to rate the gingival health based on the color, contour, consistency of the gingiva and bleeding on probing with these 3 general categories. The second set of periodontal indicators were the percentages of teeth with pocket depths of <4 mm, 4 to 6 mm and >6mm at the day of the data collection and at the prior appointment. The pocket depth was measured from the gingival margin to the depth of the pocket using a Michigan "O" probe. No data was available to determine the length between the current and prior appointment.

Both the measurements of bleeding on probing and periodontal probing depth were determined on all teeth present. Instead of using the number of teeth with mobility or gingival recession, this study included the percentage of teeth with mobility compared to the teeth present. This procedure was selected to account for the possibility that the number of extracted and missing teeth of patients with diabetes may differ from the numbers of the control group patients. A comparison of the absolute number of teeth with mobility and gingival recession would be affected by the differing numbers of teeth present in the 2 groups. In order to avoid this bias, the percentages of affected teeth compared to the teeth present were computed. However, because only the total number of teeth present was available, no determination of the percentage of teeth with recession in the esthetic zone could be computed because the number of teeth present in the esthetic zone was not available. Therefore, the num-

Table I: Background characteristics of the patients with vs. without diagnosed diabetes

	Diabetes – yes* n=77	Diabetes – no n=366	p-value
Gender:			
- male	48 (62%)	181 (50%)	0.028
- female	29 (38%)	184 (50%)	
Age: Mean/SD	64/12.7	55/16.9	<0.001
Ethnicity:			
- African American	5 (7%)	35 (10%)	0.514
- European American	60 (79%)	258 (72%)	
- other	11 (14%)	67 (18%)	
Years of schooling: Mean/SD	13/2.5	16.9/2.9	0.002
If diagnosis of diabetes:			
- No Insulin	44 (71%)	---	
- Insulin	18 (29%)		

*The question used to identify patients with versus without diabetes asked: "Were you ever diagnosed with diabetes?"

ber of teeth with recession in the esthetic zone was not included in the analysis because no percentages could be computed.

Indicators of caries included the percentage of decayed teeth, determined clinically and observed on periapical and bite wing radiographs. Other indicators included the number of missing teeth due to caries, the number of extracted teeth, the percentages of restored teeth/crowns at the day of the data collection (as well as at a prior appointment) and the number of replaced missing teeth. The number of decayed, missing and filled surfaces (DMFS) due to caries and the number of DMFT due to caries scores were determined for each patient. Information about how many teeth were missing due to caries versus other reasons (such as removal of third molars) was collected as well.

Statistical Analysis

Descriptive statistics concerning the percentages of responses were computed to provide information about frequency distributions. Independent sample t-tests were used to determine how patients with diabetes versus patients without diabetes differed in their oral health and oral health-related behaviors, as well as patients with diabetes who brushed regularly versus those who did not brush regularly. The differences were measured with continuous answer scales. Chi-square tests were used to compare the responses of these groups to categorical questions, such as whether the patients were edentulous or not.

Results

Table I shows that patients with diabetes differed in 3 ways in their background characteristics from the control group respondents. They were more likely to be male, were on average about 9 years older and had about 4 fewer years of education on average than the control group subjects, who had not self-identified as having been diagnosed with diabetes.

Concerning the periodontal indicators, a global assessment of the patients' gingival health as either good, poor or fair was included in these analyses, as well as more specific measures obtained in periodontal exams, such as the percentage of teeth with <4 mm, 4 to 6 mm, more than 6 mm pocket depth and with mobility. Table II shows that there was a tendency for patients with diabetes to be more likely to have fair and poor gingival health. The patients with diabetes did not differ in the percentages of teeth with <4 mm, 4 to 6 mm and ≥6 mm probing depth. However, the 2 groups differed as predicted in the percentage of teeth with mobility, the percentage of teeth with gingival recession and the number of teeth with recession in the esthetic zone.

Table II also shows that the number of DMFS was significantly higher in the group of patients with diabetes compared to the group of patients without diabetes, while there was only a tendency for the DMFT score to differ as predicted. However, there was a clear difference in the number of missing teeth due to caries. Patients with diabetes missed on average 11.44 teeth due to caries, while patients not diagnosed with diabetes missed on average 6.94 teeth due to caries ($p<0.001$).

Table II: Oral health indicators of patients with vs. without diabetes

Indicators of gingivitis/periodontal disease	Diabetes – yes n=77	Diabetes – no n=366	p-value
Answer alternatives concerning gingival health:			
– good	43.3%	59.3%	0.056
– fair	44.8%	31.3%	
– poor	11.9%	9.4%	
% probing depth (last charting)			
– <4 mm	77%	72%	0.195
– 4–6 mm	21%	25%	0.109
– >6 mm	1%	2%	0.535
Percentage of teeth mobility	14%	8%	0.023
Percentage of teeth with gingival recession	16%	12%	0.035
Number of teeth with recession in esthetic zone	1.17	.88	0.046
Indicators of caries			
DMFS	100.62	81.64	<.001
DMFT	22.77	21.04	.083
Percentage of decayed teeth, clinically determined	19%	13%	.093
Number of missing teeth due to caries	11.44	6.94	<0.001
Percentage of restored teeth/crowns	50%	43%	0.239
Percentage of previously restored teeth	46%	43%	0.440
Missing teeth			
Number of missing teeth due to other reasons	3.49	3.56	0.730
Number of extracted teeth	14.93	10.47	<0.001
Number of replaced missing teeth	8.19	5.32	0.010

The data also showed that the 2 groups differed in number of extracted teeth as predicted. The patients with diabetes had on average 14.93 teeth extracted compared to the patients not diagnosed with diabetes who had only 10.47 teeth extracted ($p<0.001$). On average, 3.49 of these missing teeth in the group of patients with diabetes and 3.56 of these teeth in the group not diagnosed with diabetes were extracted for reasons not related to caries (Table II).

In addition to exploring oral health differences, the second objective was to determine whether these 2 groups differed in their oral health behavior, and whether patients with diabetes showed fewer oral health promotion efforts compared to patients without diagnosed diabetes. Table III illustrates that the data supported this hypothesis – 4.1% of patients with diabetes never brushed and 11% rarely

brushed. When compared to patients not diagnosed with diabetes, only 0.6% never brushed and 1.9% rarely brushed. The percentage of patients with diabetes who brushed at least once a day was 72.6% and 87.6% among patients who had not been diagnosed with diabetes ($p<0.001$). The 2 groups also differed as predicted in their flossing frequencies, with 52.8% of diabetic patients rarely or never flossing compared to 35.5% of the non-diabetic patients.

The third objective focused on exploring whether the degree to which patients with diabetes engage in oral health-related behavior contributes to the degree of oral disease they experience. For this purpose, the oral health indicators of the 72.6% of patients with diabetes who brushed at least once a day were compared with the oral health indicators of the 27.4% of patients who brushed less than once per day. Table IV shows that patients who brush regularly had fewer teeth with 4 to 6 mm pocket depth, and more healthy teeth with <4 mm pocket depth compared to patients who do not brush regularly. In addition, there is a tendency for the patients who do not brush regularly to have a higher percentage of teeth with bleeding on probing at their last visit compared to patients who brush regularly. One finding contradicts the expectations – patients who brush regularly have a higher percentage of teeth with gingival recession compared to patients who do not brush regularly.

Concerning the caries indicators, the data showed that patients who do not brush regularly had a significantly higher percentage of clinically and radiographically determined decayed teeth when compared to regularly brushing patients. In addition, there is a tendency for non-regularly brushing patients with diabetes to have a lower percentage of previously restored teeth compared to the regularly brushing patients with diabetes.

Table IV shows that there is a tendency for the non-regularly brushing patients with diabetes to

Table III: Percentages of responses concerning oral health-related behavior and BMI

Health-related behavior	Diabetes – Yes n=77	Diabetes – No n=366	p-value
Brushing:*			
– never	4.1%	0.6%	<0.001
– rarely	11%	1.9%	
– nearly every day	12%	9.9%	
– every day	41.1%	38.6%	
– >1 per day	31.5%	49.0%	
Flossing:**			0.045
– never	12.5%	11%	
– rarely	40.3%	24.5%	
– nearly every day	25%	29.5%	
– every day	19.4%	26.7%	
– >1 per day	2.8%	8.3%	
Dental visit during past year	86.7%	82.2%	0.226

*The question concerning brushing frequency asked: "How often do you brush your teeth?"

**The question concerning the flossing frequency asked: "How often do you floss your teeth?"

***The question concerning a visit to the dentist during the last years asked: "Other than today, did you visit a dentist during the last year?"

have, on average, more replaced missing teeth compared to the regularly brushing patients with diabetes.

Discussion

Before discussing the actual findings, it is important to realize that the patients included in this study self-reported their diagnosis of diabetes by responding to the question "Have you ever been diagnosed with diabetes?" This procedure has 2 implications for the interpretation of these findings. First, no differentiation by type of diabetes can be made, and no measure of blood glucose level had been determined. Second, it is likely that there might be a substantial percentage of non-diagnosed patients with diabetes or of pre-diabetic patients among the control group respondents. This argument is supported by epidemiological data. Between 1999 and 2002, an estimated 19.3 million U.S. adults 20 years of age or older were diabetic, yet only 6.5% were diagnosed and 2.8% had undiagnosed diabetes.²⁹ In addition, 26% had impaired fasting glucose levels, resulting in a total of 35.3% or 73.3 million U.S. citizens who were either diabetic or pre-diabetic.²⁸ Given these statistics, one could argue that the oral health differences found in these data might actually underestimate the extent to which diabetes affects oral health. Future research should include a random glucose level test to objectively determine the patients' diabetic status.

Table IV: Oral health indicators of patients with diabetes who brush vs. do not brush regularly

Indicators of gingivitis / periodontal disease	Regular brushing – No n = 20	Regular brushing – Yes n = 53	p-value
Answer alternatives concerning gingival health:			
– good	25%	48%	0.244
– fair	56.2%	42%	
– poor	18.8%	10%	
% probing depth at last charting			
– <4 mm	60.29%	81.57%	0.039
– 4–6 mm	34.10%	16.73%	0.059
– >6 mm	2.04%	1.09%	0.421
Percentage of teeth mobility	14.67%	14.16%	0.949
Percentage of teeth with bleeding on probing at last visit	21.11%	13.21%	0.099
Percentage of teeth with gingival recession	5.94%	18.29%	0.054
Number of teeth with recession in esthetic zone	0.53	1.39	0.125
Indicators of caries			
DMFS	99.5	95.48	0.724
DMFT	21.92	22.15	0.918
Percentage of decayed teeth, clinically determined	31.66%	15.01%	0.033
Percentage of decayed teeth determined radio graphically	14.95%	5.51%	0.041
Number of missing teeth due to caries	12.12	9.85	0.346
Percentage of restored teeth/crowns	31.93%	55.71%	0.09
Percentage of previously restored teeth	31.93%	51.02%	0.056
Missing teeth			
Number of missing teeth due to other reasons	3.25	3.54	0.337
Number of extracted teeth	15.38	13.38	0.435
Number of replaced missing teeth	11.33	7.20	0.082

A second limitation of this study was that the oral health related data were collected in a chart review. Having calibrated examiners collect the information concerning the patients' oral health status could have improved the quality of these data. However, even despite these problems, oral health differences were found between patients with diabetes and patients not having been diagnosed with diabetes – both in periodontal health as well as in caries indicators. Concerning periodontal health differences, the data showed that patients with diabetes had a higher percentage of teeth with mobility, a higher percentage of teeth with gingival recession and more teeth with recession in the esthetic zone compared to patients not diagnosed with diabetes. It is crucial for dental health care providers to be keenly aware of these differences, because not only

is poor glycemic control in patients with diabetes related to increased severity of periodontal disease, but severe periodontal disease can result in poor glycemic control and other complications.^{11,15–17,29}

Regarding differences in caries indicators, the data also supports prior research findings. Patients with diabetes had significantly more DMFS and more teeth due to caries compared to patients not diagnosed with diabetes. These findings support the research by Taylor et al who showed that patients with diabetes had a tendency for increased caries activity.¹⁹ When discussing these findings, it is important for health care providers to also consider that prior research documented that patients with diabetes had an increase in cariogenic bacteria and higher plaque levels, pointing to the significance of

sound oral health promotion efforts among these patients.^{8,21}

When considering if diabetic patients could moderate their own oral health, the findings concerning increased levels of bacteria and plaque were used to determine the degree to which they would engage in constructive oral self-care. Unfortunately, Syrjala et al found that patients with diabetes had poorer oral health-related behavior compared to patients without diabetes,²⁵ and these findings were replicated in the current study as well. Patients with diabetes did not brush and floss as often as patients not diagnosed with diabetes. One could speculate that the increased amount of health-related activities that patients with diabetes need to engage in to control their diabetes might either preoccupy their attention or might prevent them from spending time on oral health-related activities that they might perceive as unrelated to diabetes or even as generally unimportant.²⁴ In any case, this study takes a new look at the relationship between diabetes and oral health by arguing that oral health-related behavior could be the moderating factor that might determine the strength of the diabetes–oral health relationship. Patients with diabetes who engaged in regular tooth brushing had better periodontal health and less caries compared to those with diabetes who did not brush as often. Patients with diabetes who did not cooperate with oral hygiene recommendations were less likely to have healthy probing depths of less than 4 mm compared to patients with diabetes who brushed regularly and had significantly higher percentages of decayed teeth compared to patients with diabetes who brushed regularly. It should be mentioned that patients with diabetes who brushed regularly versus those who did not brush regularly did not differ in socio-demographic background characteristics, such as age.

This new finding concerning the differences between patients with diabetes who brushed regularly versus those who did not brush regularly deserves attention, because it points to the importance of educating patients with diabetes about the importance of good oral hygiene efforts. In this context, it is also important to educate these patients about how to engage in productive oral hygiene efforts. The fact that 18% of patients with diabetes who brushed regularly had teeth with gingival recession compared to only 6% of patients with diabetes who did not brush regularly could potentially be an indicator that dental care providers need to make sure that patients with diabetes are aware of proper brushing

techniques. Educating patients with diabetes about the importance of good oral health promotion and the prevention of oral disease is also crucial because prior research has shown that patients with diabetes may have a lower utilization rate of dental care services compared to patients not diagnosed with diabetes.¹⁵

In addition to educating patients about how diabetes can affect oral health, dental care providers also need to educate their patients with diabetes about the importance of good oral health for their glycemic control and the management of their diabetes. Research shows that severe periodontal disease can result in poor glycemic control and other complications.^{15–17} The consensus is that there is a bidirectional relationship between diabetes and periodontal diseases.^{16,18} If patients understand these relationships, they might be more motivated to engage in proper oral health promotion efforts.

Conclusion

These findings replicated prior research that showed diabetes and oral health are related, and that patients with diabetes might be less likely to engage in good oral health promotion efforts compared to patients not diagnosed with diabetes. However, the contribution of this study consists in the new finding that patients with diabetes who engage in regular brushing have significantly better oral health than patients with diabetes who do not engage in regular brushing – which should alert all clinicians to the crucial importance of oral health education efforts for patients with diabetes.

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Use of Complementary and Alternative Medicine for Work-Related Pain Correlates With Career Satisfaction Among Dental Hygienists

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Introduction

Physical stress is one of the leading etiologic factors in musculoskeletal disorders such as back pain, shoulder or neck tension, eyestrain, headaches or carpal tunnel syndrome.^{1,2} Musculoskeletal disorders are an occupational risk for dental hygienists.³ Ninety-three percent of dental hygienists recognize that their work causes and aggravates musculoskeletal pain.^{2,4,5} In one study, 69.5% of dental hygienists reported musculoskeletal pain in the wrist/hand region, 68.5% in the neck region and 67.4% in the upper back.²

There are many factors that contribute to musculoskeletal disorders in dental hygienists, including repetitive motion, pinch-grasp, vibration, force and awkward positions.^{2,5,6} Other factors leading to musculoskeletal disorders include sitting for a long period of time, operator position, poor posture, lack of flexibility and strength, poor ergonomics and insufficient work breaks.^{2,3,6,7}

Musculoskeletal disorders may interfere with the tasks involved in performing dental hygiene services. Many dental hygienists continue to work in pain due to financial constraints and, as a result, must decrease the number of days they work.⁴ Dental hygienists have reported work stress and burn-out caused by musculoskeletal disorders, long working hours and working without an assistant.⁸ Some have chosen to leave the profession because of their musculoskeletal pain.^{4,9} Many studies have

Abstract

Purpose: Chronic musculoskeletal pain (CMSP) is associated with work stress and burn-out among registered dental hygienists, with prevalence estimates ranging between 64 to 93%. Complementary and alternative medicine (CAM) therapies can be helpful in managing CMSP. The purpose of this study was to determine if dental hygienists who use CAM have greater career satisfaction compared to conventional therapy (CT) users.

Methods: ADHA members ($n=2,431$) in North Carolina ($n=573$) and California ($n=1,858$) were surveyed. Data were analyzed using univariate and bivariate analyses and logistic regression.

Results: A response rate of 25.3% ($n=617$) was obtained, revealing that 76.5% ($n=472$) suffered from CMSP. The use of CAM or CT was reported among 80.7% ($n=381$) of dental hygienists with CMSP. CAM users reported greater overall health (79.3% vs. 54.0%, $p<0.001$), career satisfaction (59.2% vs. 39.0%, $p<0.001$) and were able to work the hours they wanted (69.8% vs. 64.0%, $p<0.001$) compared to CT users. Of those with CMSP, 36.4% ($n=172$) considered a career change and 13.0% ($n=59$) reported having left dental hygiene. Those with CMSP were less likely to recall that ergonomics were taught or reinforced during clinical training.

Conclusion: CAM therapies may improve quality of life, reduce work disruptions and enhance career satisfaction for dental hygienists who suffer from CMSP. Ergonomics education may help reduce the number of hygienists who suffer from CMSP. Increased student awareness of CMSP risk is needed to reduce CMSP in the future by enhancing ergonomics education and incorporating CAM, such as yoga stretches, into the classroom and clinic routine.

Keywords: complementary and alternative medicine, chronic musculoskeletal pain, career satisfaction, dental hygienists

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reported complementary and alternative medicine (CAM) therapies, including yoga, massage and acupuncture, to be effective in managing chronic mus-

culoskeletal pain (CMSP) for the general population.¹⁰⁻¹⁵ Since a large number of hygienists report work-related CMSP, this study was conducted to determine if dental hygienists are using CAM therapies to manage their CMSP and, if so, to determine if CAM therapies are associated with their career satisfaction and longevity.

CMSP and Work Disruptions

Musculoskeletal disorders cause work disruptions among dental hygienists, and most recognize that work causes or aggravates musculoskeletal symptoms.^{4,16,17} Physical discomfort has been reported to occur more frequently after 10 years of clinical practice when compared to 5 years.⁴ It has been reported that dental hygienists who complained of musculoskeletal disorders worked more clinical hours and treated more patients per day when compared to those who did not complain of pain symptoms.¹⁶ Time pressures and lack of breaks have been reported to have a physical impact on dental hygienists, who often lack control in the schedule.⁴

In one study, 31% of dental hygienists reported they work less now compared to the past as a result of musculoskeletal discomfort caused by hand and neck pain.^{4,17} Musculoskeletal discomfort caused 14.6% of dental hygienists to miss work, most frequently for lower back (7%) and hand discomfort (7%).¹⁷ In another study, the median number of sick days taken among dental hygienists as a consequence of musculoskeletal discomfort was higher (5 days) compared to those who did not experience pain (2 days).¹⁶

Career Satisfaction and Career Longevity

Career satisfaction and job satisfaction are indicators that may have an influence on career longevity. Both have been studied among dental hygienists. Job satisfaction is a strong predictor of individual happiness, and experts believe that job satisfaction trends can influence work efficiency and effort, absenteeism and staff turnover.¹⁸ It can also persuade an individual's decision to leave a profession.¹⁹ In 2007, dental hygienists in the U.S. reported high job satisfaction, with 53.8% being very satisfied and 32.2% being somewhat satisfied in their current place of employment.²⁰ Dental hygienists were most commonly satisfied with patient interactions (94.5%) and overall work hours (90.6%), and least satisfied with benefits (55.8%), number of work breaks (30.3%) and management skills of the dentist (26.0%).¹⁷

Career satisfaction is an accomplishment that can be evaluated by an independent third party, such

as compensation, promotion and work-related status.²¹⁻²³ Career satisfaction is also an assessment that an individual makes when reflecting on their own career, which may have an impact on career longevity for dental hygienists.²² It has been reported that changes in the work environment may increase the career longevity of dental hygienists.²⁴ Other factors reported to influence career longevity for dental hygienists include professional membership in the American Dental Hygienists' Association, building relationships with patients, taking continuing education courses on advanced topics in dental hygiene and participating in activities outside of the office.⁴ In one Texas study, dental hygienists were "primarily influenced by salary, followed by family responsibility, having a variety of duties, participation in decisions, professional collaboration, benefits and a safe work environment."²⁴ There are currently no reports that link musculoskeletal pain and career satisfaction among dental hygienists.

Strategies for Prevention of Chronic Pain

Many dental hygienists report that their dental hygiene training did not prepare them for the physical demands they face when working full-time.⁴ Ergonomic training can reduce work related musculoskeletal disorders for dental hygienists.^{5,25} Proper ergonomics can improve neck postures by improving equipment, proper patient positioning, stretching and technique training.²⁶

In studies by Valachi et al, prevention strategies of musculoskeletal disorders among allied dental oral health care providers include proper use of ergonomic equipment, frequent stretch breaks, maintaining lower back curve to reduce low back pain, using magnification loupes, adjusting operator chair properly, avoiding static postures, core strengthening with 20 minutes of aerobic exercise and receiving education on musculoskeletal health and injury prevention.^{3,7}

Conventional Therapies for Treatment of Chronic Pain

Dental hygienists often choose conventional therapies to help manage their CMSP. Conventional medicine is practiced by a medical doctor (MD) or doctor of osteopathy (DO) and allied health professionals, such as nurses or physical therapists.²⁷ The general population with chronic pain reported seeing their general practitioner (67.2%), hospital specialist (34.0%) and physical therapist (25.9%) for treatment. These individuals reported taking prescription medications (58.4%) and non-prescription medications (57.4%) as the severity of their pain increased.²⁸ In one study, dental hygienists reported

using medications and splints at night to help manage their chronic pain, although this study did not report its effectiveness.⁴ There are currently no reports of conventional therapy use as effective treatments for chronic pain among dental hygienists.

Use of CAM Therapies for CMS

CAM therapies are defined as "a group of diverse health care systems and practices that are not considered to be part of conventional medicine."²⁷ CAM therapies are commonly used among the general U.S. population for the treatment of musculoskeletal pain, including back pain, neck pain, joint pain or stiffness and arthritis.^{29,30} Other reasons the general population may turn to CAM therapies is due to a lack of belief in conventional medicine (28%) and cost (13%).³⁰

There are many different types of CAM therapies, including whole medical systems (homeopathic and naturopathic medicine), mind-body medicine (meditation, prayer and mental healing), biologically based practices (dietary supplements and herbal products), manipulative and body-based medicine (chiropractic care and massage) and energy medicine (Reiki and therapeutic touch).²⁷

According to the 2007 National Health Interview Survey (NHIS), CAM therapy use varied by region. The 6 most commonly used CAM therapies in 2007 included natural products, deep breathing exercises, meditation, chiropractic care, massage and yoga.²⁹ The use of CAM therapies was highest in the western region (45%) and lowest in the southern region (33%). CAM use was more widespread among women (42.8%) versus men (33.5%) and among individuals aged 30 to 69 with advanced levels of education who are not underprivileged.²⁹

Since CAM use is more prevalent among women,²⁹ one study looked at the different types of CAM therapies being used among the female population.³¹ The study found that, among women 18 years of age or older living in the U.S., 26% used vitamins and 18% medicinal herbs/teas. Women with back pain (73.5%) took vitamins and nutritional supplements at the same time as prescription or over-the-counter medications. Women used acupuncture (84%), chiropractic care (54%) and homeopathy (52%) for conditions such as musculoskeletal pain. Sixty-two percent used yoga, tai chi and meditation to stay healthy.³¹

Many studies have reported CAM therapies to be effective in managing musculoskeletal pain among the general population. Yoga, acupuncture and massage have reported significant reductions in chronic

low back pain.^{10,11,13-15} Furthermore, massage has reported short term clinical benefits for the treatment of chronic neck pain.¹²

While studies have shown CAM therapies to be effective in managing chronic musculoskeletal pain for the general population, their effectiveness of managing pain has not been studied as extensively among dental hygienists. One study reported chiropractic care, massage therapy and acupuncture treatment use by dental hygienists, although this study did not survey pain improvement.

CAM in Health Education

CAM has been integrated into health professional schools, including physician assistant programs.³² In 2001, 15 grants were awarded to health professional schools in the U.S. which were funded by the National Center for Complementary and Alternative Medicine. The programs included "11 medical schools, 2 nursing schools, the American Medical Association and 1 family practice residency program."³³ The goal was to teach conventional practitioners about CAM therapies in order to provide optimal patient care by promoting overall health and well-being.³³ CAM has been integrated into the curriculum of the first 2 years of medical school at the University of Minnesota. Students can also take an elective CAM rotation during their third and fourth years of medical school.³⁴ It was reported that medical students' attitudes toward CAM were positive, and the confidence in their knowledge about CAM also increased by the end of the course.³⁴

Many dental professionals develop musculoskeletal disorders during their career. CAM therapies have been shown to reduce CMS among the general population.¹⁰⁻¹⁵ Dental hygienists' acceptance, utilization and effectiveness of CAM therapies are not known. The main objective of this study was to determine if CAM use among dental hygienists with reported CMS is associated with greater self-reported career satisfaction and longevity when compared to conventional therapies. The current investigation was conducted to learn about the experiences of dental hygienists who use CAM therapies to manage their CMS, whether CAM helps reduce work disruptions and whether CAM improves career satisfaction and longevity.

Methods and Materials

This cross-sectional study used a survey design with approval by the University of North Carolina (UNC) Biomedical Institutional Review Board. Registered dental hygienists in California and North Carolina who are current members of the Ameri-

can Dental Hygienists' Association (ADHA) were recruited to complete an 18 item questionnaire entitled "Does Use of Complementary and Alternative Medicine (CAM) Therapy for Management of Chronic Musculoskeletal Pain Improve Dental Hygienists' Career Satisfaction?" The questionnaire was administered between July 17 and August 31, 2009.

Development of Questionnaire

The questionnaire was developed based on a review of the current literature and consultation with CAM experts. The questionnaire was critically reviewed for readability and comprehension by colleagues at UNC.

A pilot study was conducted among registered dental hygienists in North Carolina and California attending continuing education courses in each state. Following these pilot tests, further modifications to the questionnaire were made, which included changes in how questions were phrased, the addition and removal of questions and the configuration of the questionnaire from paper into Qualtrics® software. The final questionnaire was approved by the Institutional Review Board prior to administration.

Administration of Questionnaire

Research Subjects: All dental hygienists who are current members of the ADHA in California and North Carolina were recruited to participate. These 2 states were chosen for variation of CAM use among these populations. It was anticipated that the subjects in California would report greater use of CAM therapies since more adults in the western U.S. use CAM therapies when compared to adults in the South,²⁹ thus assuring this study an adequate number of respondents with experience in the primary outcome measured.

Inclusion/Exclusion Criteria

This study included all registered dental hygienists who are members of the North Carolina Dental Hygienists' Association and California Dental Hygienists' Association with email addresses (n=2,431). Dental hygienists who participated in the pilot study, dental hygiene students, members of the general public, dentists, dental assistants and others who are not registered dental hygienists were excluded.

Contents of Questionnaire

The questionnaire consisted of 6 domains:

1. Personal Experience with Chronic Pain and Pain Management
2. Use of Conventional Therapies
3. Use of CAM Therapies
4. Opinions about CAM Therapies
5. Career Satisfaction
6. Respondent Demographics

On-Line Questionnaire

The final version of the questionnaire was formatted using Qualtrics® for electronic distribution. One week before sending the link to the survey, subjects were sent an individual invitation to participate in the web-based survey in order to prevent emails from being identified as spam. One week later, individuals were sent a second email that directed them to a website to complete the questionnaire. As individuals responded, Qualtrics® logged-in respondents so that reminder emails were sent only to non-respondents. This also prevented participants from responding more than once. A first reminder email was sent 10 days after the first mailing, with the addition of a second reminder 2 weeks later. A final email reminder was sent 1 week before closing the study on August 31, 2009.

Data Capture and Analysis

Data was transferred to an Excel spreadsheet and stored in a local, secure computer for data analysis and management. Statistical analyses were conducted using SAS 9.2. Univariate and bivariate analyses were performed to determine demographic information, the most frequently reported locations of pain, number of respondents that used CAM or conventional therapies, types of CAM or conventional therapies most frequently used, work disruption caused by CMSP and career satisfaction.

Career satisfaction was assessed using dependent sample t-test. Dependent sample t-tests were also used to determine career longevity between respondents who used CAM or conventional therapies. Independent sample t-tests were used to determine the opinions about CAM and conventional therapies for CMSP management. Chi-square analysis was used to investigate the relationship between having CMSP and using CAM therapies and to compare the use of CAM therapies between dental hygienists in California and North Carolina. To control for multiple comparisons, a Bonferroni correction was used when investigating the opinions of dental hygienists toward CAM therapies.

Age, education, year degree was earned and

number of years working as a registered dental hygienist were used in the logistic regression analyses. Logistic regressions were performed to assess the relationship between having pain in relation to respondents' acceptance and opinions about CAM use for CMSP management, to investigate the relationships between the type of therapy used and the effect of pain on career satisfaction, to predict CAM use by age, health status, gender, race, type of degree and number of years practicing and to predict whether or not ergonomics were reinforced in their dental hygiene school clinic based on pain, age, education and number of years practicing.

Results

A total of 2,431 surveys were sent electronically with a response rate of 25.3% (n=617). Each state had equivalent percentages of respondents (California=25.2%, North Carolina=25.1%).

Demographics: Findings showed that a majority of the study population was female (97.7%), non-Hispanic (87.2%) and work primarily in general dental offices (72.3%). A total of 76.5% (n=472) reported having CMSP. The mean duration of pain was 6.1 years (median= 3.5). Other demographic characteristics of respondents are found in Table I.

Reported Location of Pain: Figure 1 shows the most frequently reported locations of pain among dental hygienists. Neck and shoulder were the most common sites, with hip and leg the least common.

Effect on Work Schedule and Career: Figure 2 shows career disruption among dental hygienists as a result of CMSP. About 23.5% of respondents who reported chronic pain either called in sick or missed work as a result of their pain. After accounting for conventional therapy users, individuals who used CAM therapies alone, when compared to individuals who used both CAM and conventional therapies, had 5 times lower odds of temporarily quitting work for longer than 1 month (OR=4.9, 95% CI =1.2 to 20.9).

CAM Use to Manage CMSP: Figure 3 shows reported CAM use among dental hygienists. Respondents most frequently reported using both CAM and conventional therapies to manage work-related CMSP (80.7%, n=381). Of the 472 individuals who reported work-related pain, 14.2% (n=67) used CAM therapies alone, 3.6% (n=17) used conventional therapies alone and 1.5% (n=7) did not use any therapies.

Opinions About CAM for CMSP: Dental hygienists' musculoskeletal pain symptoms improved sig-

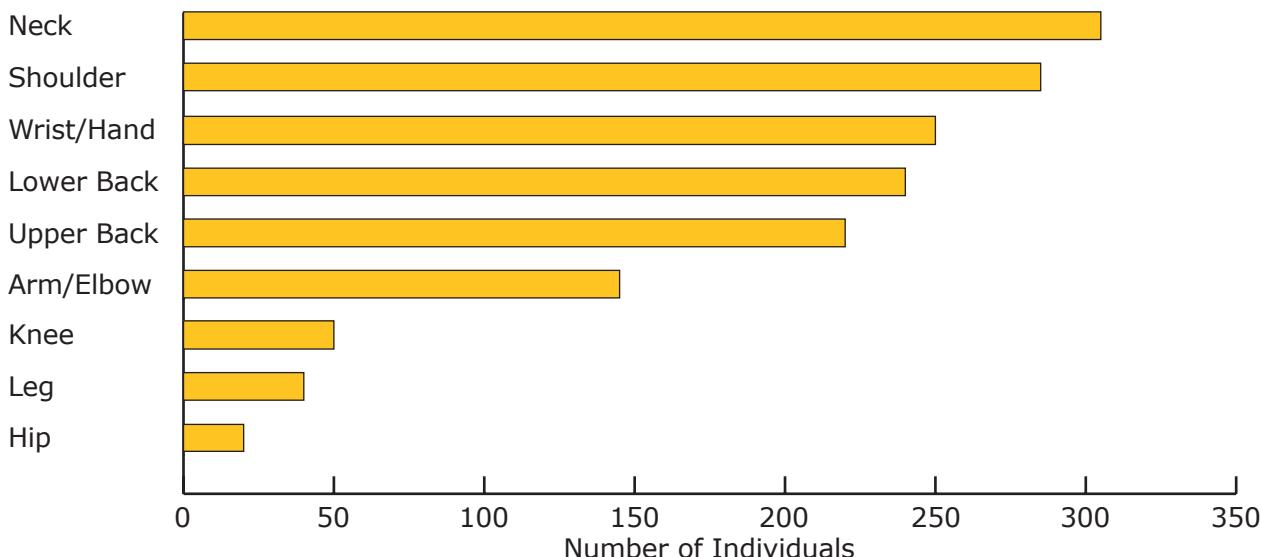
Table I: Demographics

Variable (n=620)	n	Percent
Age		
21–30	95	15.3
31–45	171	27.6
46–55	180	29.0
≥56	167	26.9
Race		
White	499	80.5
Non-White	96	15.5
Ethnicity		
Hispanic	25	4.0
Non-Hispanic	541	87.2
Gender		
Female	603	97.7
Male	14	2.3
Education		
Associate or Certificate	357	57.9
Bachelor's	209	33.9
Beyond Bachelor's	51	8.3
Year Degree Earned		
Before 1975	86	13.9
1975–1999	291	46.9
2000–2008	223	36.0
Years Employed as RDH		
<1	18	2.9
1–5	137	22.1
6–10	60	9.7
11–20	112	18.1
>20	273	44.1
Practice Type		
General	444	72.3
Other	170	27.7
General Health		
Excellent/Good	600	96.8
Fair/Poor	17	2.7

*Missing values are not included in this table

nificantly when using CAM therapies versus conventional therapies ($t(367) =3.19$, $p=0.002$). Table II shows dental hygienists who reported pain had significantly higher levels of agreement with the CAM-related opinion statements in the questionnaire. When dental hygienists who reported work-related pain were asked for their opinions about using CAM for CMSP management, these individuals were 3 times more likely to agree that CAM therapies were acceptable for CMSP management (OR=3.1, 95% CI=2.1 to 4.5) than those with no pain, and were 2 times more likely to use CAM therapies for CMSP management (OR=2.3, 95% CI=1.6 to 3.3) when controlling for age, education, year the degree was earned and years practicing as a dental hygienist.

Figure 1: Frequency of Reported Pain by Location (n=472)



CAM Use for CMSP and Reported Career Satisfaction: Table III shows respondents' agreement about CAM therapies and conventional therapies in relation to their effect on career satisfaction. Individuals who used CAM therapies alone had significantly higher odds of agreeing they were satisfied with their career as a dental hygienist when compared to users of conventional therapies (OR=2.0, 95% CI=1.0 to 4.0).

Difference between California and North Carolina Dental Hygienists: There were no statistically significant differences in use of CAM therapies between respondents in California (n=285, 61%) and North Carolina (n=86, 59.7%), p=0.78. Therefore, results for CAM use are expressed as the total sample of registered dental hygienists and is homogeneous regardless of state with the exception of 2 variables: North Carolina dental hygienists were more likely to leave clinical practice due to CMSP versus dental hygienists in California ($\chi^2=11.0$, p<0.001), and North Carolina dental hygienists were more likely to report compromising patient comfort due to CMSP than California dental hygienists ($\chi^2=6.3$, p=0.012).

Effects of Age, Self-Reported Health Status, Gender, Race, Type of Degree and Number of Years Practicing on the Use of CAM to Manage CMSP: Investigators looked at the reported use of CAM therapies and found older individuals were more likely to use CAM when compared to younger individuals (OR=1.03, 95% CI=1.001 to 1.055). CAM users were more likely to report poorer health status when compared to non-CAM users (OR=1.8, 95% CI=1.3 to 2.4). There were no statistically significant differences when controlling for gender, race, type of degree earned and number of years practicing.

Education/Ergonomics: Thirty percent (30.6%) of respondents reported their dental hygiene education included classroom lectures on ergonomics. Investigators also looked at whether respondents recalled that the principles of ergonomics were reinforced in the clinic, and found that individuals who reported pain were less likely to recall that ergonomics were reinforced in the clinic (OR=0.64, 95% CI=0.45 to 0.92). Older individuals and individuals who had been practicing longer were less likely to recall that ergonomics were reinforced in the clinic (OR=0.97, 95% CI=0.95 to 0.99) when controlling for pain, age, number of years practicing and education.

Discussion

Musculoskeletal pain is associated with work stress and burn out among dental hygienists.³ CAM therapies have been shown to be effective for reducing the risk of and managing CMSP.¹⁰⁻¹⁵ To date, no studies have examined the use of CAM for CMSP among dental hygienists, a population at increased risk for work-related CMSP. Dental hygienists recognize that their work causes and aggravates musculoskeletal pain, which decreases their ability to work.^{2,4,5} In this study, 472 (76.5%) individuals reported work-related pain, causing 23.5% of them to call in sick or miss work. This data differs from those of a previous study that found musculoskeletal discomfort caused 14.6% of dental hygienists to miss work.¹⁷ In our study, individuals who used CAM therapies alone were less likely to report temporarily quitting work for longer than 1 month. Therefore, dental hygienists who use CAM therapies may reduce work interruptions caused by musculoskeletal pain.

The present study sought to investigate if CMSP

Figure 2: Work and Career Disruption Among Registered Dental Hygienists Due to CMSP (n=472)

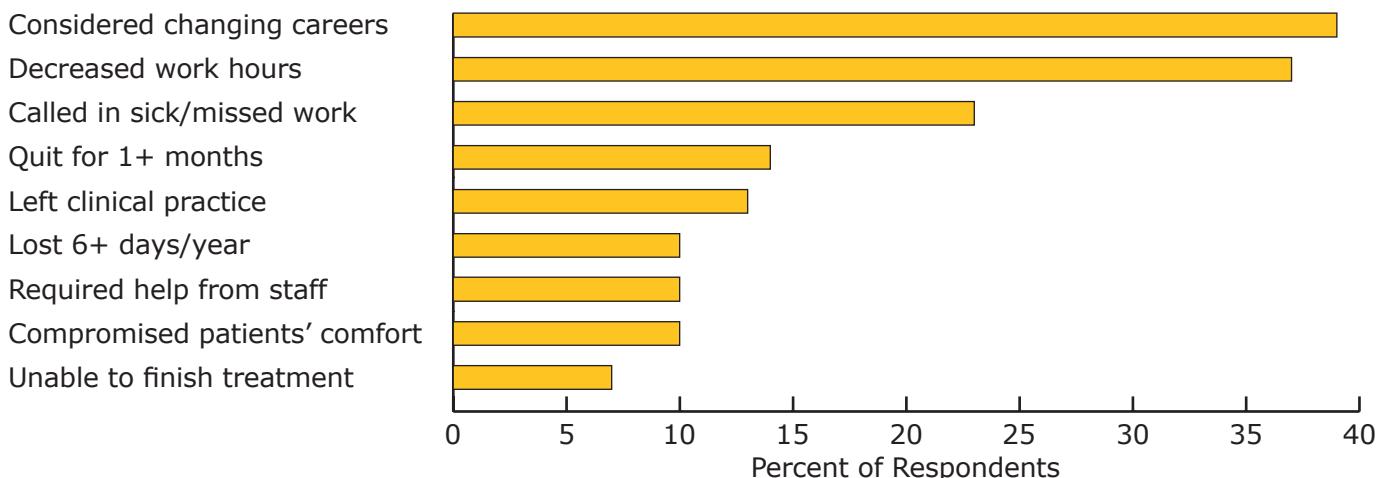
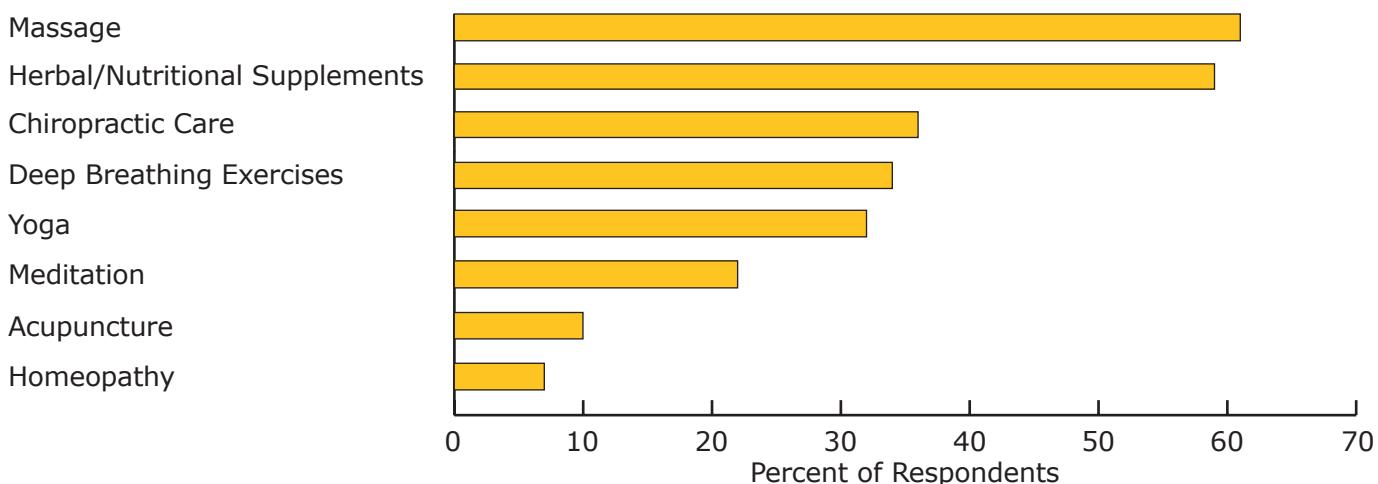


Figure 3: Reported CAM Use Among Respondents with Chronic Pain in the Past 12 Months (n=472)



is associated with reduced career satisfaction and longevity. In a 2007 study, 53.8% of dental hygienists reported high career satisfaction, even though some aspects of the job were found to be dissatisfying.²⁰ The present study reports similar findings in that respondents reported high levels of career satisfaction. Based on these findings, dental hygienists who do not suffer from musculoskeletal pain experience higher career satisfaction when compared to those who suffer from CMSP ($p=0.001$). Those with CMSP reported that it had a negative impact on career longevity. Of those with CMSP, 36.4% (n=172) considered a career change and 13% (n=59) reported having left dental hygiene. Respondents who used CAM therapies alone were more likely to be satisfied with their career as a dental hygienist compared to those who used conventional therapies alone. Therefore, dental hygienists who use CAM therapies for the prevention and management of CMSP may experience higher career satisfaction and longevity compared to using conventional therapies.

The present study demonstrated some variation when comparing our CAM users to CAM users in the general U.S. population. Based on the findings of a NHIS report, dental hygienists are more likely to utilize CAM therapies (80.7%) when compared to the general public (38.3%).²⁹ The most favored CAM therapies used by the general public include non-vitamin, non-mineral, natural products (17.7%), deep breathing exercises (12.7%), meditation (9.4%), chiropractic care (8.6%), massage (8.3%) and yoga (6.1%).²⁹ The most favored CAM therapies among participants in the current study were massage, herbal supplements and chiropractic care. One possible reason for the variation in the types of CAM therapies being used between the 2 groups may be the fact that investigators asked specifically about work-related CMSP and not about other conditions for which CAM may be utilized. If investigators had asked respondents about uses of CAM for other than work-related CMSP, they may have found closer agreement. Therefore, the variation that was found may be artificial.

The sample was predominantly female. Therefore, no gender comparison can be produced.²⁹ The sample of CAM users was similar in age (83.5% ≥ 31 years of age) to CAM users in general (30 to 69 years).²⁹ The 2007 NHIS reported a significant difference in CAM use between individuals in the western region of the U.S. (45.0%) compared to those in the southern region (33.0%).²⁹ Therefore, the investigators were surprised to find no statistically significant difference in CAM use between respondents in California and North Carolina. The survey questions did not produce any firm conclusions about this finding. However, one may conclude that since the CMS experience among dental hygienists is similar regardless of where they live, and CAM therapies are known to be effective for CMS, hygienists may seek out CAM therapy regardless of local customs. Alternately, the investigators did not take into account CAM use between rural and urban settings. For example, CAM use is high among rural Appalachians.³⁵ The investigators did not ask respondents if they lived in a rural or non-rural area. Therefore, it is possible that dental hygienists in rural Appalachian North Carolina may have been oversampled, accounting for greater use of CAM therapies than expected in North Carolina.

Therefore, if the investigators had compared rural versus non-rural dental hygienists, they may have seen a difference in CAM use between states.

In one study, 69% of individuals reported using CAM plus conventional therapies.³⁶ Another study reported that 67% of patients who saw an alternative practitioner for pain saw a conventional practitioner as well.^{28,37} In addition, 52% of primary care patients reported current or prior use of CAM ther-

Table II: Opinions about CAM Therapies for Chronic Musculoskeletal Pain Management between Respondents who Reported Pain vs. No Pain

Opinions about CAM Therapies	Difference in Opinion**	SD	t(df)
I would use CAM for chronic pain management	0.33	0.74	4.71(609)*
I would recommend CAM to a friend/family member	0.41	0.78	5.51(605)*
CAM therapies are acceptable for chronic pain management	0.48	0.75	6.67(606)*
I would use CAM in addition to conventional medicine for pain	0.20	0.75	2.76(609)
I would use CAM as an alternative to conventional medicine	0.34	1.03	3.51(610)*
CAM should be covered by medical insurance	0.32	0.71	4.75(610)*

*Indicates p<0.005

**Respondents from both groups were averaged and the difference between means was compared. A Likert scale was used ranging from 1=strongly agree and 5=strongly disagree.

Note: The mean difference is between respondents who reported pain compared to no pain. Values indicate stronger agreement about use of CAM therapies for those who reported pain.

Table III: Association between CAM and Conventional Therapy Use on Career Satisfaction

Career Variables	CAM vs. Conventional Mean Difference**	t(df)
Contributed to my overall career satisfaction	0.49	8.31(365)*
Contributed to my career longevity	0.52	7.75(366)*
Contributed to my overall health and well-being	0.64	9.62(368)*
Helped me work the hours I want	0.28	4.71(367)*
Helped me feel more secure and happy in my job	0.47	7.72(366)*

*Indicates p<0.001

**Respondents from both groups were averaged and the difference between means was compared. A Likert scale was used ranging from 1=strongly agree and 5=strongly disagree.

Note: The mean difference is between respondents who used CAM therapies compared to conventional therapies. Values indicate stronger agreement for those who used CAM therapies vs. conventional therapies.

pies for pain management.³⁸ The majority of dental hygienists in our study (80.7%) reported using both CAM and conventional therapies in a complementary fashion for the treatment of CMS. Therefore, based on our findings, dental hygienists are similar to the general population who use both CAM and conventional therapies for CMS.

It has been suggested that improvements in the work environment may help reduce the risk of developing musculoskeletal disorders.^{2,5,9,25,26,39} Im-

proving the work environment may contribute to a reduction in musculoskeletal disorders and work disruptions for dental hygienists. The investigators found that there is a relationship between ergonomics education in dental hygiene school and CMSP. Many respondents recalled receiving classroom lectures on ergonomics, but fewer recalled that the principles of ergonomics were reinforced in the clinic. Those who recalled that ergonomics were reinforced were less likely to report experiencing CMSP. This suggests that reinforcement of proper operator positioning and other ergonomic principles can have long term health effects on practicing dental hygienists. Dental hygiene educators should consider reinforcing good postural habits, along with basic CMSP prevention strategies, as an essential part of the dental hygiene curriculum. Further research is needed on the most effective strategies for incorporating CAM methodologies for prevention of CMSP into the dental hygiene curriculum.

Strengths and Limitations of this Study

One of the strengths of this study is that ADHA members who were surveyed represent the general population of ADHA members and, to a great degree, dental hygienists in general.²⁰ Therefore, the results may reflect the attitude, opinions and practices of a large number of ADHA member hygienists.

This study has several limitations. The low response rate may have been due to several factors: time of year the survey was sent (some individuals may have been on summer vacation), inaccurate email addresses, questionnaire may have been too long, title of questionnaire may have influenced individuals without pain not to participate and using an electronic questionnaire versus paper (studies have shown a higher response rate with paper questionnaires).⁴⁰⁻⁴² Therefore, the investigators speculate that a higher response rate may have been obtained using a paper questionnaire with a more neutral title administered at a different time of year.

Biases to this study include sampling bias – only ADHA members were surveyed. The general dental hygiene population may have different opinions about CMSP and CAM use. There was also a geographical bias – the researchers surveyed dental hygienists in California and North Carolina only, whereas a national sample across 50 states may have different results. Therefore, a national sample of non-member as well as member dental hygienists may have different opinions about CAM use for CMSP.

New Discoveries and Impact on Dental Hygiene Profession

In this study, dental hygienists with work-related pain who used CAM therapies reported they had greater overall health, career satisfaction, were able to work the hours they wanted and felt more secure and happy in their jobs when compared to conventional therapy users. The findings also demonstrated that dental hygienists who used CAM therapies alone had lower odds of quitting work for longer than 1 month compared to those who used both CAM and conventional therapies together. Therefore, dental hygienists with CMSP who use CAM therapies may be less likely to call in sick or miss work, and may have increased career satisfaction as well as career longevity.

The research respondents expressed the opinion that CAM should be covered by insurance. Therefore, if more insurance companies cover the cost of CAM therapies, then dental hygienists may be more likely to use CAM therapies to manage and even prevent musculoskeletal pain.

Incorporating CAM education into the dental hygiene curriculum can increase students' awareness of developing CMSP. Future research that looks at incorporating CAM therapies, such as yoga, into dental hygiene programs can assess their effectiveness by evaluating dental hygienists' musculoskeletal pain once they are in private practice. Incorporating ergonomic education and reinforcing it in the clinic also may be successful in preventing CMSP from occurring. Continuing education courses for practicing dental hygienists can be used to educate those who have not had the advantage of learning ergonomics in dental hygiene school.

CAM practitioners may be in need of information relating to the work-related pain issues of their dental hygiene clients. Therefore, the results of this study will be helpful to CAM practitioners who treat dental hygienists. Future research should consider the needs of dental hygienists and the types of CAM therapies they will benefit from the most to manage their musculoskeletal pain.

Conclusion

This study found that using CAM therapies for CMSP is associated with greater career satisfaction and longevity among dental hygienists. The investigators suggest that CAM practitioners may benefit from information on work-related pain issues for their dental hygienist clients. The effects of increasing student awareness of CMSP risk, enhancing ergonomics education and incorporating CAM therapies into the classroom and clinic routine should be investigated.

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California Dental Hygienists' Knowledge, Attitudes and Practices Regarding Herbal and Dietary Supplements

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Introduction

The use of herbs and other natural products has been part of human culture for thousands of years, and people continue to use them to treat illness or improve health and well-being. Besides prayer, herbal and dietary supplements (HDS) are the most widely used complementary and alternative medicine (CAM) therapies in the U.S.¹ Many Americans regularly use HDS on a daily or weekly basis. It is estimated that more than half of the adult population in the U.S. (nearly 114 million) consume dietary supplements.² The term dietary supplement includes herbs and botanicals as well as vitamins, minerals and other nutritional supplements. The federal government defines a dietary supplement as "a product (other than tobacco) that is intended to supplement the diet that bears or contains one or more of the following dietary ingredients: a vitamin, a mineral, an herb or other botanical, an amino acid, a dietary substance for use by man to supplement the diet by increasing the total daily intake, or a concentrate, metabolite, constituent, extract or combinations of these ingredients."³

American adults who consume HDS report taking 1 or more per day.^{2,4-12} Further, among patients that use HDS, a large percentage (41 to 70%) do not report their use to their primary care physician or even anesthesiologist.¹³⁻¹⁶ Among Americans who reported the use of HDS to a health care provider, the vast majority informed their physician while only 3% reported use to their den-

Abstract

Purpose: As more Americans use dietary supplements, the potential for increased adverse effects increases. The purpose of this study was to identify the current knowledge, attitudes and practice behaviors among California dental hygienists regarding herbal and dietary supplements (HDS).

Methods: A stratified random sample of 1,203 registered California hygienists were surveyed. The survey included items about personal characteristics as well as questions regarding knowledge, attitudes and beliefs and practice behavior about HDS. Three primary outcomes were analyzed: dental hygienists' knowledge about HDS, attitudes (confidence) about HDS and behavior practices (communication) regarding HDS. Confirmatory factor analysis was performed. Personal characteristics were assessed in stepwise multiple linear regression analysis for impact on knowledge scores.

Results: The response rate was 21% (n=249). Dental hygienists have low levels of knowledge and confidence about HDS, as well as poor communication practices related to HDS. California dental hygienists scored a low mean of 38% on their knowledge of HDS. On the confidence scale (standardized range of 0 to 10 possible), hygienists scored 3.67 ± 2.03 . On the communication practices subscales (standardized range of 0 to 10 possible), hygienists scored 4.21 ± 2.99 on general communication practices and 1.25 ± 1.66 on specific communication practices. Dental hygienists who were members of the California Dental Hygienists' Association and attended a continuing education course on HDS within the last year or who personally used HDS scored significantly higher in knowledge, confidence and communication practices than their counterparts. These 3 attributes were identified as significant predictors for higher knowledge about HDS.

Conclusion: There is a need to improve California dental hygienists' knowledge and involvement in the active management of patients who take HDS. Such actions can be expected to improve oral health outcomes. Focused training on HDS for hygienists should be designed to improve their knowledge and influence practice behaviors.

Keywords: Dietary supplements, Herbal supplements, Dental hygienists' knowledge attitudes and practices

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Investigate how dental hygienists use emerging science to reduce risk in susceptible patients (risk reduction strategies).

tist.¹⁶ Even more concerning, among adults with chronic or serious diseases, such as those affecting oncologic, neurologic, rheumatologic, cardiac, vascular, endocrine, gastrointestinal or pulmonary conditions, less than half reported using HDS to their regular health care provider.¹⁷ Dietary supplements are over-the-counter and not regulated by the Food and Drug Administration with the same scrutiny as conventional drugs.³ Because HDS include many natural products, they typically do not contain single pharmacologically active constituents like drugs, but are composed of a complex mixture of potentially active ingredients. This has raised concerns about their efficacy and safety, especially in the case where patients use HDS and prescription drugs simultaneously.^{7,16,18,19}

This concomitant use of HDS is widespread and has raised a growing medical concern over the potential for herb-drug interactions.²⁰⁻²⁵ A survey found 15% of patients on prescription drugs were also taking herbal supplements. Among these, potential adverse herb-drug interactions were observed in 40% of patients.²⁶ The adverse reactions involved all systems, age groups and severity. Concurrent use of HDS and prescription drugs is also seen in dentistry. In dental patients, 54% used some form of herbal supplements. Of those, 69% were also using prescription drugs.²⁷ Herbal and dietary supplement use among Californians exceeds national statistics. In a follow up survey to the 2001 California Health Interview Survey, investigators asked specific questions regarding multivitamin and HDS use.^{28,29} Of the 9,187 respondents, over 62% reported using 2 or more HDS in addition to a multivitamin to deal with a health problem. Without the knowledge of HDS use among patients, the health care provider will be unable to associate possible adverse effects and toxicities that may be caused by HDS. Given the large number of consumers using these supplements, dental hygienists should be aware of the use, safety and potential risks of HDS their patients may be taking.

Health Professional's Knowledge, Attitudes and Practices about HDS

There is limited information about American health professionals' knowledge, attitudes or clinical practices related to HDS. In a cross-sectional survey of 537 clinicians, physicians, advanced practice nurses, pharmacists and registered dietitians, respondents demonstrated considerable room for improvement in knowledge of herbal medicine.³⁰ Most respondents correctly identified common clinical uses of popular herbs, such as St. John's wort, but despite reporting previous formal training on herbal supplements, most were unable to identify

adverse reactions and side effects associated with these herbs. Average knowledge across all groups was substantially less than 60% of possible scores, with registered dietitians scoring significantly higher than any other group. Attitudes of these clinicians revealed that 77% had used HDS themselves on a regular basis, and 79% agreed that many herbal supplements have some therapeutic benefit. Although most participants (64%) believed they knew more about herbal medicine than their colleagues, only 21% felt they could answer questions posed by their patients, and 17% knew how to report adverse effects to local or government agencies. In a 2006 follow up study, Kemper et al conducted the largest survey to date to examine expertise about HDS among diverse health professionals (physicians, nurses, nutritionists, dieticians, pharmacists and students).³¹ Survey questions sought information on demographics and respondents' overall knowledge, attitudes (confidence) and communication practices. Of the 1,268 participants, 65.8% answered the knowledge test questions correctly, with pharmacists (70.7%) and physicians (70.3%) scoring higher than other groups. Although the authors concluded there was room for improvement in the area of confidence, dieticians had the highest confidence scores, followed by physicians, nurses, pharmacists and students. Those health professionals who were regular users of HDS scored higher in the communication practices section, making the authors conclude that higher use of these supplements among professionals affected the quality of information supplied to patients.

Dental Professional's Knowledge, Attitudes and Practices about HDS

There has been no exclusive research on dental professional's knowledge, attitudes or practices regarding HDS. A survey of health professionals by Dougherty et al included dental faculty among the 904 surveys distributed.³² Ninety-eight surveys were sent to dental faculty, with 60 returned (61.2% response rate). There was no description on whether the participants were dentists, dental hygienists, dental assistants or other dental personnel. Personal use of HDS among dental school respondents was 31.6% (n=19), considerably lower than the national average of 52% during the same time period.¹⁰ Dental faculty involved in direct patient care who recommended herbal medicine was 13.3% (n=4), the lowest reported among the groups surveyed. As with previous surveys of health professionals, this survey revealed that respondents who regularly used HDS themselves were more likely to recommend herb use to patients ($p<0.001$). No knowledge questions were asked in the survey, however, respondents who used HDS themselves

were more likely to teach students about herbal medicine ($p=0.001$). In addition, the study reported 6.8% ($n=26$) of respondents planned to expand teaching about herbal medicine during the following academic year, with only a small percentage of dental faculty planning to do so.

The case for change in dental education has suggested that significantly more curricular attention should be devoted to graduating professionals who are capable of dealing with the changing health demographics of the population, as well as patient/population desires, needs and expectations.³³⁻³⁵ The increasing popularity of HDS demands that dentists and dental hygienists be knowledgeable about the effects of these supplements in order to make appropriate treatment modifications. This includes obtaining important information from patients as well as educating patients about the risk-benefit and potential interactions that could be seen with HDS. The entry-level and current practitioner needs to have the knowledge and attitudes necessary to be able to provide the comprehensive care that exists in dental and dental hygiene practices today. The purpose of this study was to identify the current knowledge, attitudes and practice behaviors among California dental hygienists regarding HDS.

Methods and Materials

Survey Instrument Development

A 4 part survey, previously conducted among a diverse group of health professionals (physicians, nurses, nutritionists, dieticians, pharmacists and respective professional students) was modified and used with permission from the authors.³¹ The questionnaire included 3 sections designed to assess knowledge (29 items), attitudes (20 items) and practices (15 items) about HDS, and a fourth section assessing professional characteristics and demographics. Instructions to participants reminded them of their anonymity with regard to survey responses. In the knowledge section, participants were directed to complete the questions to the best of their ability and to use no outside resources.

Modifications to the original instrument were slight and in some cases related to wording that clarified the question. Three questions were added in the first section dealing with respondent's practice of seeing patients and whether or not they had attended a continuing education course on HDS. One question was added to the second and third sections of the survey. Demographic questions were modified in the fourth section to be specific with the practice of dental hygiene and included a question regarding whether or not the respondent was

a member of the California Dental Hygienists' Association. Approval for the survey was secured from the Social Science Institutional Review Board (IRB) of the University of Missouri-Kansas City. Because the primary investigator and a secondary investigator are faculty at Loma Linda University, the Loma Linda University IRB was informed. The survey instrument was piloted to a group of clinically practicing dental hygienists ($n=12$) who identified confusion on some questions. Based on the feedback, the wording of 3 questions was changed prior to the release of the final questionnaire.

Scales Development

The original study reported face validity and excellent Cronbach's alpha reliability statistics for the 2 scales that measured attitudes (confidence) and communication practices (0.96 and 0.84 respectively).³¹ It is generally agreed a Cronbach's alpha reliability statistic of 0.70 is acceptable, with values closer to 1.0 indicating stronger internal consistency of the instrument.^{36,37} For this study, scales to measure confidence and communication practices were created using the same criteria as in the original study in order to make comparisons. In addition to determining the Cronbach's alpha of the new scales, confirmatory factor analysis was performed to validate the scale by determining if the items in the scale were correlated. A confidence scale was created to measure dental hygienists' attitudes and beliefs related to HDS using all 20 questions posed to determine attitudes and beliefs from the second section of the questionnaire. Confirmatory factor analysis of the 20 questions revealed that 1 question did not load on the same factor and was therefore removed from the scale. This resulted in a single factor consistent scale, as its constituent items loaded on the same factor. As in the original study, a raw score was generated by assigning a value to the answers of the remaining 19 attitude and belief questions, with 0 (strongly disagree) to 4 (strongly agree), with a minimum possible score of 0 and a maximum possible score of 76. A communication practices scale was created to measure dental hygienists' practice behaviors related to their communication with patients regarding HDS. As in the previous study, a raw score was generated by assigning a value to the answers of the 7 questions dealing with communication practices found in the first section of the questionnaire. The original communication practices scale used 11 items from the first section.³¹ It was determined to not include 2 yes/no questions or 2 contingency questions, where the respondent only answered these 2 questions if they responded positively to a previous question. The questions were scored as a proportion corresponding to the percentage chosen (0.0 to 1.0).

Those that answered 0% were assigned a score of 0, those that answered 1 to 30% received a score of 0.25, 31 to 50% received a score of 0.5, 51 to 80% received a score of 0.75 and >80% received a score of 1.0. The possible range of raw scores for this scale was 0 to 7. Confirmatory factor analysis of these 7 questions revealed this scale was not a single factor consistent scale, as its constituent items loaded on 2 different factors. It was determined that for this study, 2 subscales were required to measure communication practices of dental hygienists. The first subscale would contain 3 of the 7 questions and measured general communication practices (GCP), with possible range of raw scores from 0 to 3. The second subscale would contain the remaining 4 of the 7 questions and measured specific communication practices (SCP), with possible range of raw scores from 0 to 4. In order to make comparisons easier to view, all 3 new scales were standardized to a scale of 0 to 10, with 0 being the lowest.

Participants

A sample of 1,203 registered dental hygienists actively licensed and residing in California were randomly recruited from a dental hygiene mailing list of 14,378 obtained from the California Dental Hygienists' Association (CDHA). A stratified random sample across 25 California geographic regions, represented by the 25 local California Dental Hygienists' Association component organizations, was used in this study. An announcement postcard was mailed to all selected dental hygienists informing them of their selection and inviting them to complete the anonymous survey online. If the dental hygienist desired to complete the survey online, instructions were provided on the postcard to send an email to Loma Linda University Health Consulting Group with the word "herbal" in the subject heading. To help ensure anonymity, an automatic response was generated back which included a link to the survey online. The participant was required to enter a unique 4 digit code from the postcard mailing label, which automatically removed the participant's address from the mailing list. Ten dental hygienists took advantage of the online survey. Three weeks following the mailing of the announcement postcard, the survey was mailed to the remaining 1,193 selected dental hygienists who did not respond to the online invitation. Six weeks following the mailing of the announcement postcard, a reminder postcard was mailed to all 1,193 selected dental hygienists.

Statistical Analysis

Three primary outcomes were analyzed: dental hygienists' knowledge about HDS, attitudes (con-

fidence) about HDS and communication practices regarding HDS. Descriptive statistics were generated using means and standard deviations for numeric values. Group comparisons were made using the Mann-Whitney U test or Kruskal-Wallis ANOVA because some numeric data were not normally distributed. Associations were explored by using the Spearman's rho coefficient to determine any correlations between knowledge, attitudes, practices and personal characteristics of dental hygienists. A multiple variable regression model to investigate independent association between the number of HDS personally used by dental hygienists during a typical week, whether dental hygienists attended a continuing education course on HDS within the previous year and if dental hygienists were members of the CDHA, was used with knowledge scores. Confirmatory factor analysis on the scales used to measure confidence and communication practices was conducted using Quartimax with Kaiser Normalization because this rotation method maximizes similarities and minimizes differences among factors.

Results

Of the 1,193 surveys mailed, 12 surveys were undeliverable despite attempts to forward to an alternate address. A total of 250 surveys were returned (10 completed electronically, 239 completed by mail, 2 surveys were returned by mail with notes from the respondents stating they were not qualified to complete the survey and 1 mailed survey was received after survey analysis was being conducted and was never opened). The response rate was 21%. Of the 249 respondents who completed the survey, 97% were female and 3% were male. The respondents were evenly split with regard to membership in the CDHA, with 49% reporting being a member ($n=122$). Most respondents reported working in a general practice (80%), while 10% ($n=24$) reported they were not currently practicing dental hygiene. Although 48% ($n=119$) reported a bachelor's degree as their highest level of college degree attained, only 40% ($n=99$) reported a Bachelor of Science degree in dental hygiene. An Associate of Science degree in dental hygiene was the highest level of dental hygiene degree held by a majority of respondents (55%). Only 2 respondents reported a Master of Science degree in dental hygiene (0.8%), while 5% of the dental hygienists indicated a master's degree or higher as their highest level of education. Most respondents ($n=213$, 86%) reported they had not attended a continuing education course on HDS in the last year (Table I). Overall, 88% ($n=220$) described themselves as having had professional contact with a patient in the previous 30 days of participation, with 12% ($n=29$) reporting no professional contact with a

patient. Respondents who reported professional contact with a patient in the previous 30 days were asked to complete all sections of the survey to include communication practices regarding HDS, attitudes and beliefs about HDS, knowledge of HDS as well as personal use of HDS and demographic information. The clinicians were also asked to estimate the number of hours they worked in patient care each week, the number of patients they saw per week and how many of their patients took HDS (Table II). Those respondents who did not have professional contact were directed to complete only 2 sections of the survey dealing with their knowledge about HDS as well as demographic information that included their personal use of HDS. A majority of respondents ($n=198$, 80%) reported using HDS themselves in a typical week. The range of supplements used was 1 to 30 per respondent per week, with an average of 5.75 ± 4.74 . The most common HDS supplements used included calcium, multivitamin and Omega 3 fish oil. Among herbal supplements, green tea and flax seed were the 2 most popular botanicals reported (Table III).

Knowledge scores

The knowledge questions included 13 true/false items and 16 multiple choice questions about the use and safety of commonly used HDS, such as black cohosh, ginger, chromium, fish oil, ginkgo biloba, glucosamine and St. John's wort. Knowledge scores were reported by percent of the knowledge questions answered correctly, and all 29 questions allowed for the respondent to choose "I don't know" as a response option. The scores ranged from a low of 4% to a high of 90%, with an average score of 38% of the knowledge questions answered correctly. The Cronbach's alpha reliability statistic of the knowledge score was 0.87. Over half of the time (55%), dental hygienists chose the response "I don't know" in this section of the survey, indicating a lack of knowledge about HDS. All dental hygienists ($n=247$, 100%) selected this answer option at least once, ranging from a low of 1 respondent selecting this option once to a high of 4 respondents selecting this option for all 29 questions. Those dental hygienists who did not attend a continuing education course within the last year chose this answer option 15% more often ($p<0.001$) than their counterparts who indicated they attended a continuing education course on HDS.

The vast majority (78%) correctly identified that glucosamine is useful in treating osteoarthritis, while over half (51%) recognized that black cohosh is useful to treat hot flashes in women and is approved by the German Commission E. Most dental hygienists (72%) noted that ginger can be

Table I: Personal Characteristics of Respondents to CA HDS Survey ($n=249$)

Gender	
Male	8 (3.2%)
Female	241(96.8%)
Age	
20-30	24 (10%)
31-40	50 (20%)
41-50	66 (26%)
51-60	67 (27%)
61-70	35 (14%)
71+	7 (3%)
Highest DH Degree Earned	
Certificate	10 (4%)
Associate of Science	138 (55%)
Bachelor of Science	99 (40%)
Master of Science	2 (1%)
Highest College Degree Earned	
Associate degree	117 (47%)
Bachelor degree	119 (48%)
Master degree	11 (4%)
Doctorate degree	2 (1%)
Practice Setting	
General	199 (80%)
Periodontics	11 (4%)
Education	6 (2%)
Public Health	3 (1%)
Corporate	1 (.5%)
Consultant	1 (.5%)
Other	4 (2%)
Not currently practicing	24 (10%)
California Dental Hygienists' Association Membership ($n=245$)	
Yes	122 (49%)
No	123 (49%)
Missing	4 (2%)

Table II: Clinician Characteristics of California HDS Survey ($n=220$)

Patient Contact in Preceding 30 days	
Yes	220 (88%)
No	29 (12%)
Average Clinical Hours Worked per Week	26.38 ± 9.44 hours
Average Patients Seen During Week	27.55 ± 10.58 patients
Estimates of Patient Weekly Use of HDS	
0%	1 (0%)
1%-30%	99 (45%)
31%-50%	50 (23%)
51%-80%	61 (28%)
>80%	9 (4%)

an effective remedy for nausea and 57% were able to identify among a list of herbs (chamomile, peppermint, cranberry and ginger) that cranberry would be the exception in treating an upset stomach. Seventy-four percent of dental hygienists knew that St. John's wort is typically used to treat depression, but few (20%) knew that St. John's wort can change serum concentrations of digoxin. Few dental hygienists (4%) knew that chromium is ineffective in normalizing serum glucose and HgbA1c levels in patients with diabetes, and 88% did not know that American ginseng shows promise in reducing postprandial (after meal) glucose levels. Only 35% knew that riboflavin (Vitamin B2) is associated with angular chelitis, but over half (54%) knew that gingko could increase the risk of bleeding.

There were no significant differences noted between knowledge scores and gender ($p=0.124$), highest dental hygiene degree earned or highest total college education ($p>0.05$) and practice setting where hygienists worked most often ($p>0.05$). Those dental hygienists who attended a continuing education course within the last year on HDS scored 13% higher ($p<0.001$) on the knowledge questions than those who did not. In addition, those dental hygienists who were members of the CDHA scored 7% higher in their knowledge scores ($p=0.002$) than those that were not CDHA members (Table IV). Using the Spearman's rho coefficient, a significant positive linear correlation between knowledge scores and the number of HDS personally used by dental hygienists was found ($r=0.365$, $p<0.001$). Not surprisingly, this analysis confirmed the more HDS used weekly by dental hygienists, the higher they scored in the knowledge section. A statistically significant positive correlation was also found between knowledge scores and membership in the CDHA, and whether the dental hygienist attended a continuing education course on HDS within the last year. There was no significant correlation found between the age of the dental hygienist and knowledge scores ($r=0.001$, $p=0.987$) or gender of the dental hygienist and knowledge scores ($r=-0.096$, $p=0.135$). Three independent predictors of high HDS knowledge were identified among dental hygienists (Table V):

1. Personal use of HDS
2. Attendance at a continuing education course on HDS within the last year
3. Membership in the California Dental Hygienists' Association

Attitudes (Confidence) Scores

Attitudes and beliefs regarding HDS were

Table III: California Dental Hygienist Herbal and Dietary Supplement Use

Type of HDS	n=249
Overall	
Mean weekly use 5.75 ± 4.7	
Nutritional Supplements	
Calcium	139 (56)
Multiple vitamin	133 (53)
Fish Oil/Omega 3	91 (37)
Vitamin D	75 (30)
Vitamin C	71 (29)
Vitamin B complex	63 (25)
Vitamin E	50 (20)
Glucosamine sulfate	42 (17)
Coenzyme Q 10	31 (12)
Herb/Botanical Supplements	
Green tea	65 (26)
Flax seed	52 (21)
Chamomile	27 (11)
Echinacea	15 (6)
Soy	14 (6)
Cranberry	11 (4)
Garlic	10 (4)
Aloe vera	10 (4)

Data is presented as mean \pm standard deviation or n (%)

gained from those dental hygienists who had professional contact with patients in the previous month ($n=220$). Responses to 20 Likert-type questions (strongly disagree, disagree, neutral/not sure, agree, strongly agree) reflected the respondents' overall confidence with HDS that their patients may be taking.

Sixty-nine percent of dental hygienists agreed they could readily record information about their patient's use of HDS in the patient record, yet only 21% agreed they knew how to ask about which brands and doses of HDS patients were using. Although only 25% felt confident responding to patient's questions about HDS, 37% reported they were confident initiating discussions with patients about HDS. Only 19% felt they could warn patients about side effects of commonly used HDS, 18% felt they could warn patients about interactions between commonly used HDS and medications and 7% knew how and where to report adverse effects related to HDS. Although 31% felt they knew where they could find reliable information about HDS for themselves, only 18% knew where to refer patients for more information about HDS, and just 11% agreed they could provide evidence-based information about HDS to patients. Most dental

hygienists were not comfortable providing information to students, with 78% reporting they could not teach a high school science class about HDS, and 74% feeling they could not give a lecture about HDS to dental hygiene students. Only 8% felt confident their dental hygiene education prepared them to manage patients using HDS.

This study revealed a low confidence scale score (3.67 ± 2.03) among dental hygienists regarding HDS. The Cronbach's alpha reliability statistic for this scale was 0.95. Mann-Whitney U test revealed no statistically significant difference seen between the confidence scale score and gender, age, CDHA membership or highest dental hygiene degree earned. Kruskal-Wallis ANOVA revealed no significant difference between the confidence scale score and highest overall college degree earned (Table VI). Spearman's rho coefficient analysis revealed a significant positive linear correlation between the number of HDS used by respondents weekly and the confidence scale score ($n=220$, $r=0.304$, $p<0.001$), as well as whether the respondent had attended a continuing education course on HDS within the last year ($n=220$, $r=0.194$, $p<0.001$). However, no correlation was seen with membership in the California Dental Hygienists' Association (Table V).

Communication Practices Scores

Scores for communication practices of California dental hygienists were acquired from respondents who had professional contact with patients in the previous 30 days prior to completing the survey ($n=220$). Responses to 15 questions dealing with professional practices regarding patients and HDS revealed dental hygienists' practice behaviors. These questions asked respondents to choose how often they completed certain practice behaviors with patients, ranging from 0%, 1 to 30%, 31 to 50%, 51 to 80% and >80%.

The majority of dental hygienists (77%), in half their patient encounters, did not question patients about their use of HDS, with 23% reporting they asked about HDS use more than half of the time. Dental hygienists were equally as reluctant to initi-

Table IV: California Dental Hygienists' Knowledge of HDS

Characteristic	Percent Knowledge Items Correct (range 4 to 86%)
Gender	
Female	38% \pm 18.0
Male	28% \pm 13.4 NS $r=0.001$ $p=0.987$
Age	
Number of HDS used weekly	
Attended CE in past year	
Yes	49% \pm 15.4
No	36% \pm 17.7 $p<0.001$
California Dental Hygienists' Association Membership	
Yes	41% \pm 17.04
No	34% \pm 18.06 $p=0.002$

Data is presented as mean \pm standard deviation or Spearman's rho based on 29 knowledge questions

Table V: Predictors of Knowledge About HDS in a Linear Regression Model

Predictor	Coefficient	p value
Personal use of HDS	0.299	0.002
Attending a CE on HDS*	2.55	0.015
Membership in California Dental Hygienists' Association*	1.53	0.047

*No=reference group

Age and gender were not significant predictors

ate discussion about HDS, as 64% reported starting the conversation with their patients in 30% or less of their patient encounters. Approximately half (51%) never asked patients they knew were using HDS about amount and frequency (dose) of the HDS, and even more (73%) never asked about the brand name or manufacturer of the HDS their patients were using. The vast majority of the dental hygienists (82%), who knew their patients were taking HDS, asked about side effects 30% or less of the time. Only 38% of dental hygienists reported documenting their patient's use or non-use of HDS in greater than 80% of their patient encounters during the preceding 30 days of practice. Most dental hygienists (70%) did not caution patients about the potential hazards associated with HDS use, and 88% did not provide any patient handouts or refer patients to specific books, articles or web sites for additional information.

This study revealed low general and even lower specific communication practices among dental hygienists. The mean GCP scale score among den-

Table VI: Confidence and Communication Practices Scores Among California Dental Hygienists

Characteristic	Confidence (Attitudes) Scale (standardized range 0–10)	General Communication Practices Scale (standardized range 0–10)	Specific Communication Practices Scale (standardized range 0–10)
Overall	3.67 ± 2.03	4.21 ± 2.99	1.25 ± 1.66
Gender*			
Female	3.66 ± 2.02	4.27 ± 3.00	1.26 ± 1.67
Male	3.99 ± 2.20 NS	2.60 ± 1.92 NS	0.77 ± 1.09 NS
California Dental Hygienists' Association Membership*			
Yes	3.79 ± 2.06	4.35 ± 3.03	1.38 ± 1.93
No	3.55 ± 1.98 NS	3.95 ± 2.89 NS	1.08 ± 1.30 NS
Highest dental hygiene degree*			
Certificate & Associate	3.78 ± 2.06	4.15 ± 3.03	1.24 ± 1.72
Bachelor +	3.48 ± 1.96 NS	4.32 ± 2.93 NS	1.26 ± 1.54 NS
Highest College degree**			
Associate	3.47 ± 2.00	3.90 ± 2.98	1.00 ± 1.37
Bachelor	3.83 ± 1.97	4.54 ± 2.97	1.49 ± 1.90
Master+	4.53 ± 2.79 NS	4.42 ± 3.19 NS	1.62 ± 1.72 NS
Number of HDS used weekly***	r=0.304 p<0.001	r=.0207 p=0.002	r=0.270 p<0.001
Age***	r=0.002 NS	r=-0.48 NS	r=-0.30 NS

*Mann-Whitney U

**Kruskal-Wallis ANOVA

***Spearman's rho

tal hygienists was 4.20 ± 2.99 . The mean SCP scale score was 1.25 ± 1.66 (Table VI). The Cronbach's alpha reliability statistic for the GCP scale was 0.78, while the Cronbach's alpha reliability statistic for the SCP scale was 0.71. Mann-Whitney U revealed no statistically significant difference seen between either communication practices scale scores (GCP or SCP) and gender, age, CDHA membership and highest dental hygiene degree. Kruskal-Wallis ANOVA revealed no significant difference between highest total college degree earned and either the GCP or SCP. Spearman's rho coefficient analysis revealed a significant positive linear correlation between the number of HDS used weekly and the GCP scale score ($n=218$, $r=.207$, $p=0.002$), as well as for the SCP scale score ($n=218$, $r=.270$, $p<0.001$) (Table VII).

This study also revealed a significant positive correlation between knowledge scores, confidence scores and communication practices scores. Those respondents who scored higher in knowledge also scored higher in confidence and communication practices. In addition, those dental hygienists who personally used HDS had higher confidence and communication practices scores (both GCP and SCP), as well as higher knowledge scores, with the highest scores for those dental hygienists using >9 supplements per week (Table V).

Discussion

This is the first study to describe the knowledge, attitudes (confidence) and communication practices of dental hygienists regarding HDS. Survey respondent demographics appear closely to represent the population of California dental hygienists. The current sample was mostly female (96.8%), which is consistent with previous reports that 97.5% of dental hygienists in the state were female.³⁸ The educational attainment of dental hygienists in this study was slightly higher than a previous California survey, with 47% of respondents reporting a bachelor's degree as their highest college degree attained, and 5% reporting a master's degree or higher compared to 43.2% and 4.6% in a previous study, respectively.³⁸ Most dental hygienists reported they were in clinical practice, working in general dentistry or periodontics (84%). This is down from a previous survey reporting 97.8% working in a private dental practice.³⁸ This downturn could be related to the increased number of dental hygienists working outside traditional private practice.

Dental hygienists reported higher personal use of HDS (80%) when compared with the only other study that looked at dental professionals (31.6%).³² However, this was slightly lower when

Table VII: Spearman's Correlation Matrix Related to California HDS Survey Results

	Knowledge	Confidence	General Communication Practices	Specific Communication Practices	Number HDS Used	CDHA Membership
Knowledge						
Confidence	0.453**					
General Communication Practices	0.321**	0.349**				
Specific Communication Practices	0.303**	0.534**	0.546**			
Number of HDS used	0.365**	0.304**	0.207**	0.270**		
CDHA Membership	0.200** (p=0.723)	0.024 (p=0.387)	0.059 (p=0.551)	0.041 (p=0.549)	0.038 (p=0.549)	
Attended CE on HDS	0.244**	0.194**	0.158*	0.244**	0.193**	0.050 (p=0.474)

Data is presented as Spearman's rho

**Correlation is significant at p<0.001

*Correlation is significant at p<0.05

compared with other health professionals that included physicians, nurses, dieticians, nutritionists and pharmacists (85.1%) who completed a similar survey.³¹ Despite the overall lower personal use of HDS, dental hygienists reported a higher median number of supplements used per week (5 supplements) than other health professionals (4 supplements).³¹ Interestingly, among these health professionals who completed a similar study, multivitamins (64%) and calcium (39%) were the top 2 HDS personally used, compared to this study where calcium and multivitamins were the top 2 HDS used weekly among dental hygienists. Results also suggest this sample of dental hygienists from California may be more likely to take HDS than the general population. Previous studies report that 48 to 60% of Americans take dietary supplements.^{2,4-12}

This survey was modified to allow the respondent to choose "I don't know" as an answer choice in the knowledge section, where other surveys of health professionals did not offer this alternative. The purpose of offering this choice was to remove a bias that favors random guessing with true/false and multiple choice questions. Research has demonstrated that more able respondents employ an intelligent guess, whereas less able respondents employ a random guessing approach.³⁹⁻⁴¹ By offering a choice of "I don't know," dental hygienists could choose this option if they had no knowledge of the topic and could not make an intelligent guess by using partial knowledge. In the study this survey

instrument was modified from, physicians, nurses, nutritionists and pharmacists scored nearly twice as well (65.8%) in knowledge compared to dental hygienists (38%).³¹ This lower knowledge score could be viewed as a more reliable representation of what dental hygienists know or don't know – distortion or inflation of the knowledge scores would be reduced since respondents were not required to guess on any questions. Since 100% of dental hygienists chose this option at least once, this could account for the lower knowledge score. Another explanation of the low knowledge scores could lie in the nearly 87% of dental hygienists who had not attended a continuing education course on HDS within the last year. There was a strong correlation between high knowledge scores and dental hygienists who had attended a continuing education course on HDS within the last year. Half the respondents were not members of the CDHA, and analysis confirmed they had significantly lower knowledge scores than those dental hygienists who were members. California dental hygienists had lower mean confidence scores compared to other health professionals in a previous study (52.5 ± 18.2 , possible range 19 to 95).³¹

Most dental hygienists (81%) did not have confidence in their dental hygiene education preparing them to manage patients who take HDS, which could also contribute to the low knowledge scores. This confirms concerns that education that is meaningful and relative to current practice should be provided, and suggests a need for changes in

entry-level curriculum to include more information about HDS.³³⁻³⁵ To address the already practicing dental hygienists, more continuing education courses focused on HDS should be made available as well. These continuing education courses should use mixed interactive and didactic formats, focusing on outcomes that are likely to be perceived as serious in order to raise the likelihood of improving knowledge and clinical practice behaviors.⁴² Further research is needed to indicate exactly where formal training is taking place and the impact of training about HDS on changes in practice behaviors to improve patient safety. This lack of confidence translated into poor communication practice behaviors, with few dental hygienists asking their patients about HDS use, dosage or adverse effects. The vast majority (98%) had never reported a suspected adverse effect from an HDS to the FDA.

This study had several strengths and limitations. Strengths included the confirmatory factor analysis conducted on the scales which corroborated their consistent and reliable measurement of attitudes as it related to confidence and communication practices. The Cronbach's alpha of the scales and knowledge questions were acceptable, which demonstrated reliability. Limitations of this study included a small pilot test sample, as well as some bias that is seen in most surveys, as only those individuals who were interested in the topic may have responded. Even though respondents were instructed not to use any outside assistance or reference while answering the knowledge questions, it was impossible to determine if the instructions were followed. This study used self-report rather than observation of clinical communication practice behaviors, and the extent to which self-report correlated with actual clinical communication practices was unknown. California dental hygienists may not be representative of the general dental hygiene population as it relates to HDS use. Finally, this survey was long, and this could have contributed to the low response rate of 21%, which may limit the generalizability of the findings.

Conclusion

Although there has been an increase in the number of continuing education programs, review articles and research available to interested dental professionals about HDS, there is still substantial room for improvement in knowledge, attitudes (confidence) and communication practices among California dental hygienists. Dental hygienists scored lower in knowledge, confidence and communication practices than other health professionals previously surveyed. Despite the limitations, this study offers important insights about the need for additional education of dental hygienists on clinical practice behaviors related to the management of patients who take HDS. Focused training for dental hygienists should be designed to improve knowledge and influence communication practice behaviors, which will ultimately improve general and oral health outcomes for patients. Future studies are necessary to address the impact of the lack of knowledge about HDS and how this issue could be addressed through future curricula and continuing education, as well as the influence of professional association membership. Given the enormous growth in the use of HDS in the U.S., dental hygienists need to be knowledgeable as well as comfortable discussing HDS with their patients. This study confirms the need for more education in the area of HDS to not only improve the knowledge base, but also the confidence and communication practices of dental hygienists.

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Comparison of Dental Hygiene Clinical Instructor and Student Opinions of Professional Preparation for Clinical Instruction

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Introduction

Clinical dental hygiene instructors serve as role models of professionalism, clinical expertise and ethical behavior.¹⁻³ Despite the crucial role filled by dental hygiene clinical instructors, they are often hired without a background in education.⁴ Furthermore, dental hygiene clinical instructors are given less professional preparation in educational methodologies than many other allied health disciplines.⁵

The dental hygiene clinical instructor is responsible for teaching clinical students about instrumentation techniques, patient and self-assessment skills and technology-based dental hygiene procedures.⁶ Dental hygiene students often spend more time with their clinical instructors than with their didactic instructors and are introduced to the importance of thorough clinical treatment by their clinical instructors.⁴ In the allied health professions, there have been numerous studies evaluating the desired qualities of a clinical instructor as determined by fellow faculty, administrators and students.^{4,7,8}

Studies strongly suggest that students deem it necessary for clinical instructors to consistently provide constructive feedback. Students describe competent clinical instructors in the professions of dental hygiene, radiology and physical therapy as approachable and as a reliable source of intellectual and emotional support.^{4,7,9} Feedback may be presented in numerous forms, including reorganizing educational material to conform to student understanding, validating correct responses, offering alternatives for incorrect responses and proposing resources for additional study.¹⁰

Abstract

Purpose: The purpose of this study was to determine the degree of professional preparation among clinical instructors employed in baccalaureate dental hygiene programs in the U.S. and to examine clinical instructors' and students' perceived need for educational preparation. The data-generating sample consisted of 285 dental hygiene clinical students and 76 dental hygiene clinical instructors from the 48 dental hygiene programs in the U.S. that offered a baccalaureate or higher degree in dental hygiene.

Methods: Online survey instruments contained both qualitative and quantitative questions and were completed by 285 clinical dental hygiene students and 76 clinical dental hygiene instructors from dental hygiene programs in the U.S. Using descriptive statistics, Chi-square analysis and the Mann-Whitney U test, the data from clinical dental hygiene instructors and students were compared to determine if the preparation in educational methods being offered to dental hygiene clinical instructors was meeting the perceived needs of both clinical dental hygiene students and instructors.

Results: According to dental hygiene clinical students ($n=285$), 60% ($n=171$) indicated that 6 to 10 years of clinical dental hygiene experience was optimal, while 37% of clinical instructors ($n=28$) identified having less than 5 years of clinical experience prior to clinical teaching. Therefore, the majority of clinical instructors have less than optimal years of clinical dental hygiene experience prior to clinical instructing. Regarding methods of pre-employment preparation, more than half ($n=40$) of the dental hygiene clinical instructors ($n=76$) reported most professional preparation occurred through informal discussion with fellow clinical instructors. Significant differences were found between the clinical dental hygiene instructors' and clinical dental hygiene students' opinions of importance of clinical instructors being given formal guidance in educational methodologies ($p=0.002$), communication skills ($p=0.027$), grading and evaluation techniques ($p=0.001$) and use of technology ($p=0.008$). Although the majority of instructors and students rated training in teaching methods and communication skills as most important, the majority of clinical dental hygiene instructors (74%, $n=53$) identified grading and evaluation techniques as the most addressed subject of training.

Conclusion: Both dental hygiene clinical instructors and students identified areas of potential improvement in the professional educational guidance of dental hygiene clinical instructors. Dental hygiene clinical education may benefit from including formal clinical instructor pre-employment preparation programs.

Keywords: dental hygiene clinical instructor, clinical education, employment preparation, professional preparation

This study supports the NDHRA priority area, **Professional Education and Development:** Identify the factors that affect recruitment and retention of faculty.

Despite the importance of the clinical instructor's role in clinical teaching, the instructor is often hired based solely on clinical experience alone, and is not always provided with formal guidance in educational methodologies in the professions of dentistry and athletic training.^{11,12} An individual with superior clinical skills is not necessarily proficient at teaching those skills.⁴ It is vital that dental hygiene programs recognize the need to hire high-caliber clinical instructors, not only for the benefit of the students but also to foster the academic relationship between the dental hygiene program and the educational facility in which the dental hygiene program is located.¹³

In a study conducted by Mason, clinical radiology students described detrimental stressors, such as the instructor belittling, discrediting and condemning students and giving negative responses to student questions.¹⁴ In contrast, the students identified positive clinical instructor traits as giving positive feedback, supporting them through mistakes and accepting errors as part of the learning process. Clinical instructors who are trained to provide quality, student-centered education are likely to avoid these stressors and provide a quality, respectful learning environment.¹⁴

Dental hygiene clinical instructors are generally experienced dental and dental hygiene clinicians.⁴ However, learning to be an effective clinical instructor requires time, instruction and guidance.¹⁵ With little to no proper pre-employment preparation, many clinical instructors base their teaching skills on their own educational experiences, despite the fact they may have been negative.¹⁶ Studies by Giordano and Hand in the professions of radiology and dentistry, respectively, demonstrated that intervention, such as formal continuing education in instructional strategies for the clinical instructor, may be necessary in order to facilitate a positive clinical learning environment.^{9,11} Additionally, there may be substantial changes in both technology and teaching methods between the time the clinical instructor graduated as a dental hygienist and began teaching as a clinical instructor. The Commission on Dental Accreditation (CODA) mandates that dental hygiene clinical instructors have a minimum of a bachelor's degree, which includes coursework in educational methods. In addition, accredited dental hygiene programs must provide teaching methodology instruction for clinical instructors as mandated by CODA.¹⁷ Still, according to Kacerik et al, experienced clinical instructors utilize appropriate clinical teaching methodologies with more frequency than novice clinical instructors.⁸

Qualified dental hygiene clinical instructors must include evidence-based research theories within

their clinical instruction and guide students to do the same.⁵ A study conducted by Collins et al evaluated full-time dental hygiene faculty employed in a bachelor's degree program and their inclination for conducting research.¹⁸ The study revealed that only 19% of 114 faculty surveyed from 26 different accredited dental hygiene programs in the U.S. were engaged in basic research. The respondents, on average, presented at 26 professional conferences over the duration of their careers and published an average of 6.8 articles in refereed professional journals.¹⁸

One method of professional preparation for dental hygiene clinical instructors is mentoring.¹⁹ Key components taught through mentoring are modeling expertise, coaching, providing conceptual scaffolding, fading, articulation, reflection and exploration.²⁰ According to Swann, continuing education programs can be designed to teach important concepts such as interpersonal communication skills and how to provide skillful feedback. These skills will maximize communication between the clinical instructor and student, as well as the clinical instructor and patient. Some clinical instructors inherently possess effective communication skills, whereas others need to be taught how to provide positive and constructive feedback to their students.²¹

The provision of clinical instructor guidance in educational methods has proven to be beneficial. Instructors who have completed continuing education programs related to instructional methods in the physical therapy profession have identified feeling more confident because of the organizational skills, conflict resolution strategies and goal setting methods learned.²² In a 2008 study at a state university in Illinois, 124 clinical supervisors from varied allied health specialties were surveyed, and more than 50% of respondents indicated they would benefit from a clinical educator's workshop. Specific areas of interest to the clinical instructors included learning to assist students who required remediation and addressing students with distinct learning styles. Two-thirds of those surveyed specified that a teaching preparation website would be beneficial, and could offer resources such as educational standards, program specific policies, clinic manuals, grading protocols and links to outside resources. Additionally, electronic resources would ensure that all clinical instructors have access to the same information.²³

The Department of Dental Hygiene at the University of Texas Health Science Center at San Antonio began offering clinical teaching workshops in 2000. The yearly workshops are presented in 2 or 3 days and include topics such as developing critical thinking skills, producing appropriate feedback, team

building, conflict resolution and promotion of clinical competence. After presenting workshops for 4 years, 142 participants from 38 dental hygiene programs were sent qualitative surveys to determine the efficacy of the workshops. Participants indicated the workshops improved their clinical instruction abilities, made them more aware of the type and content of feedback they provided to students and stated that they benefited greatly from networking with clinical instructors from programs across the U.S. and Canada.⁶ Platt reported that the more workshops attended, the greater the perceived benefit.⁸

Clinical instructors from many health disciplines have benefited professionally and personally from attending relevant professional preparation workshops.^{2,24,25} Many clinical instructors guide students based on their personal educational experiences and not on current instructional methodologies.^{9,11} Clinical instructor guidance in educational methods may occur in many forms, including formal faculty development workshops, supplemental hard copy materials, Internet-based materials and modeling by experienced clinical instructors.^{1,2}

The purpose of this study was to determine the degree of professional preparation among clinical instructors employed in baccalaureate dental hygiene programs in the U.S. and to examine clinical instructors' and students' perceived need for educational preparation. The data-generating sample consisted of 285 dental hygiene clinical students and 76 dental hygiene clinical instructors from the 48 dental hygiene programs in the U.S. that offered a baccalaureate or higher degree in dental hygiene.

Methods and Materials

A list of entry-level baccalaureate degree dental hygiene programs was obtained from the American Dental Hygienists' Association website. In March 2009, when the surveys were distributed, there were 48 dental hygiene degree programs fitting the study criteria of offering an entry-level baccalaureate or higher degree in dental hygiene. Survey questions were piloted and tested for reliability using a convenience sample of 5 clinical dental hygiene instructors and 5 clinical dental hygiene students. The final clinical instructor survey contained 13 questions and the final student survey contained 10 questions. Both surveys utilized multiple choice, Likert scale and open-ended questions. Study approval was obtained through the University of Bridgeport's Institutional Review Board.

The electronic surveys were distributed by email to 48 dental hygiene program directors or deans with

the request that the email be forwarded to all clinical instructors and students within their programs. The directors or deans were informed that, in order to maintain anonymity, their program's survey results would be compiled with results from the other participating dental hygiene programs and would not be identified as originating from their program. A second email requesting participation was sent to the same 48 dental hygiene program deans or directors 2 weeks after the initial contact. The survey took approximately 10 minutes to complete and remained available online for 3 months.

The statistical analyses included descriptive statistics, Chi-square analysis and the Mann-Whitney U test. Qualitative responses were grouped and categorized for like responses, and the significance level of statistical tests was $p < 0.05$.

Results

The potential total study population was difficult to determine, since the number of dental hygiene students and clinical faculty is static and the author was unable to find statistics regarding total numbers of clinical faculty and dental hygiene students in the U.S. The survey was completed by 285 dental hygiene clinical students and 76 dental hygiene clinical instructors. After searching web sites of the 48 dental hygiene programs, it was estimated that the potential return for clinical instructors could have been approximately 161 clinical instructors. Therefore, the rate of return was approximately 47%.

Ninety-eight percent ($n=280$) of the dental hygiene clinical students and 100% ($n=76$) of the instructors were female. Of the clinical students, 3.9% had completed less than 1 semester of clinical instruction, 15.4% had completed 1 semester, 22.1% completed 2 semesters, 23.9% completed 3 semesters and 34.7% completed 4 semesters of clinical instruction. Most of the clinical student respondents (64%, $n=182$) were under 24 years of age. More than half of the clinical instructors ($n=42$) were between 40 and 60 years of age (Table I).

Ninety-two percent ($n=262$) of clinical student respondents were earning their bachelor's degree at the time of survey completion. The clinical instructors' responses indicated that the majority ($n=41$) had earned a master's degree (Table II).

When clinical dental hygiene students were asked how many years of clinical dental hygiene experience clinical instructors should have prior to clinical teaching, 60% indicated that 6 to 10 years of clinical dental hygiene experience was optimal, while 37% identified having less than 5 years of clinical experience

prior to clinical teaching was optimal. A Chi-square test of independence was performed, revealing statistically significant differences ($p<0.05$) between student perception of clinical experience necessary prior to clinical teaching and actual years of experience reported by clinical instructors (Table III).

Table III. Difference between student perception of ideal years of clinical experience prior to clinical teaching and instructor reported years of clinical experience

Regarding the years of clinical experience a clinical instructor should have prior to clinical teaching, clinical student respondents provided 84 open-ended comments, from which 3 main categories were identified. The 3 categories included:

1. The value of being exposed to both clinical instructors with teaching experience and those who were new to clinical teaching
2. The importance of clinical instructors having clinical employment experience in diversified settings
3. The benefit of clinical instructors being able to relate to the role of the clinical student

Both dental hygiene clinical instructors and clinical students were asked to rate the importance of 5 pre-employment instruction topics on a Likert scale of 1 to 5, with 1 being the most important and 5 being the least important. The topics included professional preparation in teaching methodologies, communication skills, grading and evaluation techniques, policies and procedures of the program and new technology relevant to dental hygienists. Clinical students rated educational guidance for clinical instructors in teaching clinical skills as most important, with 44% rating it as their first choice. Forty-one percent of clinical instructor respondents rated communication skills as most important (Figure 1).

The Mann-Whitney U test results showed that there is a significant difference ($p<0.05$) between whether one is a clinical instructor or clinical student and one's rating of the importance of pre-employment preparation in educational methodologies ($p=0.002$), communication skills ($p=0.027$), grading and evaluation techniques ($p=0.001$) and use of technology ($p=0.008$). However, a significant difference was not

Table I: Age and gender of clinical instructor and clinical student respondents

Demographics	Clinical Dental Hygiene Instructors (n=76)		Clinical Dental Hygiene Students (n=285)	
Variable	n	%	n	%
Gender				
Female	75	98.7	280	98.2
Male	1	1.3	5	1.8
Age				
<24	1	1.3	182	63.9
25-29	5	6.6	60	21.1
30-39	18	23.7	30	10.5
40-49	20	26.3	11	3.9
50-59	22	28.9	1	0.4
>60	10	13.2	1	0.4

Table II: Degree being earned by clinical students and degree completed by instructors

Degree Earned	Clinical Dental Hygiene Instructors' Degree Level Completed (n=76)		Clinical Dental Hygiene Students' Degree Being Earned (n=285)	
Variable	n	%	n	%
Associate	1	1.3	23	8.1
Bachelors	30	39.5	262	91.9
Master's	41	53.9	0	0
PhD	4	5.3	0	0

Table III: Difference between student perception of ideal years of clinical experience prior to clinical teaching and instructor reported years of clinical experience

Years of Clinical Experience Prior to Clinical Teaching		
	Student perception	Instructor reported
Chi-square	391.439*	15.447**
df	4	4
Asymp. Sig.	.000	.004

*Zero cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 57.0.

**Zero cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 15.2.

noted ($p=0.755$) when referring to the importance of educational guidance in program specific policies and procedures (Table IV).

Although clinical students and clinical instructors rated professional preparation in teaching methods

and communication skills as most important, 74% of clinical instructors reported the most addressed pre-employment training topics as grading and evaluation techniques. Sixty-six percent of the clinical instructors rated program specific policies and procedures as the second most addressed topic of educational preparation.

Of the clinical dental hygiene instructor respondents, 43% indicated being provided with a formal background in teaching methodologies and communication skills. Therefore, pre-employment preparation included the topics identified by clinical students and instructors as being most important less than 50% of the time.

In response to the question about which topics were addressed, 18% of clinical instructors responded with open-ended responses, with 13% indicating they did not receive any pre-employment educational guidance. Of the remaining 4 clinical instructors offering open-ended responses, 1 indicated being trained by a teaching internship, 1 indicated all topics were covered in an informal manner, 1 stated "calibration" and 1 indicated being offered educational support regarding problem-based learning and generational differences.

When asked to indicate all methods of pre-employment professional guidance they received when hired as a clinical instructor, more than half ($n=40$) indicated professional preparation by informal discussion with coworkers. The provision of a paper manual or document was chosen by 47% of clinical instructors as the second most popular form of pre-employment instruction. Twenty-two percent identified a college degree in education as contributing to their clinical instructing career. Eighteen clinical instructors indicated having professional educational preparation in the form of a workshop, with 12% stating the workshops were less than 4 hours in length, and 12% indicating they attended a workshop of 4 to 8 hours in length. None of the clinical instructors indicated receiving formal instructional guidance in the form of web-based methods.

Figure 1: Clinical student and faculty rating of importance of professional preparation topics (%)

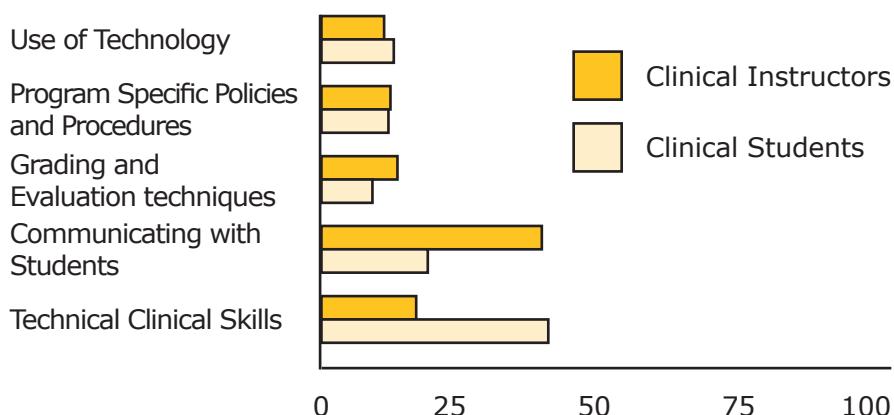


Table IV: Mann-Whitney U test analyzing differences between clinical student and clinical instructor rating of importance of professional preparation topics

Hypothesis Test Summary	
Null Hypothesis	Sig.
The distribution of instructor rating of importance of training in educational methodology is the same across categories of clinical instructor or student dental hygienists.	0.002
The distribution of instructor rating of importance of training in communicating with students is the same across categories of clinical instructor or student dental hygienists.	0.027
The distribution of instructor rating of importance of training in grading and evaluation techniques is the same across categories of clinical instructor or student dental hygienists.	0.001
The distribution of instructor rating of importance of training in program specific policies and procedures is the same across categories of clinical instructor or student dental hygienists.	0.755
The distribution of instructor rating of importance of training in use of technological equipment is the same across categories of clinical instructor or student dental hygienists.	0.008

The significance level is 0.05

Thirty-two percent supplied open-ended responses under the other category. From this qualitative data, 4 additional methods of professional educational instruction for clinical dental hygiene instructors were identified:

1. Shadowing other clinical instructors ($n=8$)
2. Student teaching in a clinical setting ($n=8$)
3. Mentorship by other clinical instructors ($n=3$)
4. Attendance of a clinical teaching workshop of longer than 8 hours ($n=3$)

The remaining 2 responses that did not correspond with the identified categories were on the job training and faculty meeting.

As identified in Figure 2, when clinical dental hygiene instructors were asked who provided the most professional preparation or support to them in the beginning of their teaching career, 66% indicated fellow clinical instructors.

Fifty-nine percent of clinical instructors agreed or strongly agreed that they would have been more effective in their interactions with students if they had been provided with more professional preparation. Furthermore, of the 10 clinical instructors who indicated they were not provided with any pre-employment clinical instructor educational support, 90% agreed or strongly agreed that pre-employment professional guidance in educational methodologies would have made them more effective in their student interactions.

On the clinical student survey, 59% ($n=169$) noticed a difference in the teaching skills between recently hired clinical instructors and more experienced clinical instructors. The student's qualitative responses ($n=148$) regarding the differences noticed between experienced and inexperienced clinical instructors were coded by positive comments about new and experienced instructors, negative comments about new and experienced instructors and neutral observations (Figure 3). The majority of comments ($n=41$) were coded as positive for experienced instructors and negative ($n=55$) for new instructors. For example, a positive comment about a new instructor was: "I find that the newer faculty have newer ideas and ways of teaching; keeps everything current and up to date." Another student stated: "The more experienced instructors promptly answer your questions with confidence, [are] more knowledgeable; know how to handle difficult situations better; know how to teach, aid and motivate students." One comment coded as neutral stated: "I think it did not make a difference if they were newly hired or old. Some are effective and some are not as effective."

Discussion

The intent of this study was to add to the existing body of knowledge about dental hygiene clinical education. It is proposed that, based on the results of this study, dental hygiene program administrators and clinical instructors will realize the benefits of and understand the justification for implementing faculty development for its clinical instructors. Given the advancements in technology, learning strategies and teaching methods, studies have recognized the many benefits of clinical

instructor educational guidance across the health disciplines.^{11,12,25} There was a paucity of information regarding the ideal dental hygiene instructor pre-employment professional preparation methods and topics as identified by clinical students and instructors, which is what this study sought to address.

The majority of the dental hygiene clinical instructors surveyed in this study had earned their master's degree, with the next highest majority having earned a baccalaureate degree. Furthermore, over 20% of the study population was working on completing a subsequent degree at the time of survey completion. These results demonstrated that the majority of clinical instructors surveyed were higher credentialed than the most common minimum degree requirements for clinical instructors, which are an associate or baccalaureate degree.¹³ Higgs et al noted the importance of continuing educational development for clinical instructors: "Becoming and being a clinical educator is a developmental process, mirroring in some ways the developmental process clinical educators strive for their students. This journey of growth and development as a clinical educator requires active learning approaches coupled with reflection on one's practice as a clinical educator."¹⁵

This research indicated that pre-employment clinical instructor professional preparation topics identified as most important by clinical dental hygiene instructors differ from the pre-employment educational topics identified as most important by clinical dental hygiene students. These findings were supported by Giordano's 2008 study, which noted differences between the opinions of clinical instructors and students about necessary behaviors of clinical instructors.⁹

Through open-ended responses in this study, clinical students identified the importance of being exposed to different clinical instructors with varying degrees of experience in diversified clinical settings. Additionally, the clinical students identified the importance of instructors being able to empathize with the difficulties of being a clinical student. These categories correlated with Hand's report of the top-rated clinical competencies of clinical teaching.¹¹ Hand defined competencies as: "The knowledge, skills, behaviors and values identified as necessary for successful functioning as a dental faculty member."¹¹

In order to improve dental hygiene clinical education, clinical education programs must first identify areas in need of improvement. Not every clinical instructor will meet or exceed every competency,

which is why it is important to employ clinical instructors with varying backgrounds and expertise. Additionally, the identification of clinical instructor strengths and weaknesses within a dental hygiene program serves to guide the administration in their faculty development decisions.¹¹

Although this study demonstrated that clinical dental hygiene instructors and students identified potential areas of improvement in clinical instructor pre-employment support, changing existing methods of professional preparation may prove difficult. Clinical instructors' opinions of what teaching concepts are most important may differ from those presented in formal clinical instructor continuing education courses, and this may cause resistance to change on the part of the clinical instructors. Therefore, organizational support is critical when implementing any modifications or additions to existing clinical instructor pre-employment instruction methods.⁶ Previous studies have shown extensive benefits from even a brief clinical instructor educational support session, which would not require a great deal of financial and personnel resources on the part of the dental hygiene facility or surrounding educational institution.^{8,11,26}

As a result of this study, the dental hygiene program where the author is employed implemented a more detailed faculty-to-faculty mentoring program to enhance the clinical teaching skills of clinical faculty. The fact that the dental hygiene program's clinical instructors were provided professional preparation could be advertised as an employment benefit to attract clinical instructors and as a positive feature for prospective students. Therefore, the provision of pre-employment educational guidance for dental hygiene clinical instructors will benefit both the dental hygiene program and the educational facility with which it is associated.

At the time of this research, minimal information was found in the literature specific to the profession of dental hygiene and the professional preparation in educational methodologies of its clinical instructors. In order for the profession of dental

Figure 2: Individual responsible for clinical instructor professional educational guidance

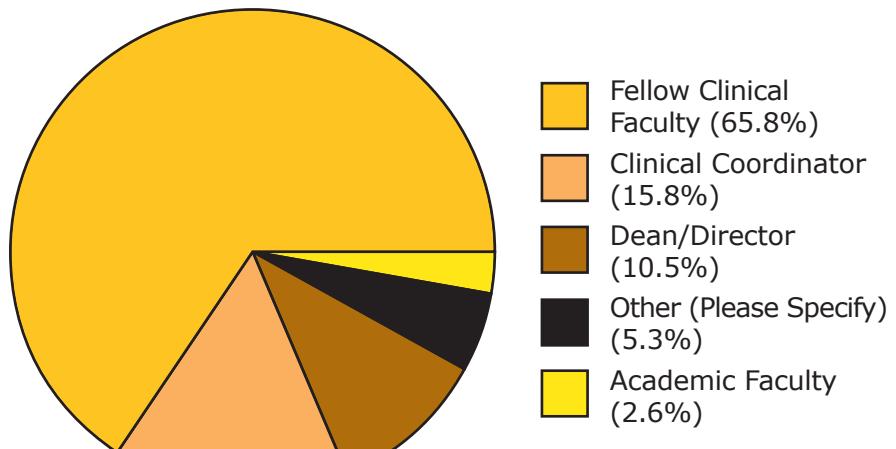
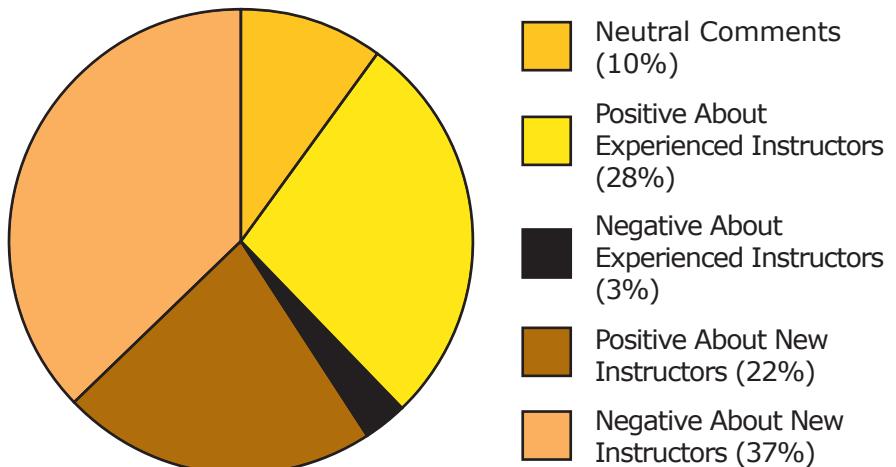


Figure 3: Categories of student qualitative comments regarding differences between experienced and inexperienced clinical instructors



hygiene to continue to grow as an allied health discipline, it must remain current in its educational methodologies regarding clinical practice. Dental hygiene clinical instructors play an important role in the clinical education of dental hygiene students, as the observation and application of clinical concepts is crucial to their development as effective dental hygiene clinicians.⁴

While the results of this study have provided useful information about clinical dental hygiene education, numerous possibilities exist for future research of this subject. This study could be replicated with a larger sample population, including pre-clinical and associate degree level programs. Additionally, a study could be conducted of dental hygiene programs to identify program-specific areas of clinical instructor proficiency and deficiency. Future studies could identify the specific negative

and positive financial implications of the provision of dental hygiene clinical instructor professional preparation. A longitudinal study could be conducted to evaluate clinical dental hygiene student and instructor perceptions of professional educational support both before and after the continuing education in teaching methodologies is provided. Furthermore, future studies could evaluate the opinions of dental hygiene program administrators and college administrators on providing formal training in educational methodologies to its clinical educators, or could evaluate the potential benefits and disadvantages of implementing a clinical dental hygiene instructor–mentoring program.

Conclusion

In the opinion of the dental hygiene clinical students, clinical dental hygiene instructors should have more clinical experience prior to teaching and should be given professional preparation in teaching methodologies. Clinical instructors cited a need for guidance in educational methods to improve communication skills. Before clinical instructors are placed in a situation of teaching students, training should occur to increase teaching effectiveness.

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Oral Hygiene Knowledge and Practice Among Dinka and Nuer from Sudan to the U.S.

Mary S. Willis, PhD; Rachel M. Bothun, BS

Introduction

Nearly 2.5 million refugees entered the U.S. between 1975 and 2001, however, few originated from Africa (5%) compared to East Asia (52%) and the USSR and Europe (29%).¹ Although refugees from Africa's largest country, Sudan, began to flee as the civil war escalated in the 1980s, the majority arrived to the U.S. during 2000. Individuals and families were resettled among 400 U.S. resettlement sites, including 3 within Nebraska.¹ Despite a low number of primary settlements to the state – just 208 refugees from Sudan had been officially resettled by 2001, the Sudanese refugee population has steadily increased in Nebraska.¹

A health survey conducted in the city of Lincoln during 2003 revealed that nearly one-third of the Sudanese refugee respondents had not visited a dental professional since their arrival to the U.S.² This is not surprising given that refugees are not automatically provided a dental screening as part of resettlement assistance, no matter where they originate and how they survived. Still, when asked about the kinds of dental treatments they might wish to have, refugee survey respondents did not list conditions often of concern to Western populations. Instead, replacement of teeth removed during a childhood ritual in Sudan was considered the most important health priority for 2 of 14 ethnic groups surveyed.³ Subsequently, a dental project was designed to address this perceived need, but also to assess dental health status, provide prophylaxis and treatment and collect data on oral hygiene knowledge to be used as a basis for oral hygiene training.

Abstract

Purpose: The purpose of this study was to determine knowledge and use of oral hygiene methods for refugees from Sudan now living in the U.S. prior to conducting elective implant surgery.

Methods: The sample included 34 adults of the Dinka or Nuer tribes who participated in 1 or more phases of a project to restore 6 lower anterior teeth with implants. An English language survey was administered by an interpreter for whom Dinka or Nuer was a first language. Each interpreter underwent an elective restorative procedure prior to acting as an interpreter. The project survey covered demographics, traditional and current oral hygiene practices, perceived aesthetics and dental visits since arrival to the U.S.

Results: Data analyses revealed that male participants outnumbered female participants, and all were under 30 years of age. Traditional dental practices paralleled Western oral hygiene methods and current oral hygiene involved 1 brushing event per day and prevalent toothpick use. Most participants wished to have all teeth in place, bright white coloration and a maxillary diastema. Few had visited a U.S. dental facility more than once, and none were using biannual checkups to maintain dental health. All participants required detailed oral hygiene education to fill the knowledge gap between traditional and U.S. systems and to maintain their newly restored dental health status.

Conclusion: Refugees arriving to the U.S. from a non-Western country may be in great need of Western oral hygiene training to create or maintain a high dental health status. Resettlement programs should include dental screening, treatment and oral hygiene training to prevent further decline in dental health status.

Keywords: Oral Hygiene Knowledge, African Refugees, Oral Health Beliefs, Traditional Dental Practice, Refugee Dental Care

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Investigate the effectiveness of oral self-care behaviors that prevent or reduce oral diseases among all age, social and cultural groups.

One might anticipate that refugees from war-torn countries, who have no less than 3 years in refugee camps with minimal nutrition and health care, would arrive with compromised oral and general health status. Because the oral health condition is an important indicator of overall health status, immediate dental assessment could provide a window into other chronic or urgent health needs. But as with low income populations nationwide,

refugees have limited access to dental care, and Nebraska is no exception. For example, in Lincoln, a city with a population of approximately 250,000 that also serves as a refugee resettlement location, there are only 2 facilities (a dental college and a federally-funded health clinic) which could provide dental services on a sliding fee scale, and just 1 free mobile dental clinic with limited operating hours. For those individuals and families with Medicaid, dental health choice is equally limited. Few dental clinics accept Medicaid as a form of payment and public clinics are often booked months in advance. Consequently, the authors used a community request for tooth replacement as an opportunity to provide free dental assessment, treatment and oral hygiene training to this vulnerable population.

Sudanese Refugees

The Sudanese refugees in this study, the Dinka and the Nuer of Sudan, are described as "Nilotic" peoples because they originate from cities and regions on both sides of the Upper Nile River and its main tributaries. Despite a common origin and continuous contact that has included inter-marriage, they maintain distinct ethnic identities, geographic land-bases and mostly oral languages.^{4,5} However, both embrace agricultural-pastoral-piscatorial economies, emphasize cattle and traditionally rely upon extensive kinship systems to ensure resource sharing and nutritional support.⁶⁻⁸ Because both the Dinka and Nuer utilize limited technology and retain the knowledge to produce nearly everything by hand, the learning curve once in the U.S. is great. Moreover, few aspects of a traditional life in Sudan are of value in the U.S., and once significant life essentials (cattle and kin) are no longer accessible. Many required elements of life, such as anterior tooth extraction, no longer have meaning in the U.S., despite their significance for generations of Dinka and Nuer. In fact, removal of the lower anterior teeth was once mandatory for both boys and girls at the time of permanent eruption, and was linked to enhanced sound production, an attractive appearance, preparation for marriage and tribal identity.⁴⁻⁶ The ritual may have originated when lockjaw or tetanus rates were high – an open space in the lower jaw would allow the tongue to be depressed and liquids to be inserted.⁴⁻⁶ Now in the U.S., such a gap is no longer an asset but a source of discomfort.

Based upon the 2003 Nebraska health assessment, the Sudanese refugee population now living in the state is relatively young, less than 29 years, and men outnumber women by 2 to 1.² Males of the Dinka tribe in Lancaster County often arrived as "The Lost Boys of Sudan," a population sepa-

rated from their families during childhood and entering the U.S. as unaccompanied minors. Other Nebraska assessment descriptors include under educated and low income. Fifty percent of refugees surveyed had not completed a Western K-12 education, and many had not been educated beyond 8th grade.²

The authors were unable to locate a single study of dental practices in regions or countries where traditional systems are still in place. By contrast, the available literature on Western dentistry and non-Western populations focuses on the introduction of Western dental systems to a developing country, or on refugee and immigrant populations receiving Western dental care after resettlement to countries such as the U.S. or Australia. This lack of knowledge concerning traditional, non-Western dental systems means that effective oral hygiene training cannot be designed for newly arriving populations – the gap which needs to be filled remains undefined for each unique population. Also, in failing to understand how populations worldwide have maintained high dental health status in the past, valuable tools for enhancing dental health worldwide may have been overlooked.

The overall need for refugee dental care has been assessed in a limited number of studies.⁹⁻¹³ Although the few assessments that have been conducted demonstrate a need for dental treatment and hygiene among newly arriving populations, there appears to be differences between sites and circumstances of origin. For example, refugee children from Eastern Europe had more caries experiences and more untreated caries compared to African refugee children.⁹ This was true despite the fact that African children were less likely to have ever visited a dental professional. Multiple factors for higher dental health status among African refugee children may include traditional diets low in sugar and carbohydrates, effective traditional dental practices and genetic protection.⁹ Historically, increased caries prevalence has been tied to availability and amount of refined sugar consumed.¹⁴ African refugee populations have had limited access to sweeteners of any kind while living in camps, and do not regularly consume sugar as part of a traditional diet. However, once in the U.S., African refugee children have constant exposure to sugar-rich food products, and consequently might be expected to experience increased caries rates.¹⁵ Given the limited dental health services offered to refugees, and the limited research conducted on newly arriving populations, studies to confirm dental health needs are critical for those who have endured compromised health conditions prior to arrival in the U.S.

Methods and Materials

A descriptive questionnaire research design was utilized. The primary investigator drafted the questionnaire in English. Two of the project participants, native speakers of Dinka and Nuer, also worked as interpreters throughout the project. Dinka and Nuer are mostly oral languages and few of the participants could read their first language.¹⁶ Also, software to print Dinka and Nuer is limited in the U.S. Thus, for each interview, the primary investigator read the question in English and the native speaker translated the question into the participant's primary language. Participants then responded in their primary language and the interpreter translated the response into English. The Institutional Review Board of the University of Nebraska-Lincoln reviewed and approved the survey instrument in December 2004 with annual renewals through 2007 (IRB #200411101). For those participants that could not read nor understand English, the interpreter translated the consent form into the first language and read the consent form to each individual. Participants were selected from a list of Dinka and Nuer refugees living in Nebraska who had expressed interest in dental restoration for teeth removed during a childhood ritual. All had previously contacted the first author, an anthropologist who began working with the Sudanese refugee population after Nebraska's Health and Human Services' Office of Minority Health asked for assistance with a new population arriving to the U.S. from Africa. Focus group discussions, health surveys and community events resulted in the selection of dental restoration as a top health priority by the majority of Dinka and Nuer who participated in these events. Long-term relationships were established by offering informal social service assistance, advice and mentoring while funds were raised and resources located to cover costs of refugee dental and general support services. A list of those wishing to undergo restoration was compiled, starting in 2000. From this list, 34 adults of the Dinka and Nuer tribes of Sudan were selected and interviewed as potential participants between March 28 and 30, 2005 and between January 21 and 23, 2006. No identifying markers were included in the questionnaire – it was completely anonymous. Interviews lasted 1 or more hours for each participant and compensation for transportation was provided at the end of the interview session.

The questionnaire was divided into 7 sections:

1. Demographics
2. Traditional dental removal
3. Traditional oral hygiene practice
4. Diet
5. Dental aesthetics
6. Current oral hygiene
7. Western dental visits, procedures and treatment

Sections 2 and 4 were previously reported in journal publications.^{15,17} All other questions were designed open-ended with some including multiple prompts or examples. The demographic information section included gender, education, ethnic group, length of residency in the U.S. and dental coverage status. The last section of the questionnaire asked participants to indicate how many visits had been made to a dental facility since arriving in the U.S. and what kind of procedures or treatment they had received in each of these visits.

Prior to survey implementation, 3 men, all native speakers of Nuer and Dinka, were administered the survey and were the first to undergo the dental implant procedure. This allowed interpreters to understand all aspects of the project prior to the time that they interpreted questionnaire materials and procedural guidelines for each individual participant. Although 34 individuals from the Dinka or Nuer tribes participated in the questionnaire portion of the project, only 26 completed the project and received implants to replace the 6 missing anterior teeth.

Inclusion criteria included male or female refugees from Sudan above 19 years in age and missing the mandibular anterior dentition, 22 through 27, removed during childhood. Exclusion criteria included ability to attend all appointments and good bone and overall dental health. This participant population represents a very small portion of all Dinka and Nuer refugees from Sudan in Nebraska, however, the exact number of each ethnic group is unknown due to multiple migrations within the U.S. Still, population estimates are in the thousands, making Nebraska's Sudanese refugee population one of the largest such communities now in the U.S. All participants were interviewed in a University of Nebraska-Lincoln laboratory. Data from the questionnaires were manually entered into a Microsoft Excel spreadsheet. Descriptive statistics were used due to sample size limitations.

Results

A total of 34 questionnaires were collected, with 2 participants not completing the entire study, and therefore not answering all portions of the questionnaire. Thus, the responses of 32 participants form the basis for most of the study results.

Demographics

The Sudanese refugees in this study are from the 2 largest ethnic groups of Southern Sudan – the Dinka and the Nuer. Nine of the participants (26%) were female and all were of the Nuer ethnic group. Twenty-five (74%) of the study par-

Figure 1: Education Levels

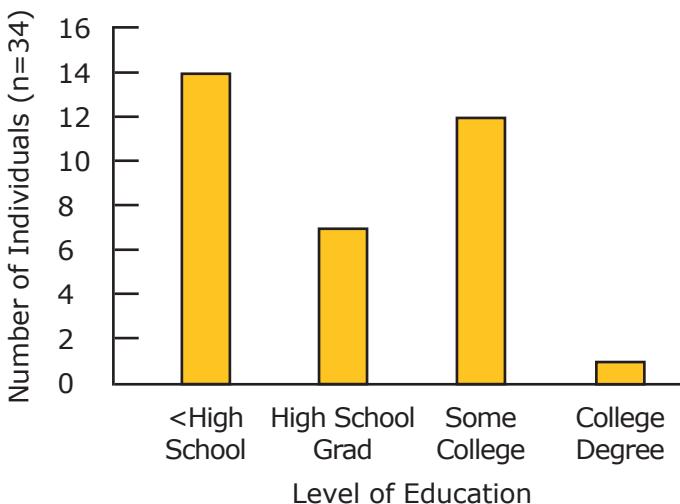


Figure 2: Source of Dental Care Coverage for Participants

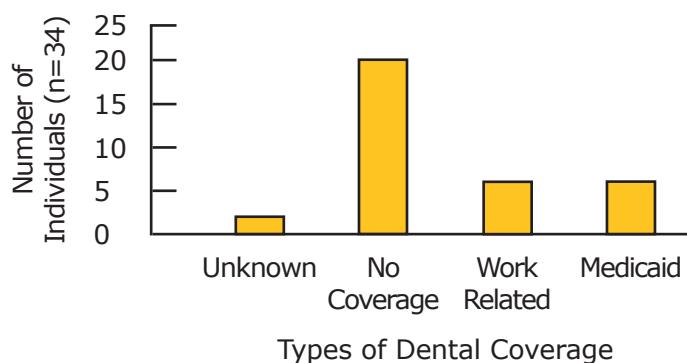


Table I: Traditional Hygiene Methods: Dinka Lost Boys

Method of Cleaning	n=15	Percent
Cow-Dung Ash	3	20
Ash Use Unknown	12	80
Stick use/day: 1x	3	20
2x	6	40
3x+	6	40
Reeds and Grasses	7	47

Table II: Traditional Hygiene Methods: Nuer in Sudan

Method of Cleaning	n=19	Percent
Cow-Dung Ash	15	79
Ash Use Unknown	4	21
Stick use/day: 1x	4	21
2x	10	53
3x+	02	11
Reeds and Grasses	10	53

ods of their ethnic group. By contrast, 79% of the Nuer participants reported using ash at least once per day, often in conjunction with other cleaning methods (Table II).

The second method combines brushing and a kind of inter-dental cleansing through use of the "toothbrush tree," a method that involves the use of a stick or branch of *Salvadora persica* (*miswak* in Arabic, *achuil* in Dinka and *chuil* in Nuer) (Tables I, II, Figures 3, 4). The stick is applied to the teeth and a scrubbing, circular motion is used until the stick itself splays. The ends then allow the teeth to be cleaned and scrubbed between the teeth and gums. All of the participants reported daily use of this method. Among the Dinka Lost Boys, 3 (20%) reported use of the toothbrush tree once per day, and twelve (80%) reported use 2 to

ticipants were male. Of these, fifteen (44%) were of the Dinka ethnic group, and the remaining ten (29%) were Nuer. Thus, slightly more than half (56%) were Nuer. The mean age of participants was 29.3 years, with a range of 20 to 49. At the time of the study, 14 of the participants (41%) had not completed high school, while 19 had earned a high school diploma and/or a GED certificate or had completed some college (Figure 1). None of the women in this study had been able to complete high school. Twenty-three participants (70%) were employed, 6 had work-related dental insurance, 6 were covered by Medicaid and 20 (59%) had no insurance coverage (Figure 2). Ten participants (30%) arrived in the U.S. between 1993 and 1996 (17 to 14 years ago), 5 (15%) arrived between 1997 and 2000 (10 to 13 years ago) and 18 (55%) came to the U.S. in 2001. One female participant did not indicate her year of arrival to the U.S.

Traditional Dental Practice

Traditional dental hygiene practices of the Dinka and Nuer, as reported in this study, consisted of 3 primary methods (Tables I, II). The first is similar to brushing with toothpaste in the U.S. and makes use of the ash taken from cow dung fires. The participants reported that ash could be applied to the teeth directly or water could be mixed to make a paste. The index finger is used to brush and apply this baking soda-like cleaner. Several participants reported a salty taste to the ash, and that this cleaning method resulted in very white teeth. Only 3 (20%) of the Lost Boys of Sudan, all of whom are Dinka, reported using ash – most left home quite young and spent the majority of their lives in refugee camps (Table I). This limited time in Sudan would have prevented them from learning or practicing the traditional oral hygiene meth-

Figure 3: 'Toothbrush Tree' Use by Dinka Lost Boys of Sudan

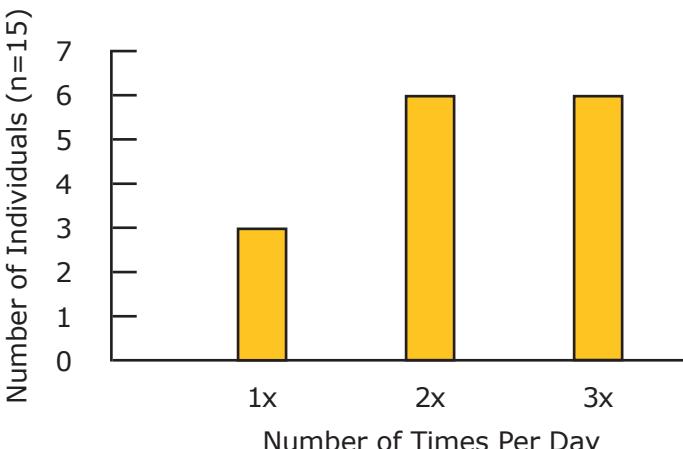
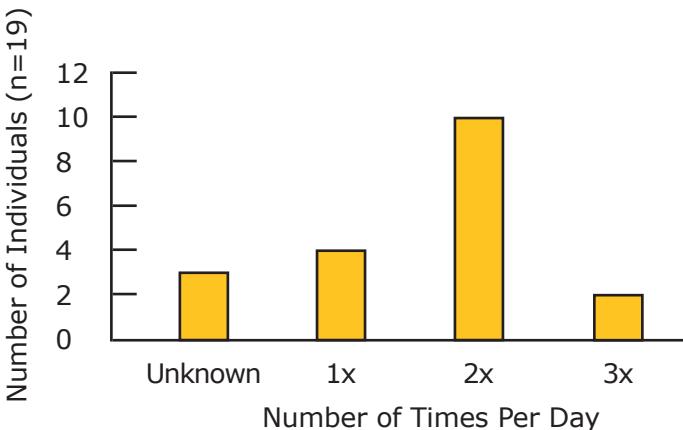


Figure 4: 'Toothbrush Tree' Use by Nuer



3 times a day. By contrast, 4 Nuer reported using the toothbrush tree once per day, 10 (58.8%) reported using the toothbrush tree twice per day, 2 reported application of the sticks 3 times per day and 2 Nuer participants did not specify the number of times per day that the toothbrush tree was used (Figures 3, 4).

The final method involves something similar to using dental floss. Reeds and grasses are used to clean between the teeth in the same manner that dental floss is used. This method is commonly employed after one consumes meat, as is method 2 above. Method 3, the inter-dental cleaning using reeds or grass, was used by half of all participants at least once a day. Among the Dinka Lost Boys, 7 (46.6%) employed the use of reeds and grasses, while 10 of 19 Nuer (53%) made use of this method (Tables I, II).

Current Oral Hygiene Practices

Participants were asked about current oral hygiene practices used since arrival to the U.S. All reported brushing their teeth daily. Fifteen (44%)

Table III: Oral Hygiene Practices in U.S.

Hygiene Method	n=34	Percent
Toothbrushing Per Day		
1x	15	44
2x	06	18
2-3x	02	06
3x	07	21
3-4x	02	06
Unknown	02	06
Toothpicks	24	71
Floss	03	09

Figure 5: Frequency of Toothbrush Use



reported brushing just once per day, 8 reported 2 or more times per day, while 9 reported brushing 3 or more times per day (Table III, Figure 5). Although they affirmed use of a toothbrush as an oral hygiene method, 2 participants did not specify the number of times they brushed each day. The majority of participants (71%) reported use of toothpicks for cleaning between teeth. Toothpicks were commonly used to remove meat and other dense foods. Just 9% of participants reported use of dental floss prior to implant surgery.

All but 5 participants reported the use of toothpaste while brushing. Twenty-nine (85%) could name 1 or more brands of toothpaste. Four different types of toothpaste commonly available in the U.S. were listed by respondents when asked about their brushing habits. A toothpaste containing Triclosan was the most commonly named brand of toothpaste (59%). Most participants suggested they had used this brand or knew of this brand in Africa. In a few cases, participants could name a toothpaste type but did not cite the frequency of toothbrush use.

Perceived Aesthetics

When asked to list important dental characteristics, more than half (59%) suggested that having all of one's teeth is a very important attribute (Figure 6). While traditional practices for both ethnic groups in Sudan have historically involved the extraction of 6 lower anterior teeth, their attitudes towards dental aesthetics changed with relocation to the U.S. Most of the individuals surveyed stated they wanted all of their teeth for a variety of reasons. For example, one individual stated that he wished to have all of his teeth in place because "they are useful for eating." Another participant stated that teeth "are natural, and you should have what you're born with." Several individuals mentioned they wanted their teeth for the sake of living and adapting to life in the U.S. and that they "don't want to be different" from others in the U.S.

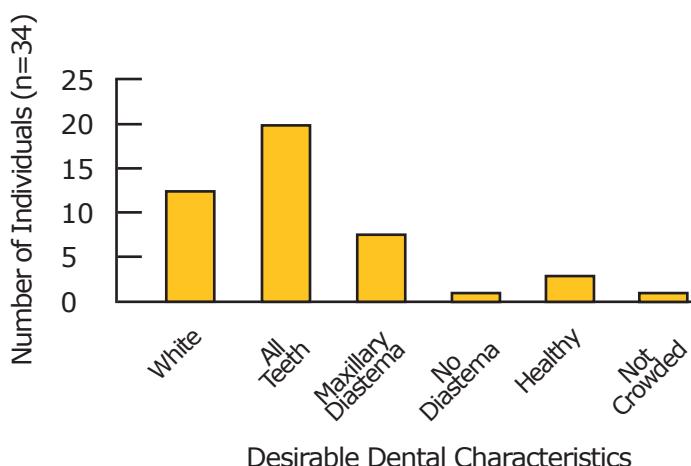
The next important trait was to have white or very white teeth (38%), something suggested by many participants as less common in the U.S., particularly when using U.S. oral hygiene methods (i.e. toothbrushes and toothpaste). Seven participants noted that a maxillary diastema was an important dental attribute, which they did not wish to have changed, despite the contrast to typical U.S. dental aesthetics. One person noted that they did not wish to have a maxillary diastema, while another respondent suggested that the teeth should not be crowded. Three participants simply noted that they wanted their teeth to be healthy.

Dental visits, Procedures, and Treatment since Arriving in the U.S.

While the year of arrival to the U.S. spanned 8 years (1993 to 2001), 56% of respondents had visited a U.S. dental facility no more than once prior to the onset of the dental restoration project (Figure 7). Twelve percent had made 1 or 2 dental visits, while 6 respondents (18%) had completed 2 or 3 dental visits since arrival. Two participants had never visited a dentist, while 4 (12%) had visited a dental facility 3 or more times. None of the participants had been given a complete dental screening at the time of arrival or reported visiting a dentist for a biannual dental check-up.

Eight participants (24%) had untreated decay at the time of their initial exam in 2005. Furthermore, all study participants were missing 4 to 8 anterior teeth as the study began. These anterior teeth had been removed just after permanent eruption during a childhood ritual in Sudan. In addition, 14 (41%) were missing other teeth, on

Figure 6: Perceived Aesthetics by Refugee Participants



average 2.4 with a range of 1 to 7. Most of these missing teeth were molars. Based on patient histories, the majority of participants with additional missing teeth had to have them pulled once in the U.S. due to decay and/or extensive periodontal disease and bone loss. Five participants had an average of 5 filled teeth, with a range of 1 to 9 fillings.

Regardless of the number of times a participant had visited the dentist since arrival to the U.S., all were in need of a routine prophylaxis to create a baseline of oral health. Six respondents (18%) required debridement or root scaling and planing, 9 (26%) were diagnosed with various levels of periodontal disease and 10 (29%) required 1 or more teeth to be filled or crowned, while 9 individuals required extractions for carious teeth or for third molars which could not be fully functional. Four individuals (13%) required root canals for the maxillary incisors.

Discussion

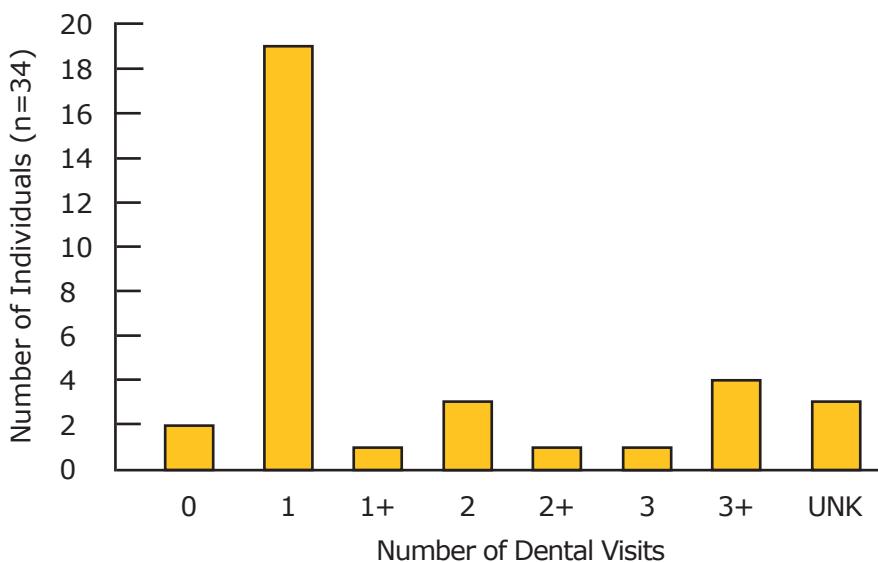
The Sudanese refugees in this study, the Dinka and Nuer, are undoubtedly a small subset of the refugee population from Sudan currently living in Nebraska. However, demographic data parallels results obtained in a recent general health survey of refugees from Sudan now living in the state.² For example, as in the general health survey, this study also demonstrates that Dinka and Nuer males outnumber females 2 to 1, the refugee population is relatively young in age (<30) and males, but not females, had earned a GED or a high school diploma. Similarly, although 68% of the population in this study was employed, most reported income levels at or below the U.S. Federal Poverty Guidelines, a finding documented in the general health study.² Furthermore, most do not have any

form of dental health coverage, despite employment. Thus, while this relatively young population should be establishing a good oral health baseline, limited resources will prevent them from doing so in a dental health care system which requires substantial investment throughout the year.

The study population spent no less than 3 years in a refugee camp before arrival, and had been living in the U.S. for 5 to 10 years before the project began.² Thus, the refugee population in this sample had limited access to any oral hygiene care or dental treatment while in refugee camps, and minimal access to Western oral hygiene education, treatment and dental coverage since coming to the U.S. At present, domestic refugee resettlement programs do not routinely provide dental screenings, treatments or hygiene education for any refugee population, regardless of potential need and experience with Western health systems. This means that refugee populations in the U.S. are likely to have dental care needs that go untreated for an extended period of time, requiring invasive treatment and more extensive costs in emergency care facilities.

While utilizing traditional health systems in Africa, the Dinka and Nuer in this study reported the use of oral hygiene methods which parallel each of the Western oral hygiene practices (i.e. brushing, flossing and toothpaste use). However, the materials associated with Dinka and Nuer oral hygiene practices are vastly different from those available in the U.S. In Africa, they could be easily obtained in the natural environment without cost. Sticks of approximately 8 inches in length are cut from the evergreen shrub or small tree, *Salvadora persica*, and one end is forcefully rubbed against the teeth until it splays, creating a bristled brush.¹⁸ This method was reported to be the most frequently used hygiene tool among participants while living in Africa. Given the fact that *Salvadora persica* has inhibitory effects on multiple strains of caries-inducing aerobic bacteria, such as *Streptococcus mutans*, such common use is not surprising.¹⁹⁻²¹ For many African and Middle Eastern populations, this hygiene tool is the most easily acquired, has antibiotic and analgesic properties and is low or free in cost.¹⁹⁻²¹ In one study of Sudanese *Salvadora persica* users, periodontal status was higher than that of toothbrush users living in the same community.²²

Figure 7: Number of Dental Visits Since Arrival to the US



A kind of flossing was accomplished using stiff grasses or reeds selected from a variety of species whose scientific names could not be determined. Flossing was reportedly used as it is in the U.S., when food items such as meat were consumed and not easily removed with brushing, inter-dental cleaning occurred with reeds or fibrous grasses. The ash-paste (*arop* in Dinka and *pok* in Nuer) was described as grainy or textured, providing an abrasive cleanser during brushing. The consistency reported by participants appears to be comparable to U.S. commercialized toothpastes. However, participants stated that ash-paste results in a whiter dental coloration.

Although each of the above methods can be described as comparable to Western oral hygiene practices, there is no direct connection from 1 dental hygiene system to the other. For example, while all participants are brushing their teeth in the U.S., it is less frequent than their reported use in Sudan. None of the participants are now using dental floss and few understood what the word floss meant. Rather, toothpicks may be used in place of the reeds and grasses which removed meat and other dense food from between the teeth in Sudan. The most commonly used toothpaste brand was already known to participants while living in Africa. However, it is unlikely that the toothpaste was actually purchased by participants prior to arrival in the U.S. given traditional livelihood strategies (i.e. cattle-herding) and no access to income generation in refugee camps.

Dental aesthetics once embraced by the Dinka and Nuer are markedly different from those valued in the U.S. For example, in Sudan the removal of the 6 lower teeth, with the resulting inclined lip,

was considered beautiful and a mark of one's ethnic identity.^{5,6} Now in the U.S., the desire to have the missing teeth replaced indicates a change in perceived aesthetics, something resulting from intense social pressure and the observation that these visible teeth are so vital to U.S. notions of beauty and health.²³ By contrast, the maxillary diastema was valued in Sudan, and continues to be valued in the U.S., perhaps because this trait is not perceived as repulsive in the States.

None of the participants had received a dental screening at the time of arrival and none had utilized the preventive biannual checkup. Despite the length of time in the U.S., the majority of participants had not been to a U.S. dental facility more than once. As noted above, this limited use of Western dental care is likely related to lack of dental coverage, expendable monetary resources and knowledge of Western preventive systems. Even those with Medicaid coverage would have a difficult time accessing care since few dental facilities accept this form of payment. Finally, limited dental visits may be linked to a lack of understanding related to preventative health care systems and the associated knowledge of Western dental ailments (i.e. caries, tartar buildup and periodontal disease). In fact, conference proceedings and regional strategies prepared by the World Health Organization to improve oral health in Africa have indicated that neither dental caries or periodontal disease are as common or severe as in Western populations living in developed countries.^{24,25} Moreover, those dental issues of greatest concern in Africa, including *Cancrum oris*, acute necrotizing ulcerative gingivitis and oral manifestations of HIV/AIDS, have not yet been reported among refugees from the Sudan to the U.S. or Nebraska.^{24,25} Nevertheless, this lack of understanding and experience with common Western dental ailments were borne out in the treatments required prior to the implant surgeries. For example, all participants were in need of a routine prophylaxis, and nearly 20% required more extensive cleaning. Nearly one-third were diagnosed with various levels of periodontal disease. Similarly, one-third required fillings or crowns. Two of the participants, who wished to replace the 6 lower anterior teeth, were also missing a large number of teeth which had been extracted in the U.S. due to extensive decay and bone loss. These individuals had to be removed from the study because they could not support the implants. Nine of the participants which remained in this study also required removal of 1 or more teeth, due to caries or an impacted third molar.

This initial study of a refugee population from

Sudan had several limitations related to budget constraints and resulted in a small sample of convenience, incomplete surveys and self-reported data. Should additional funding be available, a more comprehensive dental health study should be conducted with a random sample of refugees from Sudan. Several of the participants were removed from the study due to poor dental health status, while some did not answer all survey questions. Apart from perceived need, which was determined during the screening process, most of the data were self-reported and should be interpreted accordingly. Misinterpretations could have occurred during survey delivery. To minimize this kind of difficulty, interpreters were selected from the Sudanese refugee community and underwent all project procedures prior to the time of acting as interpreters and translators. There is little data from newly arriving populations concerning their dental health status, treatment needs and previous dental practices. All of the refugee participants in this study had spent a minimum of 3 years in a refugee camp, and during this time, oral hygiene systems of any kind were difficult to access. Also, all refugees had been in the U.S. for at least 4 years prior to the time this study began. Consequently, it is impossible to determine the dental health status that each individual might have had if they had remained in Sudan and used their traditional oral hygiene techniques. Despite the fact that results of this study may not be representative of refugees from Africa to the U.S., it is clear that a different kind of oral hygiene training is necessary for populations such as the Dinka and Nuer, who have never been exposed to Western health systems, but must now use them to survive.

Conclusion

The results of this initial study demonstrated that this refugee population from Sudan had limited knowledge of, and experience with, Western oral hygiene methods. Dinka and Nuer refugees in this sample stressed the replacement of visible missing teeth as the most critical dental health need. By contrast, none of the common U.S. dental needs were listed by the participants as important to their dental health status (e.g. fillings, gum disease, wisdom tooth removal and braces). Limited income, education, dental coverage, English language skills and training in Western oral hygiene methods were barriers to accessing dental care. It is important that dental health professionals understand that many world populations do not use or have a need for Western dental hygiene methods. Knowledge of preventative dental care is not a part of health practice for the Dinka and Nuer because many of

the dental maladies which Westerners seek to prevent are not commonly experienced in Sudan. Extensive oral health screening and treatment upon arrival to the U.S. is essential if we want to return individuals to a high dental health status or prevent future decline in dental health. Furthermore, comprehensive Western oral hygiene training will provide individuals with the tools to maximize oral health in this new cultural context. Likewise, dental and dental hygiene programs should expand clinical rotations to provide training in non-Western oral hygiene methods because these are the most common dental systems worldwide. In addition, dental health professionals should receive exposure to the immigrant and refugee cultures which are now arriving to the U.S. on an annual basis.

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Assessment of the University of Michigan's Dental Hygiene Partnership with the Huron Valley Boys & Girls Club: A Study of Students' and Staffs' Perceptions and Service Learning Outcomes

Sarah Christensen Brydges, RDH, BSDH; Anne E. Gwozdek, RDH, BA, MA

Introduction

The goal of the Boys & Girls Club of America (BGCA) is to establish a safe environment for children and teens after school and during the summer. Typically serving low-socioeconomic children, the BGCA provides mentorship and guidance to those who would, typically, be left at home unsupervised.

The BGCA requires all clubs to present health-related curriculum each year in order to receive funding. One specific curricular guideline pertains to dental health education. To provide a standard educational format for each club to follow, the BGCA has adopted Crest's Cavity-Free Zone program, which assists by laying out oral health-related topics, objectives and activities. In the past several years, the Huron Valley Boys & Girls Club (HVBGC) in Ypsilanti, Michigan has formed a strong and dependent relationship with the University of Michigan (UM) Dental Hygiene students, creating a bond of service learning reciprocating benefits to both partners. With the assistance of the UM Dental Hygiene students, these oral health curricular requirements have been addressed at the HVBGC through students presenting oral health education to the club members throughout the year. Students have had the opportunity for involvement at the HVBGC through 3 of their dental hygiene courses, Health Education Methods year), Community Dentistry (junior year) and Community Practicum (senior year).

Abstract

Purpose: The Boys & Girls Club of America (BGCA) requires a health curriculum be taught. With the assistance of the University of Michigan (UM) Dental Hygiene program, these requirements have been addressed at the Huron Valley Boys & Girls Club (HVBGC) through dental hygiene students presenting oral health education to club members throughout the year. This study assessed the outcomes and benefits of the service learning initiative between the UM Dental Hygiene Program and the HVBGC from both the students' and staffs' perceptions.

Methods: Three surveys were distributed: one to the HVBGC staff, one to UM's Dental Hygiene class of 2012 (with no service learning experience at the HVBGC) and one to UM Dental Hygiene classes of 2010 and 2011 (most of whom had experience at the HVBGC). Qualitative and quantitative data were collected and evaluated.

Results: The respondents from the class of 2012 were less knowledgeable about the BGCA and access to care issues. The members of the classes of 2010 and 2011, 79% of whom had HVBGC experience, identified they had benefitted from this service learning experience. The HVBGC staff survey indicated a high level of satisfaction with the student presentations and felt their curricular requirements were being met. Future topics of safety, orthodontics and gardening/nutrition were identified.

Conclusion: This study indicates the service learning initiative has been beneficial for both the UM Dental Hygiene students and the HVBGC. Future studies should use a longitudinal design to obtain baseline and post-service learning data.

Keywords: Service learning, access to care, dental hygiene curriculum, Boys & Girls Club of America

This study supports the NDHRA priority area, **Health Promotion/Disease Prevention:** Validate and test assessment instruments/strategies/mechanisms that increase health promotion and disease prevention among diverse populations.

(sophomore year), Community Dentistry (junior year) and Community Practicum (senior year).

Research supports dental hygiene programs that include service learning experiences in their curriculum, as it provides various benefits to the students

as well as the communities they serve. Through service learning partnerships, community members are able to gain access to care they otherwise may not be able to receive.¹ Faculty involved reported a rise in students' confidence levels, producing students that are better prepared to work with diverse populations upon graduation.² The purpose of this study is to evaluate the partnership formed between the HVBGC and the UM Dental Hygiene Program, specifically the benefits the students receive and outcomes of the partnership as perceived by the HVBGC staff.

Boys & Girls Club of America

Determined to lower the percentage of high school dropouts, teenage parents, teenagers involved with drugs and childhood obesity, the BGCA comprises a national network of 4,300 club facilities, making themselves available in communities where they are needed most, and available to an at-risk generation.³ As an organization with goals and objectives, the parents find their children learning, being active and building friendships. Typical day-to-day attendance at the BGCA fluctuates. On average the HVBGC serves approximately 100 children per day, according to club director Frank Rigger (Rigger, personal communication, June 2009). Membership primarily comes from a lower socioeconomic status (SES) population in Ypsilanti, Michigan, and members are primarily of African American descent.

Demographics of Ypsilanti

Survey information from the U.S. Census website indicates 13% of Ypsilanti families are below poverty level, which is 3.2% above the national average.⁴ The percentage of Ypsilanti individuals below poverty level is almost double that of the national average – while Ypsilanti shows 24.8% of individuals are below poverty, the nation only shows 13.3%.⁴ Being below the poverty level may limit the ability for families to seek dental care. As the income of a family decreases, the first expenses cut may be those considered luxuries, including preventive services, such as dental examinations and prophylaxis. Thus, money may be spent only for emergency services. Children of low-income families have a greater tendency to receive episodic or emergency dental care, which may create a fear or dislike of dental visits and treatment.⁵ This habit of only going to the dentist when a problem arises may also make treatment more complex and costly.

Risks of African Americans and Low Socioeconomic Levels

In the past, dental caries etiology primarily focused on factors within the oral cavity that cause

decay.⁵ However, with an array of known risk factors not inclusive to those within the oral cavity, there is an increased understanding of various contributing factors, including SES status, which may affect an individual's caries rate. Primarily targeting those from minority and low SES families, nearly 80% of dental disease identified in children is found in less than 25% of the child population.⁶ These minority and low SES children experience nearly 12 times as many restricted activity days (including being taken away from the classroom and after-school activities) from dental disease compared to children from higher SES families.⁶

A study performed by Tellez et al concluded factors within the neighborhood also have an effect on the caries rate of African-American children in low-SES areas.⁷ Results indicated that as the number of grocery/convenience stores increased, so did the caries rate.⁷ Energy-dense, highly refined and sugary food choices, such as soda, chips and candy, are common contributing factors to dental caries development.^{8,9} Foods and drinks that are numerous in choices and easily accessible in grocery and convenience stores include those that may contribute to the development of caries. With the BGCA population being primarily unsupervised directly after school, it is fairly easy for members to purchase unhealthy food on their way to the HVBGC in the afternoon, increasing their intake of cariogenic foods.

Access to Care

Dental provider availability in the Ypsilanti area consists of local dentists, several dental clinics and the UM School of Dentistry. There are a multitude of private practices, yet many do not accept Medicaid coverage and may not offer a reduced fee schedule. There are a minimal number of reduced fee or donation based clinics within the area.¹⁰ These factors may limit the amount of treatment low SES residents are able to receive. What initially seems like a multitude of resources for this population scales down considerably once taking insurance issues and payment options into account.

Crest's Cavity-Free Zone Program

With an increased risk for caries documented in children from lower SES families, Procter & Gamble® (Crest) developed an oral health promotion program, the Cavity-Free Zone program (Procter & Gamble®, Cincinnati, Ohio), for the BGCA to implement on an annual basis. The month long Cavity-Free Zone curriculum consists of 2 weekly 1 hour sessions. Oral health education lesson plans include: lessons directed at building self-esteem in one's smile, development of appropriate oral hygiene habits, education

with respect to anatomy of teeth and gums, development of a positive attitude towards dental professionals and dental visits and the development of nutritional awareness.¹⁰

Biesbrock et al implemented such a program at a BGCA facility. Following the Cavity-Free Zone program, the 75 club members in the study achieved a 51% reduction in their gingival index scores and a 29% reduction in their plaque index.¹¹ While this data was collected immediately following the final presentation of the Cavity-Free Zone program, the results nonetheless are astounding. There is, however, potential for these positive results to decrease over time if the children are not exposed to the oral health information on a regular basis.

Although the Cavity-Free Zone program was available for UM Dental Hygiene students to follow, its plan for delivery during a 1 month time frame did not address the issue of BGCA members' inconsistent attendance. This would mean that not all members would be exposed to the information and even those who are regularly present may not retain the knowledge and habits long-term. In order to sustain a program year-round, the HVBGC and UM Dental Hygiene students have formed a service learning partnership. While the members are being educated about good oral health habits and dental knowledge, students gain insight on underserved populations and have the opportunity to enhance their professional development.

Service Learning

Service learning combines educational goals with service to the community, with the community and school being equal partners.¹² Service learning promotes skills associated with teamwork, community service, problem solving and deeper learning, while students address complex problems in real-world experiences.¹³ Because of the skills associated with service learning, this method of learning is thought to be more personally meaningful to the student. It challenges their values and ideas while supporting social, cognitive and emotional learning development.¹³ Through engaging in service learning opportunities, students are able to apply what they have learned in the classroom and clinical settings to a new environment. Not only does this provide the student with a unique learning opportunity, but the community gains benefits as well. Jiminez et al discuss the benefits to all who participate in the service learning programs – community members receive access to care while students are provided a rich learning environment.¹⁴ With service learning programs being incorporated into higher educational programs throughout the country, schools are seeing students

become more familiar and comfortable in engaging in new and different settings as they graduate and begin their career. Schools have also noticed their students have an increased awareness of the need to help underserved populations and have committed their services to such communities in need.

Service learning can increase the depth of knowledge of dealing with an array of populations. Coulton found that by integrating service learning into dental and dental hygiene curricula, graduates are better prepared to provide care for diverse populations.¹ By providing the opportunity for students to explore other environments and reach out to different communities, their comfort zone increases in interacting effectively with those from varied backgrounds.

Students' Perceptions

Service learning allows students to experience a wide array of clinical and non-clinical settings. By engaging in these experiences, students see firsthand the underserved populations, problems associated with access to care and the hardships low SES families face. Reising et al found students who participated in service learning benefited from personal and interpersonal development, increased social responsibility and improvements in academic learning.² The implementation of service learning has been thought to affect the student's perceptions of their professional responsibility as well. Hood found dental professionals may learn their social responsibility and aspects of professionalism through a well-structured service learning program, preparing them for their career post-graduation.¹² Wehling determined service learning helps to increase professional maturity and ingenuity that cannot be taught within the classroom.¹⁵

Aston-Brown et al studied the effects of service learning with dental hygiene students. Through the analysis of both qualitative and quantitative data, they witnessed the dental hygiene students' perceptions of service learning transform through their dental hygiene program.¹⁶ Students graduated with an increased awareness of underserved populations, cultural diversity, ethical patient care and knowledge about public health career opportunities.¹⁶

Brunick conducted a study with the dental hygiene students at the University of South Dakota, which has embedded service-learning in their curriculum.¹⁷ After reviewing and assessing the effects service learning has had on the dental hygiene students, Brunick found graduates to have higher self-esteem, awareness of underserved populations and a desire to be involved with underserved communities post-graduation.¹⁷

Methods and Materials

This study assessed the students' perceptions of their professional involvement with the HVBGC and the outcomes of the partnership as perceived by the HVBGC staff. Quantitative and qualitative data were gathered through online Likert-scaled and open-ended question surveys which were developed and administered to 3 classes of dental hygiene students and 2 of the HVBGC full-time staff. The survey, along with other requested information regarding the study, was sent to the UM Institutional Review Board who granted the study exemption status.

Participants of this study consisted of UM Dental Hygiene classes of 2010 (27 students), 2011 (29 students) and 2012 (31 students), and 2 full-time staff members from the HVBGC. The students had varying amounts of experience working with the HVBGC, including an incoming class of dental hygiene students who may not have had any prior experience with the BGCA. The class of 2012 served as a baseline for those without dental hygiene educational experience with the HVBGC since those from the classes of 2010 and 2011 did not participate in a baseline survey prior to beginning the UM Dental Hygiene Program.

Using information gathered from the literature review, in addition to collaboration with UM Dental Hygiene faculty members whose courses provided student placement at the HVBGC, the 3 Likert-scaled surveys were developed.¹⁸⁻²⁰ Two student surveys were developed: 1 for the class of 2012, which contained 15 questions, and 1 for the classes of 2010 and 2011, which included 21 questions. Both student surveys specifically examined knowledge of the population served at the BGCA, access to care and the perceived benefits from the service-learning experience. A third survey comprised of 12 questions was given to the HVBGC staff members and examined the effectiveness of the service-learning program, determined if the BGCA curricular needs were being met and identified any gaps in the current oral health promotion program. The HVBGC employs 3 full-time staff members, a club director, an education coordinator and an athletic coordinator. The club director and education coordinator were asked to complete this survey.

Prior to dissemination, the surveys were pilot-tested with individuals who had a dental hygiene background, including 2 UM Dental Hygiene faculty members, 2 UM dental hygiene graduates from the class of 2009 who had experience with the HVBGC and 4 dental hygienists with no BGCA experience. Modifications to the surveys were made based on the pilot participants' feedback.

Recruitment of both the students and staff consisted of both in-person and online invitations. First, an in-person announcement was made to the 3 UM Dental Hygiene classes of students, and a phone call was made to the HVBGC director. During these initial contacts, the purpose of the survey was introduced and a request for participation was extended. That same day, an email was sent to students and HVBGC staff members with directions for accessing and completing the survey along with the Survey-Monkey link. A reminder email was sent five days later to the students and HVBGC staff. The survey remained open for a 10 day period. Students and staff participation was completely voluntary and anonymous.

Results

Previous BGCA Experience

The overall response rate for the class of 2012 survey was 77.4%. From the class of 2012 respondents, 95.2% (n=20) had never been a member or volunteer of a BGCA, while 1 (4.8%, n=1) indicated they had been a volunteer at a BGCA prior to attending the UM Dental Hygiene Program. The response rate for the classes of 2010 and 2011 survey was 85.7%. Of these respondents, 2.3% (n=1) had been a former BGCA member, 14% (n=6) had volunteered at a BGCA prior to their UM Dental Hygiene education and 83.7% (n=36) had never been a member or volunteer.

Surveys distributed to both the class of 2012 and the classes of 2010 and 2011 were divided into 3 additional sections: access to care, BGCA knowledge and service opportunities at the HVBGC. For the class of 2012, the access to care questions were formatted to allow insight about the student's perceptions of people who lacked ability to obtain dental care in the U.S., and the BGCA questions enabled the authors to determine if the students were knowledgeable about this population prior to their UM Dental Hygiene service learning experience. The service opportunity questions sought to determine what benefits the students felt they would gain from the service-learning experience they would soon encounter. For the classes of 2010 and 2011, a descriptive analysis of the survey responses was used to determine if the service-learning experience at the HVBGC had in fact deepened student knowledge of the club and its population, and if the perceived benefits were gained from their HVBGC service learning experience. These students were also asked additional questions related to future BGCA involvement and lessons learned.

Table I: Professional Benefits Derived from Service Opportunities at HVBGC, Class of 2012

Survey Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Will improve my interpersonal skills (communication, presentation, interaction)	45%	50%	0%	0%	5%
Will develop a greater awareness of oral health needs of BGCA members	40%	50%	10%	0%	0%
Will develop skills to address oral health needs of this community group	40%	55%	0%	5%	0%
Expect to learn about the role of the dental hygienist in public health settings	45%	50%	5%	0%	0%
Will develop skills to present oral health information to a community group	45%	50%	0%	0%	5%
Will help develop confidence in working with this community group	38.1%	47.6%	14.3%	0%	0%

Access to Care and BGCA Knowledge

Of the class of 2012 respondents, 95.2% believed access to oral health care is a problem facing the nation. Ninety-five percent also agreed service to the community is a professional responsibility of the dental hygienist. Only 4.8% disagreed with these statements, while 3 participants skipped these questions. When asked what they perceived were contributing factors to the access to care problem, a majority (90.5%) responded insurance issues, either a lack of insurance or lack of insurance acceptance by providers. Other contributors addressed in the survey included a lack of financial resources (81% agreeing), the oral health knowledge of individuals (76.2% agreeing), the parent or guardian's perception of importance (71.4% agreeing), the availability of a dental professional in the area (57.1% agreeing) and transportation (42.9% agreeing). Inquiring about their BGCA related knowledge, 42.8% agreed the clubs are located in lower SES areas, and 67% agreed the club's focus is to support at-risk children and adolescents in succeeding in school and developing healthy life habits.

The classes of 2010 and 2011 respondents had a better understanding of the BGCA in comparison to the class of 2012 respondents, with 88.9% agreeing the clubs are located in lower SES areas and 90.5% agreeing about the club's focus. With regard to access to oral health care, 100% believed this was a problem facing our nation and 95.3% agreed service to the community was a professional responsibility of the dental hygienist. Figure 1 identifies factors related to access to care, including financial resources (100% of the classes of 2010 and 2011 agreeing), insurance issues (95.3% agreeing), oral health knowledge and transporta-

tion (90.7% agreeing), parent's or guardian's perception of importance (79.1% agreeing) and availability of a dental professional in the area (74.4% agreeing). Figure 1 also compares the access to care responses from the classes of 2010 and 2011 respondents with the class of 2012 respondents.

Perceived HVBGC Service-Learning Benefits

The survey results indicated the students from the class of 2012 felt a service learning experience at the HVBGC would provide professional benefits. Ninety-five percent felt this opportunity would improve and further develop their interpersonal skills (which included presentation, communication and interaction skills), awareness of oral health needs of the club members, skills to address oral health needs of this community group and skills to present oral health information to a community group. Eighty-six percent felt this future experience would help develop their confidence in working with this community group. Ninety percent felt their partnership with the HVBGC would benefit the club members (Table I).

The students from the classes of 2010 and 2011 were asked questions that evaluated the benefits they felt they gained from participating in an oral health promotion program at the HVBGC. The survey showed that 55.9% felt their experience at the HVBGC had helped to develop their interpersonal skills. Sixty-seven percent gained confidence in working with this community group, and 64.3% felt they developed skills to present oral health information to a community group. Sixty-one percent felt they had developed a greater awareness of the oral health needs of the club members, and 65.2% felt they developed skills to address the

Table II: Benefits Gained from Participation in Service Opportunities at HVBGC, Classes of 2010 & 2011

Survey Question	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Not Applicable
Improve interpersonal skills (communication, presentation, interaction...)	23.3%	32.6%	16.3%	2.3%	0%	25.6%
Greater awareness of oral health needs of BGCA members	18.6%	41.9%	9.3%	4.7%	0%	25.6%
Developed skills to address oral health needs of this community group	4.7%	60.5%	4.7%	4.7%	0%	25.6%
Became aware of the role of the dental hygienist in public health settings	14.3%	50%	9.5%	0%	0%	26.2%
Developed skills to present oral health information to a community group	21.4%	42.9%	7.1%	2.4%	0%	26.2%
Developed confidence in working with this community group	33.3%	33.3%	9.5%	2.4%	0%	21.4%

oral health needs of this community group. This service-learning experience also allowed 64.3% to feel they had become more aware of the role of the dental hygienist in public health settings. Overall, 67.5% felt their partnership with the HVBGC had benefited the club members, and 78.6% felt the year-round involvement the UM Dental Hygiene Program offers has made a positive impact on the club members (Table II).

Classes of 2010 and 2011: Future BGCA Involvement and Lessons Learned

The survey distributed to the classes of 2010 and 2011 also included 2 open-ended questions in which several key themes emerged. When asked if the students would volunteer or work on an oral health project at the HVBGC in the future, 76.7% responded they would. Those that agreed indicated they would likely do so because it provides benefits to the members, they feel service to the community is a part of the dental hygiene profession, it benefits the community and they enjoy volunteer work. Those who did not think they would volunteer in the future thought so because they didn't like the HVBGC, they would like to volunteer elsewhere, they will be relocating, they felt the presentation information was too repetitive and the members were uninterested. Specific student responses can be found in Table III.

The second open-ended question inquired about the most significant lesson learned from their experience at the HVBGC. Of the responses, 3 common themes emerged: 15% indicated the experience helped them understand teaching methods, specifically strategies to keep children engaged and interested, and 25% identified they were encouraged that many of the children retained knowledge

from previous presentations. Some listed specific topics the children recalled, such as how to properly brush, while others indicated concepts were not retained, including why it is important to brush. Another significant finding addressed by 15.6% of the respondents was that not all people have the same privileges as them and the importance that those more fortunate should offer their services and knowledge in assisting and educating those less fortunate. Detailed student responses can be found in Table IV.

The UM Dental Hygiene Program is considering spearheading the development of a garden initiative at the HVBGC. This garden would not only provide healthy snacks to the club members, who often come to the club hungry and rely on food provided at the HVBGC, but could also teach the members life-long lessons on how to plant and sustain their own food sources. This question was included in the survey to obtain the students' perceptions of the benefits of such an initiative and to determine their interest in implementing this initiative at the HVBGC. Survey results showed 83.8% felt a garden would benefit the HVBGC by providing food to their members as well as work to support the Cavity-Free Zone curricula of the BGCA.

Staff Survey

The answers from the HVBGC staff survey focused on determining whether or not the oral health curriculum requirements of the HVBGC have been met, and if there were any gaps in the current initiative that should be addressed in future presentations. The results of the HVBGC staff survey showed that full-time staff members were pleased with the outcomes the UM Dental Hygiene student presentations have provided their club mem-

Table III: Students' Likelihood of Future Involvement with the HVBGC

Students' Likelihood of Future Involvement with the HVBGC	Total Postings n=36
Will likely volunteer in future...	
Because they enjoy volunteer work <ul style="list-style-type: none">• "I enjoy volunteering and would like to do as much as I can to help."• "I enjoy community service activities in general..."	5.5%
Because of the benefits to the children <ul style="list-style-type: none">• "I feel all children deserve the right to care. The children should not have to suffer due to lack of care. I think the HVBGC involvement is a great way to help teach children about the importance of oral health."• "I want to help educate the children in the Boys & Girls Club."• "I will because it is benefiting the community and children!"• "...it was obvious some of the children are only exposed to this type of education there and need as much info and encouragement as possible!"• "I really enjoyed working with the kids and being able to provide education for them."• "I would volunteer in the future because I feel that the children that attend the club benefit from our presentations."	36.1%
Because it is important as a dental hygiene professional <ul style="list-style-type: none">• "It was a good learning experience, and gave me insight to better explain our role as a hygienist in the community."• "...it is my duty as a future dental hygienist."• "I think working with the children is a great benefit not only for the children learning but for us future hygienists as teachers."• "I feel it is part of my profession to do volunteer work for people at the Boys & Girls Club."	16.7%
Because of the benefits to the community <ul style="list-style-type: none">• "I believe that I, as well as other dental professionals, can make a difference by reaching out to the community and stressing the importance of oral hygiene"• "I will because it is benefiting the community and children!"• "Great opportunity to lend a hand to the community"• "Beneficial to the members and gives the hygienist greater involvement with the community."	13.9%
Will not likely volunteer in the future...	
Because they did not like the HVBGC <ul style="list-style-type: none">• "It was unorganized and staff seemed to lack control of the children."• "The Boys and Girls Club is not my niche."	8.3%
Because they would like to volunteer at other places <ul style="list-style-type: none">• "I will not because in my opinion the first thing people think about when they think about an uninformed or needy population is children. Mostly because children usually have an organized group i.e. BGCA or a school instructor or any other camp of that nature that reach out and ask for help. I feel that I would prefer to work with adults and volunteer my time with the less thought about population."• "I want to see if I can volunteer at other places as well."	8.3%
Because they will be relocating soon <ul style="list-style-type: none">• "I may no longer be in this area to help."• "I already worked there and when I graduate I will most likely move back home."	8.3%
Because they felt the presentations and year-round involvement at the HVBGC was too repetitive <ul style="list-style-type: none">• "I would be apprehensive about doing so because of the boredom displayed toward the oral health and health eating habits from the members who have heard it repeatedly from the UM Dental Hygiene presentations."	5.5%

bers. Both staff members strongly agreed the oral health presentations have fulfilled Crest's Cavity-Free Zone requirements. Both strongly agreed the

year-round involvement has increased the members' oral health knowledge, as well as allowed for more members to be exposed to the information.

Table IV: Students' Perceptions of Significant Lessons Learned from HVBGC (n=32)

What was the most significant thing you learned during your HVBGC experience and why?	
Effective methods for teaching children • "I learned a lot about how kids learn best, and that they love to learn." • "That the children who attend this club need to have hands on learning activities to keep their attentions and engage them to want to sit and learn more. Once we gained the interest of the children they were really cooperative and asked many great questions regarding healthy snacks, and healthy oral habits." • "The thing that these kids need most is love and attention (that it seems some don't get at home). And the learning comes after they become comfortable with us." • "It is difficult to go in there just to "TEACH" the kids. You must first build a relationship with them, before they will really listen to the material you are presenting. Once the relationship is established, the children are sponges to learn the material that is being presented to them."	15.6%
Many of the children retained information from previous presentations and were more knowledgeable than the students thought they would be • "The children at the Boys and Girls club absolutely LOVE when students come to interact with them. They had fun, and we found that they remembered a lot of what we taught them. Seeing their smiling faces and hearing them ask when we were going to come back made me feel like I was really impacting their lives." • "I was surprised when I went to do my oral presentation at the HVBGC of how much information that the kids retained and remembered from the previous year of presentations."	25%
Not everyone has the same privileges; those more fortunate should offer service and knowledge • "Underprivileged child are not as aware of oral health as other children may be. Everyone regardless of social status should understand oral health and why it is so important for overall health, kids and parents both need to understand this concept." • "Not everyone has the same opportunities no matter what we think. It is our responsibility to help lower SES individuals whenever we can to make sure that everyone has the same access to knowledge of oral health care needs."	15.6%

They also strongly agreed the students have accurately planned age and culturally appropriate lessons. Other than the dental hygiene student's presentations, the staff noted the club members are seldom exposed to any oral health education or activities while at the HVBGC. When inquiring about topics the staff felt should be covered in the future, orthodontic information and safety issues were suggested. Overall, both staff members felt the nutrition and oral health presentations have met and exceeded the curriculum requirements.

ing their knowledge gained regarding access to care and the BGCA. They also gathered opinions about what students felt they had gained professionally from this service-learning experience. The strength of the study would have been enhanced if the UM Dental Hygiene classes of 2010 and 2011 were each able to participate in a pre-HVBGC service-learning survey followed by a post-HVBGC service learning survey. The study would be further strengthened if it were continued longitudinally with data gathered from additional students and staff.

Discussion

The ability to gather a baseline and a post-service learning experience survey from the same sample of students was not feasible. Therefore, the incoming class of 2012 UM Dental Hygiene students' responses provided pre-HVBGC service-learning baseline information. This gathered student insight as to what those with no experience at the HVBGC expected to gain from the service learning initiative, as well as their knowledge about access to care and the BGCA. The responses from the 2010 and 2011 classes provided post-HVBGC service learning information. Answers provided by these respondents reflected their actual experience at the HVBGC, demonstrat-

When evaluating the students' BGCA knowledge, the classes of 2010 and 2011, who had experience developing and implementing an oral health promotion program at the HVBGC, understood the mission and demographic parameters of the BGCA to a higher degree than the class of 2012, who had not had any UM Dental Hygiene Program experience at the HVBGC. A larger percentage of the respondents from the classes of 2010 and 2011 also had a better understanding of the access to care problem facing our nation and factors affecting this issue. The increased understanding of the BGCA and access to care demonstrated by the classes of 2010 and 2011 may have been higher due to their involvement at the HVBGC. However, other educational experienc-

es and knowledge obtained through UM Dental Hygiene curricula may have also affected the students' responses to these survey questions.

Comparing the results of the questions pertaining to the students' perceived benefits from the service learning experience, the class of 2012 had higher expectations of what they thought they would gain professionally from this experience compared to what the classes of 2010 and 2011 felt they had gained from their experience at the site. One factor influencing this data is only 15 students from the class of 2012 had on-site HVBGC experience, while the remaining 12 students had not participated in service learning at this site. Although a lesser percentage of 2010 and 2011 respondents (31% average) agreed about the perceived benefits than the class of 2012, 21% of these class members did not have HVBGC service-learning experience. This percentage of respondents from the classes of 2010 and 2011 could account for those who responded "not applicable" to the questions inquiring about the benefits gained from the HVBGC service-learning experience. Recommended areas of further study include the investigation of dental hygiene service learning-related curriculum and its impact on student community understanding. Also important would be post-graduation follow-up to determine if these experiences contribute to community volunteer involvement as licensed professionals.

The HVBGC staff survey indicated they are pleased with the year-round involvement the UM Dental Hygiene Program is able to provide, especially with the fluctuation they see with the club member's attendance. Incorporation of additional oral health related topics will benefit both students and club members, allowing the benefit of regular interaction with the members and delivery of oral health information to continue. Expanding topics covered would also address the student concern that content covered was too repetitive.

Conclusion

This study has shown the service learning partnership between the HVBGC and the UM Dental Hygiene Program has provided benefits to both the students and the club. In addition to understanding the issues surrounding the access to oral health care crisis, the students were able to develop and refine oral health promotion skills to address the needs of this population. The HVBGC staff indicated the content presented in their oral health educational sessions addressed the requirements of the BGCA Cavity-Free Zone curriculum. The UM Dental Hygiene Program has gained insight into additional topics that could be addressed in the future. The staff and student's agreed the year-round involvement has increased the HVBGC member's oral health knowledge.

Future studies should consider incorporating a longitudinal design method for examination, allowing for pre-HVBGC service-learning information and post-HVBGC service-learning information to be gathered from each class. Continuing to examine the outcomes of this partnership will be important to determine if this service-learning initiative sustains in providing a positive outcome for both HVBGC members and UM Dental Hygiene students.

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Factors Affecting the Performance of Oral Cancer Screenings by Texas Dental Hygienists

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Introduction

Oral cancer ranks twelfth among all cancers.^{1,2} Each year, approximately 30,000 U.S. residents are diagnosed with oral and pharyngeal cancers, and nearly 8,000 die from their cancers.³ The American Cancer Society estimated the incidence of new cases of oral cancer in 2008 would be 35,310, with men showing more than twice the risk of women.¹ Although oral cancers are readily curable when diagnosed and treated early, the U.S. 5 year survival rate for oral cancer is only 52%.^{4,5} From 1973 to 1996, the U.S. experienced little change in early detection techniques, such as oral cancer screenings (OCS) or in 5 year relative survival rates. Estimated deaths associated with oral cancer in 2008 were projected at approximately 7,590.¹ These findings suggest a deficiency in professional and public education regarding the early diagnosis of oral cancer.^{6,7}

Oral Cancer Prevention

The Healthy People 2000 objectives for oral cancer prevention and early detection include education of the public as to risk factors for oral cancer, the availability of oral cancer screenings and the need for health care providers to provide oral cancer examinations routinely and competently.⁸ Healthy People 2010 reports that only 13% of Americans reported having an oral cancer examination in the past year.⁹ Early detection and risk prevention provided by the dental professional are

Abstract

Purpose: The 5 year survival rates for oral cancer have not changed in the last 50 years. A simple intra- and extra-oral examination provided by health care professionals could help to reduce morbidity and mortality of oral cancer. This study focused on Texas dental hygienists' performance of oral cancer screenings (OCS) and factors that influenced their performance of this examination.

Methods: A 33 question survey of 608 randomly selected Texas dental hygienists was conducted. Frequency, chi-square and Spearman correlation tests were performed.

Results: Three hundred and six hygienists replied and provided the data for this study. The data indicated that 45.8% "always" performed OCS, 23.5% performed OCS at the initial appointment and 47.4% at the recall appointment. Experience and comfort level were the greatest influences on OCS performance. Dental hygienists practicing for 16 or more years performed OCS 51.2% of the time, while those with only 0 to 5 years of experience performed OCS 25.5% of the time. A statistically significant correlation ($p=0.15$, $p<0.007$) was found between years of experience and performance of OCS. A significant correlation ($p=0.18$, $p<0.001$) was found between the identification of a suspicious lesion and the performance of OCS. Forty-nine percent of dental hygienists reported feeling "very comfortable" with intra-oral examinations, but only 26.5% felt "very comfortable" with extra-oral examinations. A statistically significant correlation ($p=0.16$, $p<0.001$) was found between comfort level in the performance of an OCS and reported frequency of OCS. The majority of subjects performed poorly on the knowledge portion of the survey (mean=53%). There was a significant correlation ($p=0.22$, $p<0.001$) between attendance at OCS continuing education courses and the performance of OCS.

Conclusion: Dental hygienists' knowledge about oral cancer was not current and comfort levels with performing OCS were low. These indicate a need for a stronger emphasis on the importance of OCS for students during dental hygiene education and a more thorough continuing education for practicing dental hygienists.

Keywords: Oral cancer, screening, dental hygienists, knowledge, education

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Assess the use of evidence-based treatment recommendations in dental hygiene practice; Investigate how dental hygienists identify patients who are at-risk for oral/systemic disease.

the 2 best public tools to reduce morbidity and mortality of oral cancer.¹⁰ Early detection of oral cancer lesions is complicated by the fact that they are typically asymptomatic in nature. Clinical lesions may appear as ulcers, leukoplakia, erythroplakia, a combination lesion called erythroleukoplakia, soft tissue masses, lesions that will not heal and radiolucencies of unexplained origin. All of these lesions remain suspect until proven otherwise by biopsy.

An important part of oral cancer prevention and detection is the recognition of risk factors. A review of the literature reveals several risk factors and populations at most risk for oral cancer. Risk factors include the use of tobacco products, alcohol abuse, excessive unprotected exposure to sun, lack of consumption of fruits and vegetables, use of marijuana and viruses.^{8,11,12} Increased oral cancer and esophageal cancer risk have been associated with high meat intake, low consumption of fruit, low levels of particular vitamins and a poor nutritional status.¹² Males are more likely than females to develop oral cancer, although these numbers are changing due to the increasing incidence of smoking in females and the elderly female population. Age is also a significant risk factor – 90% of oral cancers occur in people older than 45 years of age.⁵ Among older populations, there is also an increased incidence of oral cancer in edentulous or partially edentulous elderly. This has to do with the lack of care or access to care contributing to risk factors, such as poor oral hygiene and broken teeth.¹³

The human papilloma virus (HPV), specifically HPV 16 and 18, is a newly identified oral cancer risk factor more frequently found in younger populations, both male and female. HPV 16 is more commonly associated with oral cancer, and HPV 18 is much less so. There is a significant association of HPV in the oral tissues with oral cancer independent of smoking and drinking habits.¹⁴⁻¹⁶ Behavior, a subject's immune status and contributing risk factors do not indicate a predisposition to HPV oral cancer.¹⁷ HPV can appear as an innocuous lesion on the lips, tongue and soft palate. The more posterior the location of the HPV, the more likely it is to be a serious risk factor for oral cancer. Testing for HPV 16 and 18 is currently a subject of research along with the use of the Gardasil vaccine as a preventive measure.¹⁷

Role of Dentists and Dental Hygienists

The dentist and dental hygienist are trained to detect oral cancers and identify risk factors so that the mortality and morbidity of oral cancer can be

reduced by early detection. The American Cancer Society recommends that people aged 40 years or older, or anyone at high risk of developing cancer, should receive an annual oral cancer examination.¹⁸⁻²⁰ Early detection and evaluation of the oral environment can have a major impact on minimizing debilitating treatment and improve cure rates.⁶ Early detection refers to a tumor that does not exceed 4 centimeters in its largest diameter and has not spread to adjunct structures or tissues.¹⁰ Also, with early detection there is no detectable metastasis to regional cervical lymph nodes or other organs.²¹

Dentists and dental hygienists can play a crucial role in the early detection and prevention of oral and pharyngeal cancer.² A thorough intra- and extra-oral cancer screening using visual and tactile senses takes only 90 seconds to complete.²¹ Ideally, dental practitioners should provide a full head and neck examination for all patients, as well as a risk factor assessment and clinical and radiographic examinations.²¹

A survey of dentists practicing in Texas reported that 86% were providing OCS for all patients, and 43% were performing complete intra- and extra-oral examinations on all patients. Twenty-two percent of Texas dentists reported feeling that there was no time during regular appointments for oral cancer examinations, even though the exam takes only 90 seconds.²² A survey of dentists along the Texas–Mexico border reported that, while 99% agreed that dentists were qualified to perform oral cancer examinations, only 54% were of the view that dental hygienists were qualified to perform oral cancer examinations.²³

Dental hygienists have long been recognized as playing an important role in health promotion and disease prevention. Dental hygienists focus on primary prevention – they provide oral cancer examinations and related health education as part of dental hygiene care and play a critical role in helping patients attain and maintain good oral health.²⁴⁻²⁷ While dental hygienists cannot diagnose oral cancer, they can be instrumental in detection and referral. Standard quality health care mandates thorough oral, head and neck examinations, and oral disease risk factor assessment for all patients on a routine basis.²⁸ Dental hygienists need to be familiar with oral cancer risk factors, because some risk factors are synergistic in nature, and the elimination of only 1 risk factor can greatly decrease their patients' overall risk for oral cancers. Dental hygienists also need to be confident in their performance of comprehensive oral cancer screenings.

A national survey conducted in 2001 showed that dental hygienists were seriously uninformed on several key aspects of oral cancer risks and diagnostic procedures.²⁹ While 99% of dental hygienists identified tobacco as a risk factor for oral cancer, only 19% knew that most oral cancers are diagnosed in patients 60 years or older.²⁹ While 85% knew the correct examination of the tongue, only 18% correctly identified erythroplakia as first and leukoplakia as second as the 2 most likely conditions closely related to oral cancer.²⁹

Forrest et al found that 98% of dental hygienists agreed oral cancer examinations should be provided annually for adults over the age of 40, yet only 66% reported doing so every time. The survey also showed that only 25% indicated they routinely palpated the necks of their adult patients to assess their lymph nodes.³⁰ A 2006 study conducted in New York reported that 78% of dental hygienists indicated they provided oral cancer screenings on 80% of their patients 40 years and older.² One 2002 qualitative study conducted on dental hygienists in Maryland reported that the top 2 reasons for not routinely performing oral cancer screenings were limited time during the appointment and dentists not wanting them to perform the screenings.²⁷

A study conducted to assess Maryland dental hygienists' confidence in the performance of OCS reported that 77% felt their training was adequate to perform the screenings.³¹ In a North Carolina study, 75% reported feeling adequately trained to examine patients for oral cancer, 64% percent reported being adequately trained to palpate lymph nodes and 62% reported feeling comfortable with this procedure.²⁵

A 2001 national survey reported that 39.75% of dental hygienists had attended an oral cancer continuing education course in the last year, and 44.9% within the last 5 years.²⁹ A North Carolina survey of dental hygienists reported that 21% had attended an oral cancer continuing education course within the last year, 47% within 2 to 5 years and 15% at 5 years or more.²⁵ Surveys conducted in Maryland in 2001 and North Carolina in 2006 also showed that recent graduates of a dental hygiene program were more knowledgeable about oral cancer and risk factors for oral cancer, supporting the belief that there is a need for continuing education classes for practicing dental hygienists.^{25,31} In a 2001 national survey, dental hygienists indicated their preferred format for oral cancer continuing education. Eighty percent preferred a lecture format, 49% were interested in clinical participation during the course and 30% preferred continuing edu-

cation journals or booklets with a self-test. These studies of dental hygienists strongly suggest that oral cancer prevention and early detection need to be addressed by continuing education programs. The format of these courses should emphasize hands-on training in conducting a comprehensive oral cancer examination.²⁹

The purpose of this study was to assess whether Texas dental hygienists are performing oral cancer screenings and to identify factors that influence their performance of screening. To date, there has been no assessment of Texas dental hygienists' knowledge and practice of OCS. The research questions of this survey consisted of the following:

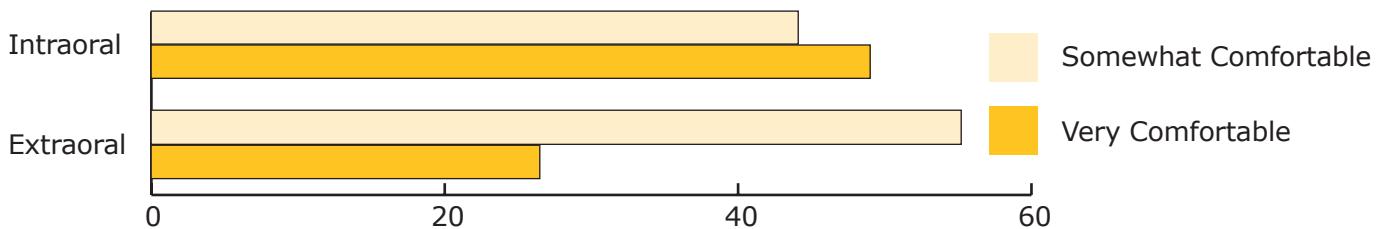
1. Do Texas dental hygienists perform oral cancer examinations?
2. What was their knowledge of oral cancer and risk factors?
3. Did knowledge of oral cancer, practice experience and formal and post graduate education influence performance of OCS?
4. What type of continuing education did they prefer for oral cancer training?

Understanding gaps in knowledge and practices is essential in planning educational programs in dental hygiene curricula, as well as for continuing education courses.

Methods and Materials

The population for this study consisted of 7,055 registered dental hygienists who were practicing in Texas. Using website information from the Texas State Board of Dental Examiners, addresses were obtained and participants were identified as to the status of their license. A random sample of 365 was selected based on an error rate of +5% using Dillmanns' sampling formula.³² Estimating an expected response rate of 60%, the necessary sample size was increased to 608. A survey instrument consisting of 33 questions was created using components from similar surveys conducted in Maryland and North Carolina.^{25,31} Questions included demographics, performance, comfort level, oral cancer and risk factor knowledge, experience and continuing education preferences. The survey was pilot tested twice and received approval from Texas A&M Health Science Center Baylor College of Dentistry Internal Review Board. The survey was conducted via the postal service using 2 separate mailings to maximize response rate. Descriptive, chi-Square and Spearman rank order correlation tests were performed on the data received using SPSS version 15 software.

Figure 1: Comfort Level in the Performance of Oral Cancer Screenings



Results

A total of 340 surveys were returned, and 306 were acceptable for data analysis, resulting in a 50% response rate. Table I illustrates the demographics for the respondents. The majority (53.6%) had been in practice for 16 or more years, were employed in a general practice setting (84.6%) and held an associate degree (74%).

Dental hygienists reported they "always" performed OCS 45.8% of the time, and 33.7% reported "most of the time." Dental hygienists performed OCS at the initial appointment 23.5% of the time and 47.7% during recall appointments. However, 49.9% reported they did not perform extra-oral palpations during the OCS at initial or recall appointments.

As illustrated in Figure 1, dental hygienists indicated they were more comfortable with the performance of intra-oral examination (49% "very comfortable") than with extra-oral examination (26.5% "very comfortable"). A statistically significant correlation ($p=0.16$, $p<0.001$) was found between comfort level in the performance of an OCS and reported frequency of OCS.

Common reasons why dental hygienists did not perform OCS are shown in Table II. The most frequent reasons were the "dentist performs the examination" (23.2%), followed by "takes too much time" (13.1%), "not adequately trained" (7.5%) and "not necessary or needed" (4.9%).

Table III shows how well dental hygienists felt their dental hygiene program prepared them to perform OCS. Only 38.9% reported their program was "very thorough." There was a significant correlation ($p=0.26$, $p<0.001$) between dental hygienists view of how well their dental hygiene program prepared them for the performance of OCS and their comfort level in performing an intra-oral examination. The same was true for their comfort with performing the extra-oral examination ($p=0.33$, $p<0.001$).

Length of time in practice was significantly related to performance of OCS. Approximately 50% of dental hygienists practicing 6 or more years reported they "always" performed OCS, while those practicing 5 years or less reported they "always" did

Table I: Demographics

	n	Percentage
Years in Practice		
16+ years	164	53.6%
11-15 years	38	12.4%
6-10 years	49	16.0%
0-5 years	55	18.0%
Total	306	100.0%
Practice Type		
General Practice	259	84.6%
Specialty	35	11.4%
Public Health	10	3.3%
Other	2	0.7%
Total	306	100.0%
Degree Type		
Associate Degree	227	74.2%
Bachelor Degree	79	25.8%
Total	306	100.0%

Table II: Most Important Reason Why Dental Hygienists Did Not Perform OCSs

	n	1st Reason Percentage
Dentist does it	71	23.2%
Takes too much time	40	13.1%
Not adequately trained	23	7.5%
Not necessary/Needed	15	4.9%
Unsubstantiated by research	3	1.0%
Not cost effective	1	0.3%
Total	153	50.0%

Table III: Dental Hygienists' Perception of Preparedness to Perform OCS

	n	Percentage
Very thorough	119	38.9%
Somewhat thorough	89	29.1%
Adequate	38	12.4%
Very inadequate	38	12.4%
Not sure	21	6.9%
Total	305	99.7%

Table IV: Questions Most Often Answered Incorrectly

	Correct	Incorrect	Don't know	Correct answer
Lesion type most suspect for OC ranked 1st	26.2%	57.8%	15.7%	Erythroplakia
Male or female greater risk for HPV	14.2%	57.7%	28.1%	Male
Lesion type most suspect for OC ranked 2nd	34.6%	43.5%	1.6%	Leukoplakia
Increased risk of OC by HPV location	14.2%	33.4%	52.3%	Oropharynx
Most common site for HPV	23.8%	30.0%	46.2%	Posterior

so only 25.5% of the time. There was a significant correlation ($p=0.15$, $p<0.007$) between years of experience and performance of OCS. Chi square analysis indicated that the association between years of experience and performance of OCS was real and more than could be expected by chance ($\chi^2=18.9$, $p<0.026$). This indicates that the longer a dental hygienist was in practice, the more likely they were to always perform an OCS.

The identification of a suspicious lesion and a positive diagnosis of oral cancer also significantly influenced performance of OCS. Approximately 82% reported they had identified a suspicious lesion that later was referred for biopsy. Of these cases, 46.4% came back with a positive diagnosis for oral cancer. A significant correlation ($p=0.18$, $p<0.001$) was found between the identification of a suspicious lesion and the performance of OCS. A significant correlation ($p=0.16$, $p<0.001$) was also identified between a positive diagnosis of oral cancer and the performance of OCS. Experiences of identifying lesions and discovering oral cancer were associated with an increased frequency in the performance of OCS by dental hygienists.

Concerning knowledge about oral cancer and risk factors, scores ranged from 14 to 94%, with a mean score of 52.6%. The majority of respondents scored at or below 70% on the oral cancer test. Table IV shows questions most frequently answered incorrectly or "don't know" on the test portion of the survey. Questions concerning HPV were answered incorrectly or "don't know" at least 50% of the time. Only 26.2% correctly identified erythroplakia as the highest suspect lesion, and only 34.6% identified leukoplakia as the next highest suspect lesion.

Attendance at a continuing education course on oral cancer was the only other significant factor associated with the performance of OCS, with 20.3% indicating they had taken an oral cancer continuing education (OCCE) course within the past year, 53.3% within 2 to 5 years and 19.6% more than 5 years (Table V). Also, 5.9% never attended an OCCE and 1% had yet to attend any continuing education classes. There was a significant correlation ($p=0.22$,

Table V: Last Oral Cancer Continuing Education Taken

	n	Percentage
Within the past year	62	20.3%
2–5 years	163	53.3%
More than 5 years	60	19.6%
Never	18	5.9%
Have yet to attend any CE	3	1.0%
Total	306	100.0%

$p<0.001$) between attendance at an OCCE and the performance of OCS. The more often they attended OCCE, the more often they performed OCS. Regarding format, the largest group of dental hygienists (40%) preferred a lecture format for OCCE, followed by professional meetings (22.9%) and clinical demonstrations (19.9%).

Discussion

The 5 year survival rates for oral cancer have not changed in the past 50 years. Dental hygienists, as a part of the dental team, have the opportunity to greatly improve this statistic. The performance of a simple intra- and extra-oral examination and the evaluation of a patient's risk for oral cancer are a part of the dental hygiene assessment and should be performed at every visit. Dental hygienists have a legal and ethical obligation to perform oral cancer screenings on all patients. Standard of care practices include a complete head and neck examination once a year. Legal ramifications for failure to identify abnormal lesions do apply to dental hygienists.

The purpose of this study was to assess whether dental hygienists were performing OCS and what influenced this performance. The study also investigated interest in continuing education and format preferences for oral cancer classes.

Dental hygienists in this survey reported that less than 25% performed an OCS at the initial appointment, and less than 50% did so at the recall appointment. When specifically asked how often they

performed OCS, less than 50% reported "always." Almost all of the dental hygienists reported they did not perform extra-oral palpation. One-third performed OCS at the initial and recall visits on all patients regardless of the patient's age, indicating that patient age did not influence the performance of the OCS.

The top 3 reasons dental hygienists reported for not performing OCS were "their dentist does it," "takes too much time" and "not adequately trained." Regarding their training, the dental hygienists' perception of their preparation influenced whether or not they performed OCS. Approximately 33% of dental hygienists reported "very thorough" or "somewhat thorough" in how well they felt their program prepared them to perform OCS. This could point to a need for changes to the dental hygiene curriculum as to training in OCS. Consistent with dental hygienists reporting that OCS took "too much time" is a current lack of a mechanism for reimbursement for this procedure. Generally, practitioners are concerned with production, so that if OCS were billable, they might be performed more frequently.

When asked how comfortable they felt in performing OCS, a little less than 50% reported feeling "very comfortable" in performing an intra-oral examination, and only 25% felt "very comfortable" for the extra-oral examination. As indicated by the significant association between the performance of OCS and comfort level in performing intra- and extra-oral examinations, the more comfortable dental hygienists felt performing OCS, the more likely they were to perform them. This lack of comfort possibly explains the low level of OCS performance, especially with the extra-oral exam.

The responses of Texas dental hygienists in this study closely mirrored studies conducted on a national and state level. In a national study, 66% of dental hygienists reported providing OCS and 25% routinely palpated extra-orally as compared to approximately 20% in this study.¹¹ As in this study, national studies indicated that dental hygienists were uninformed about risk factors such as age and appearance of lesions.²⁹ A qualitative study conducted in Maryland indicated that one of the top reasons dental hygienists did not perform OCS was limited time during the appointment.²⁶ Additionally, dental hygienists in New York felt that OCS was out of their scope of practice.²

This survey indicated that years of experience significantly influenced the hygienist's performance of OCS. Dental hygienists practicing 6 or more years reported "always" providing OCS about 50% of the time, while only 25% of dental hygienists, practic-

ing 5 years or less, reported "always." This could have been due to increased confidence, attendance at oral cancer continuing education courses and/or an improvement of instrumentation skills over time, leaving more time during the appointment for assessment procedures. An alternate reason could be that OCS training in the past was more extensive than it is presently. Another explanation for the increase in OCS performance could be that the longer dental hygienists are in practice, the more opportunity they may have to actually identify a suspicious lesion. Approximately 82% of those surveyed reported they had identified suspicious lesions and referred those patients for biopsy. Within that group, almost 50% indicated that the biopsies of lesions came back positive for oral cancer. In this study, both the identification of a suspicious lesion and a positive diagnosis were significantly correlated with the performance of OCS. Dental hygienists may have been more inclined to perform OCS on patients and suspect abnormalities if they had previous experience with such discoveries.

Half of the dental hygienists reported attending a continuing education course on oral cancer in the last 2 to 5 years, with less than 25% attending within the past year. In this study, attendance at an OCCE significantly influenced the performance of OCS. This indicates that dental hygienists who had recently attended an OCCE were more likely to perform an OCS.

The respondents in this study performed poorly on the knowledge question, with an average score of about 50%. The majority of questions missed concerned newer information about oral cancer, its risk factors and HPV. Dental hygienists who had not attended continuing education courses on oral cancer or read professional journals may not have been aware of this newer information. Other questions missed more than 50% of the time were about the identification of risk factors for patients and the appearance of suspect lesions. If dental hygiene practitioners do not have the correct information about these topics, they will not correctly assess or recognize the risk for oral cancer in their patients. This suggests that dental hygiene programs and/or continuing education programs should be more focused on awareness of oral cancer risk factors, such as age and HPV, and the appearance and common sites of lesions.

Education & Professional Recommendations

Clearly there was a lot of important information that dental hygienists were misinformed about or did not remember about OCS, indicating a need to improve their education. With a stronger empha-

sis on OCS and risk factors during dental hygiene school, new graduates may be less inclined to bypass this important assessment to save time. This added emphasis could in turn bolster preparation and comfort level for dental hygienists. A rotation to a clinic or hospital for cancer patients would also help to make an indelible impression on students and give them an opportunity to work with these patients.

Hands-on clinical demonstrations are needed to improve comfort level and performance of extra-oral palpation. These factors are good arguments for considering oral cancer refresher courses as mandatory for licensure. Currently, dental hygienists in Texas are required to maintain CPR certification bi-annually, an ethics and jurisprudence course every 3 years and 12 hours of continuing education every year to maintain licensure. Considering that an oral cancer screening is an assessment procedure a dental hygienist can perform that may save a patient's life, it should be considered as important as CPR training that is required every 2 years.

Nearly all respondents indicated that they would be interested in attending an OCCE course. In this survey, almost 50% were interested in a lecture format at professional meetings, the usual format for OCCE courses. Although the respondents did not prefer clinical demonstrations, they need to do hands-on examinations in order to learn how to perform them. Current OCCE courses should be changed to address deficiencies in dental hygienists' knowledge.

Another adjunctive measure to increase knowledge could be online discussion groups or blogs dedicated to oral cancer risk assessment. A dedicated online chat room, blog or Facebook page could be supported by the American Dental Hygienists' Association. On a local level, study clubs could offer OCCE and demonstrations to aid in comfort level and education of practicing dental hygienists.

In addition to professional and ethical obligations, there are legal concerns. Dental hygienists can be held legally liable for missing lesions or incomplete documentation. Updates to the current CODA standards would reinforce the importance of OCS. More questions about oral cancer and its risk factors could be added to the Dental Hygiene National Board Examination and jurisprudence tests for state licensure. Finally, further OCCE should address the

legal aspect of performing an OCS and documentation of findings and referrals to help protect patients and dental hygienists. There is currently no mechanism for billing OCS. Efforts should be undertaken to create a code to bill for this potentially life-saving screening.

Conclusion

This study found that almost 50% of dental hygienists were performing OCS, and less than 50% were palpating extra-orally. Reasons for not performing OCS were the dentist did the exam, felt it took too much time and they were not adequately trained. Respondents with the most experience in terms of years or the identification of suspicious lesions were most likely to perform OCS. Comfort level also had a significant influence on the performance of OCS. The more comfortable respondents felt with their technique, the more likely they were to perform the exam.

While knowledge level did not affect the performance of oral cancer screenings, the respondents were misinformed or unaware about oral cancer and its risk factors, especially HPV, patient age and appearance of lesions. This poor performance indicates a need to strengthen education about the importance of OCS, new risk factors and the recognition of lesions. Greater emphasis on the importance of oral cancer assessment and screening of each patient is needed while students are in dental hygiene school and throughout their careers. Continuing education courses in oral cancer screening and risk factors could also decrease the morbidity and mortality rate of oral cancer.

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Predicting National Dental Hygiene Board Examination Success Based on Specific Admission Factors

Lynn D. Austin, RDH, MPH, PhD

Introduction

Applications to dental hygiene programs in the U.S. are at an all-time high.¹ Interest in dental hygiene education has remained strong, with approximately 3.8 times as many applicants as available first-year class positions.¹ Often, selection committees must turn away qualified applicants due to limited class sizes. Therefore, selecting those applicants who are more likely to be successful in the academic program and pass the National Board Dental Hygiene Examination (NBDHE) is critical.

The means of selecting an incoming dental hygiene class varies from school to school. A few schools utilize a waiting list, taking those students in order who have satisfactorily completed the pre-requisite classes. Other dental hygiene programs utilize an admissions rubric to determine which applicants will be offered a position in the program. It is critical that admissions committees carefully decide who is most likely to be successful in the program due to the lockstep nature of the curriculum. While the application process varies greatly among schools, dental hygiene applicants typically submit transcripts of previous course work as well as scores from the ACT or SAT tests.¹ While schools are careful to select those candidates most likely to remain in the program for 2 years, it is also critical to determine if specific factors are more likely to be correlated with success on the national licensing examination.

Historically, dental hygiene program directors have had access to NBDHE scores of each student

Abstract

Purpose: The purpose of this study was to determine if there are specific admissions criteria that are significantly correlated with a student's National Board Dental Hygiene Examination (NBDHE) total score and case-based score. Specifically, the study examined the relation between an individual's reading acuity and their scores on the NBDHE. Because of the competitive nature of most dental hygiene admissions, selecting those applicants who are more likely to be successful in the academic program and pass the NBDHE is critical.

Methods: Total NBDHE scores and case-based scores of 214 students attending Western Kentucky University's Program of Dental Hygiene between 2002 and 2010 were examined to determine if significant correlations existed. Specific factors examined were each student's total NBDHE score, as well as the score on the case-based section of the examination, age, microbiology lecture grade, microbiology lab grade, anatomy and physiology grade, college GPA, English grade, psychology grade, composite ACT score and subcomponent scores of the ACT (math, reading, English and science).

Results: Results revealed that the strongest predictors of total NBDHE scores were the score on the reading portion of the ACT ($r=0.715$, $r^2=0.511$, $p=0.01$) and the grades in Microbiology lecture ($r=0.644$, $r^2=0.414$, $p=0.01$). Results revealed that the strongest predictors of scores on the case-based portion of the NBDHE were students' scores on the reading portion of the ACT ($r=0.673$, $r^2=0.452$, $p=0.01$) and the microbiology lecture grade ($r = .637$, $r^2 = .405$, $p = 0.01$).

Conclusion: Traditionally, schools have looked at specific science-based pre-requisite courses as a means of determining admission to schools of dental hygiene. Findings from this study suggest that a broader approach may need to be taken, specifically as it concerns a student's reading aptitude.

Keywords: National Board Dental Hygiene Examination, College Admission Criteria, ACT

This study supports the NDHRA priority area, **Professional Education and Development:** Validate and test measures that evaluate student critical thinking and decision-making skills.

from their respective institutions. However, beginning in 2012, directors will only receive individual scores of those candidates who were not successful

(score of 74 or below) in their attempt. While the policy of the Joint Commission on National Dental Examinations is that exam scores are not meant to be used as a means of assessment for programs of dental hygiene, admissions committees are still tasked with selecting those applicants who will be able to be successful on the NBDHE.

The purpose of the NBDHE is to assist state boards in determining qualifications of dental hygienists who seek licensure to practice dental hygiene. While the NBDHE has undergone several transformations since it was first administered in 1962, the purpose of the examination has always been to assess the ability to understand important information from basic biomedical, dental and dental hygiene sciences, and the ability to apply such information in a problem-solving context.² In 1998, the NBDHE was modified to include 150 case-based questions as a significant portion of the exam. Unlike typical stand-alone questions, case-based questions pertain to a presented case. Typically, 9 to 12 questions are asked about each of the 15 specific cases. It is likely that success on this modified NBDHE involves different skills than on the previous exam. The 15 cases that comprise the case-based portion of the NBDHE involve more reading than the older version of the test. Similarly, the 24 community-related questions also involve more reading than the stand alone questions. Existing studies have not examined the correlation between a student's NBDHE score and their reading aptitude.

The purpose of this study was to determine if there are specific pre-admission factors that are significantly related to success on the NBDHE. Much of the literature describes correlations between post-admission factors, such as specific dental hygiene course grades and success on the NBDHE. If it can be shown that there is a correlation between specific pre-admission factors and success on the NBDHE, admissions committees may wish to include additional criteria in admission rubrics.

Many schools have adopted different approaches to determine the specific criteria of dental hygiene students who have the greatest likelihood of being successful on the NBDHE. Earlier studies have reported the correlation between internal board review courses and NBDHE scores, as well as the relationship between student grades in online and on-campus dental hygiene courses and NBDHE scores.^{3,4} While yielding useful data, information is still needed on predictors of student success as part of the admission process. Identifying those variables that have been shown to accurately predict success on the NBDHE before a student has been admitted

would enable selection committees to make more informed choices regarding applicants.

Downey et al conducted a 6 year study to determine which factors were best able to predict success on the NBDHE.⁵ Examining records from 134 dental hygiene students at the Medical College of Georgia, the authors found that a student's incoming GPA was the best predictor for success on the NBDHE. Further, the authors reported that dental hygiene GPA was best predicted by both the incoming GPA and the total SAT score. The authors also reported that the GPA in science pre-requisite courses was not significant in predicting NBDHE success.

A study by Bauchmoyer et al examined 173 dental hygiene students who had graduated between 1998 and 2002 from The Ohio State University.⁶ Results of this study indicated that the strongest variables in predicting NBDHE scores were a student's dental hygiene coursework GPA and the GPA in the 3 science pre-requisite courses. While a student's GPA in pre-requisite course work would be helpful in the admissions process as a predictor of NBDHE scores, a student's GPA in specific dental hygiene coursework would not be determined until after a student has been admitted.

Methodology for a study conducted by Alzahrani et al included examining the records of students ($n=235$) enrolled at Old Dominion University between 1998 and 2002 to determine which variables significantly predicted graduation and successful completion on the NBDHE.⁷ Unlike the results found by Bauchmoyer et al,⁶ but similar to the results found by Downey et al,⁵ the researchers found no correlation between GPA in the science pre-requisite courses and success on the NBDHE. The researchers did determine, however, that a significant relation ($p=0.0008$) existed between the final grade in the oral pathology course and NBDHE success. Since oral pathology is taken after a student has been admitted to a program of dental hygiene, these findings are of limited use in the candidate selection process.

Similarly, a study conducted by Mills et al revealed that the most accurate predictors of NBDHE scores were student grades in dental anatomy and head and neck anatomy.⁸ The researchers gathered data on 132 students enrolled in the University of New England Dental Hygiene Program from 2005 to 2007. A pre-requisite course, anatomy and physiology, was not shown to be an accurate predictor of student success on the NBDHE. While poor grades in dental anatomy and head and neck anatomy may alert faculty to the need for student remediation prior to taking the NBDHE, this finding does not as-

sist in determining which applicants are going to be most successful on the NBDHE following completion of the dental hygiene coursework.

Also finding a correlation between NBDHE success and dental hygiene coursework, Ward et al conducted a study to determine if a relationship existed between predicted NBDHE success and GPA at graduation.⁹ Findings from their study revealed moderate correlations between probability models and success on the NBDHE. Additionally, the authors found the best predictor of success on the NBDHE was GPA while enrolled in the dental hygiene curriculum. Similar to other studies, the dental hygiene GPA will not aid admissions committees in selection of the applicants most likely to succeed on the NBDHE.

DeWald et al also examined the effect of GPA and national board review courses on NBDHE scores.¹⁰ Results of their study indicated that there was not a significant difference in national board scores based on whether or not a student had participated in a national board review session. Similarly, the researchers found that a student's GPA was not related to performance on the NBDHE. The researchers did, however, find that those students who did not participate in a review course had a significantly higher GPA ($p<0.05$) than those who did take the review course.

A review of the literature concerning predictors of student success on the NBDHE reveals different findings. Some researchers found the GPA coursework was the best predictor of NBDHE success.^{6,7,9} Other researchers identified specific dental hygiene courses as the best predictor.^{7,8} Lacking in the literature are current studies which are capable of assisting admissions committees in the critical selection process, especially as related to non-science pre-requisite variables.

Methods and Materials

Prior to initiation of the study, an exempt status proposal was approved by the Western Kentucky University's Human Subjects' Review Board. As a portion of the admission process to Western Kentucky University's Program of Dental Hygiene, applicants take the following pre-requisite classes: microbiology, anatomy and physiology, English composition and introduction to psychology. Other required materials as part of the admission process include college transcripts and ACT scores.

NBDHE scores of students who were enrolled at Western Kentucky University's Program of Dental Hygiene from 2002 to 2010 ($n=234$) were exam-

ined. Some of these 234 students had not taken the ACT or their scores were not available to the researcher. Exempted from the study were those students whose application did not include an ACT score as well as separate grades for microbiology lecture and lab, leaving a sample of 214 students.

The following variables for each student were entered into a spreadsheet: NBDHE score, case-based section score, age of student when admitted to the program, microbiology lecture grade, microbiology lab grade, anatomy and physiology grade, college GPA, English grade, psychology grade, composite ACT score for math, reading, English and science subcomponent scores of the ACT. Data were analyzed using SPSS 17.0. Pearson product-moment correlation coefficient was used to determine the strength of the association between NBDHE scores and specific variables. Further, the square of the correlation coefficient was used to estimate the fraction of the variance in the NBDHE score that is explained by the reading ACT score and the microbiology grade in a linear regression analysis.

Results

Results of this study revealed that the strongest predictors of total NBDHE scores were the scores on the reading portion of the ACT ($r=0.715$, $r^2=0.511$, $p=0.01$) and the grades in microbiology lecture ($r=0.644$, $r^2=0.414$, $p=0.01$). Weaker correlations were found to exist between the anatomy and physiology grade and total NBDHE score ($r=0.461$, $p=0.01$), college GPA and total NBDHE score ($r=0.445$, $p=0.01$), total ACT score and total NBDHE score ($r=0.438$, $p=0.01$), English grade and total NBDHE score ($r=0.418$, $p=0.01$) and microbiology lab grade and total NBDHE score ($r=0.368$, $p=0.01$). No significant correlations were shown to exist between a student's age and total NBDHE score, psychology grade and total NBDHE score or other subcomponent scores of the ACT and total NBDHE score.

Case-Based Scores

A separate analysis of the above factors and student performance on the case-based portion of the NBDHE was also conducted. Findings from these analyses indicated that the most significant correlations existed between a student's score on the reading ACT ($r=0.673$, $r^2=0.452$, $p=0.01$), the microbiology lecture grade ($r=0.637$, $r^2=0.405$, $p=0.01$) and the case-based score. As with the total score, weaker correlations to the case-based score were shown to exist with total ACT score ($r=0.440$, $p=0.01$), college GPA ($r=0.417$, $p=0.01$), anatomy and physiology grade ($r=0.390$, $p=0.01$), English grade ($r=0.334$, $p=0.01$) and microbiology

lab grade ($r=0.282$, $p=0.05$). No significant correlations with the case-based scores were shown to exist between a student's age, psychology grade or other subcomponent scores of the ACT.

Discussion

Previous research has examined success on the NBDHE and the grades attained on science-based courses before and as part of the dental hygiene curriculum. Grades on courses that are part of the dental hygiene course sequence, however, cannot be used as part of admissions criteria. Studies concerning grades on pre-admission science-based courses only have yielded conflicting results.^{5,6}

Findings from this study suggest that the grade a student attains on the reading portion of the ACT is an important predictor of success on the NBDHE. Also important, however, is a student's grade in microbiology. One possible explanation regarding the correlation between a student's microbiology grade and NBDHE score is that there is a microbiology subsection of the NBDHE. Students who have performed well in Microbiology would, logically, score well on that section of the NBDHE. This finding is consistent with that of Bauchmoyer et al when they found that the GPA in certain pre-requisite courses, including microbiology, were strong predictors of NBDHE scores.⁵

Further, the coefficient of determination indicated that 51% ($r^2=0.511$) of an individual's total NBDHE score can be explained by an individual's score on the reading portion of the ACT. Similarly, the coefficient of determination indicated that 41% ($r^2=0.414$) of an individual's NBDHE total score can be explained by an individual's grades in microbiology lecture. Concerning case-based scores, the coefficient of determination indicated that 45% ($r^2=0.452$) of an individual's score can be explained by their score on the reading portion of the ACT. Similarly, the coefficient of determination indicated that 40.5% ($r^2=0.405$) of an individual's NBDHE case-based score can be explained by their grades

in microbiology lecture. While knowledge of course material is essential, results of this study suggest that a student's ability to read and assess the meaning of questions is critical.

Results of this study can be used to augment existing admissions rubrics in order to select a dental hygiene class more likely to succeed on the NBDHE. Findings from this study revealed that, of the variables examined, students' scores on the reading portion of the ACT were most strongly correlated with their total score on the NBDHE ($r=0.715$, $p=0.01$), as well as their scores on the case-based section ($r=0.673$, $p=0.01$). The microbiology lecture also was found to have a strong correlation with total NBDHE scores ($r=0.644$, $p=0.01$), as well as case-based scores ($r=0.637$, $p=0.01$).

It is recommended that this study be expanded to include other means of assessing a student's reading ability. Examples of other means of assessment may include grades in English literature classes or verbal scores on the SAT examination. Additionally, future studies may wish to examine reasons for the strong correlation between microbiology grades and NBDHE scores.

Conclusion

This study found that scores on the reading portion of the ACT and microbiology lecture grades were strong predictors of NBDHE scores. Applications to dental hygiene schools are likely to continue to experience rapid growth in the coming years. In order to select those students most capable of achieving success on the NBDHE, admissions committees may wish to consider modifying existing admissions rubrics to incorporate a student's reading acuity.

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Financial Management Practices and Attitudes of Dental Hygienists: A Descriptive Study

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Introduction

Making financial decisions is a daunting task in the best of times. Choosing to set aside monetary resources for the future in the midst of a global financial crisis is anxiety producing, even among working professionals. According to a 2009 Bureau of Labor Statistics report, dental hygienists in private practice offices stand to earn a national average of \$66,950 per year.¹ The agency also reports that dental hygiene ranks among the 20 fastest growing occupations.

Although dental hygienists may be able to obtain jobs, benefits in the dental hygiene profession are often contingent upon full-time employment. However, less than 50% of currently employed dental hygienists work more than 32 hours per week. Of these, approximately 50% receive employer-sponsored benefits.² Given these statistics, many hygienists may not be financially prepared to retire with adequate resources.

Government-sponsored retirement benefits are not necessarily the answer for dental hygienists who are inadequately prepared for retirement. Statistics show that the number of Americans over the age of 60 has grown rapidly over the past 50 years, thus placing unrealistic expectations on the government's ability to support retirees. According to the American Dental Hygienists' Association's (ADHA) Job Market and Employment Survey of 2009, 55% of hygienists are 45 to 59 years of age, with retirement looming within the next 10 to 15 years.² Those who

Abstract

Purpose: The purpose of this study was to determine the financial management goals and practices of registered dental hygienists, their satisfaction with their current financial situations and their attitudes about savings, investments and retirement.

Methods: A 40 question electronic survey was completed by 388 registered dental hygienists. The descriptive instrument assessed financial practices, attitudes, goals and beliefs, retirement mindset, savings habits, debt tendencies and demographic characteristics of respondents. Statistical analyses compared respondents' beliefs about their financial independence and security with their current financial practices. Analyses included: independent samples t-tests, chi-square analysis and ANOVA.

Results: Most dental hygienists believed themselves to be financially independent and reported satisfaction with their current financial situation. Significant relationships existed between respondents' satisfaction with their current financial situations and their financial attitudes and practices (saving regularly and having limited debt). Those who indicated they had personally saved for retirement were more likely to view these savings as their largest source of income during retirement, as opposed to Social Security benefits. A majority agreed that financial management education should be included in the dental hygiene curriculum, and that they would attend a continuing education course on the subject if offered.

Conclusion: The results of this study suggest that hygienists have confidence in their ability to provide secure financial futures for themselves. Hygienists who practiced sound financial planning, such as adhering to monthly budgets, having wills, lowering debt and saving regularly, reported a higher level of financial security than those who did not. Most respondents expressed interest in receiving education about financial management through the dental hygiene curriculum and continuing education courses.

Keywords: Financial satisfaction, financial independence, retirement, workplace benefits, dental hygienist

This study supports the NDHRA priority area, **Professional Education and Development:** Identify the factors that affect recruitment and retention of faculty.

did not plan for retirement income that would meet their needs may need to alter their expectations or plan to continue working longer. New graduates are

entering the profession during an economic downturn, which has brought to light the need for sound financial planning and practices. The emphasis on early formal financial planning is imperative for new professionals with high earning potential.

Amidst the state of a tumultuous global economy and uncertainty about future governmental provisions, personal financial responsibility is critical. Therefore, it is important to identify the factors that influence dental hygienists' motivation to manage their incomes effectively and responsibly for their futures. The purpose of this study is to determine the financial management practices of these professionals, their satisfaction with their current financial situation and their attitudes about retirement planning.

Research on the financial practices of dental hygienists is limited to workforce and career retention studies that have been conducted over the past fifteen years.³⁻⁵ Johns et al identified workforce retention factors among Texas dental hygienists.⁵ The study compared responses of dental hygienists still employed in the profession ($n=358$) with those who left active practice ($n=82$). In regard to employee benefits in general, less than 50% of both groups received any type of benefits while employed. Similarly, a recent ADHA survey of 5,000 dental hygienists in the U.S. found only 33% received health insurance, and almost 50% received retirement benefits.⁶

In another study, Calley et al identified factors that influence job satisfaction for dental hygienists in private practice.³ Of the 6 identified factors for remaining in a practice setting for more than 5 years, the category "employer support of professional career" contained 5 factors, 1 of which was "adequate benefits." No mention of retirement or personal investment assistance was specified. Furthermore, DeAngelis et al studied factors that influence dental hygiene as a career choice.⁴ Among available choices, salary was the only offering which pertained to personal finance. None of these studies specifically explored employer-sponsored investment options or financial education opportunities in dental practice settings.

Published research in the nursing profession is also primarily workforce related. This allied health profession mirrors dental hygiene because its labor force is largely female and soon to be affected by the large number of retiring baby boomers.^{7,8} Blakely et al reported that only 24% of Canadian nurses surveyed had done a significant amount of financial and retirement planning. The authors concluded that these professionals need to focus more

on financial preparation and begin the process early in their careers.⁷

Because the dental hygiene population is overwhelmingly female, literature which addresses gender trends in investing and saving is relevant to this study. Sundén et al analyzed data from over 8,000 households using the 1992 and 1995 editions of the Survey of Consumer Finances, which the Federal Reserve Board of the United States conducts every 3 years.⁹ They studied patterns in types of investments, such as higher-risk/higher-yield stocks as opposed to lower-risk/lower-yield bonds. In general, marital status, educational level and gender were predictive of financial knowledge and the manner in which investment choices were made. However, this data showed that women were less likely than men to have employer-sponsored investment plans. The authors concluded that even though their sample was large and the data were significant, the results are descriptive rather causal. Regardless of their findings, if some groups, especially single women, do not make higher-yield investment choices, they stand to yield significantly lower retirement wealth.

A recent large scale study on the financial management practices and attitudes of young Americans in their 20s and 30s revealed they identified key behaviors in saving and planning for a secure future.¹⁰ When asked about current financial practices, such as saving and contributing to retirement, most believed they could be saving more. Self-reported knowledge of specific financial tools showed a need for professional investment education. The majority of respondents reported receiving financial advice from their parents, the very group of Americans who are at or nearing retirement at this time.

The recent economic downturn has made it even more difficult for women to invest in their retirement. Wharton financial economist David Babbel described what he calls a perfect storm of forces within this country's financial picture, calling the situation "particularly precarious" for women.¹¹ He proposes that the combination of decreasing rates of return on Social Security contributions, the demise of defined benefit pensions, the drain on the Social Security system as the baby boomer generation transitions to retirement, increased life expectancy and smaller post-baby boomer generations supporting boomers' unfunded benefits, stand to create a financial crisis. Therefore, he encourages women to seek higher learning on financial products such as annuities, and obtain the education needed to become more sophisticated investors in their futures.

Much research has addressed the failure of Americans to plan for future economic security. Unfortunately, the results have been disturbing. By identifying the financial management practices and attitudes of dental hygienists, this exploratory study will illuminate the need for financial literacy within the profession. As dental hygiene educators, it is the belief of the authors that there is a need for investment and savings planning early in one's career. Future research on the effects of financial education for dental hygiene students will add to the body of research in this area and provide emerging professionals with the tools for future financial security.

Methods and Materials

A 6 part, 40 question survey was adapted with consent from a recent joint study by the American Savings Education Council and the American Association of Retired Persons.¹⁰ The current survey content was reviewed by a group of 8 dental hygiene educators and researchers to determine its clarity and content validity. Survey questions addressed the following topics: current financial status, savings and debt, financial goals and beliefs, workplace benefits, retirement mindset and characteristics of survey respondents. Three and 5 point Likert-type scales (very satisfied=1, very dissatisfied=5), multiple choice and rank order scaling were used to assess the financial management practices and attitudes of dental hygienists. Following approval of the University of Bridgeport's Institutional Review Board, the survey was formatted and distributed through SurveyGizmo.

The sample population consisted of 388 registered dental hygienists who responded to an invitation to participate in the electronic survey via the ADHA's bi-weekly electronic newsletter, *Update*. In addition, a survey link was posted bi-weekly on the AmyRD-Hlist.com listserve, an online community of 5,100 dental professionals, for a 12 week time period. The survey link was also accessible to members of the Friends of Hu-Friedy online community newsletter, which is accessed by approximately 2,400 members per issue.

Questionnaire data was analyzed through descriptive and inferential statistics using IBM SPSS 18 software. Statistical analyses included independent samples t-tests that tested the relationship between reported financial security and various financial practices, as well as when comparing differences in levels of confidence in retirement resources (personal savings and Social Security) and personal savings practices. Chi-square analyses were employed to test the relationship between retirement savings practices and beliefs about retirement income. Fi-

Table I: Sample Personal Demographic Characteristics

Demographic	n (%)/M (SD)
Gender	
Male	4 (1.0%)
Female	384 (99.0%)
Age	
< 30 years	83 (21.4%)
31–40 years	79 (20.4%)
41–50 years	93 (24.0%)
51–60 years	113 (29.1%)
60+ years	20 (5.2%)
Race / Ethnicity	
White/Caucasian	330 (85.1%)
Black/African American	10 (2.6%)
Hispanic/Spanish / Latino	9 (2.3%)
Asian/Pacific Islander	18 (4.6%)
Other	9 (2.3%)
No answer	12 (3.1%)
Education	
Associate's degree	201 (51.8%)
Bachelor's degree	139 (35.8%)
Master's degree	46 (11.9%)
Doctorate	1 (0.3%)
Professional degree (e.g., DDS, JD)	1 (0.3%)
Marital Status	
Single, never married	53 (13.7%)
Unmarried, living with partner	19 (4.9%)
Married	256 (66.0%)
Separated	10 (2.6%)
Divorced	45 (11.6%)
Widowed	5 (1.3%)

nally, ANOVA were conducted to examine whether there were any differences in financial security pertaining to the levels of debt, retirement mindset and financial goals reported by the respondents.

Results

Sample Demographics and Employment Characteristics

A total of 388 registered dental hygienists completed the online survey. Respondents were primarily white (n=330, 85.1%) and female (n=384, 99%), and more than half were 41 years of age or older (n=226, 58.3%). Fifty-two percent had earned an associate's degree and 35.8% held bachelor's degrees. Sixty-six percent were married. The sample was geographically diverse, with 43 states and 9 countries represented (Table I).

Nearly all respondents (n=373, 96.1%) were employed at the time of the survey. Most (72.7%) worked between 16 to 39 hours per week. The ma-

jority (76%) worked in a private practice setting. Thirty-three percent had been in professional practice for 25 or more years (Table II).

Personal Finances and Current Financial Status

Regarding their finances and assets, 56% reported they earned \$40,000 to \$80,000 in 2008. The highest percentage of respondents (38.5%) earned \$50,000 to \$79,999. Household income totaled more than \$80,000 for most ($n=244$, 61.6%). More than 40% reported having savings and investments of \$100,000 or more, but 26% held less than \$10,000 in these accumulated assets (Table III).

When measuring respondents' perceptions about their current financial status, most respondents ($n=331$, 85.3%) considered themselves to be financially independent (Table IV). Respondents rated satisfaction with their current financial situation using a 5 point Likert-type scale, ranging from 1 (very satisfied) to 5 (very dissatisfied). With a mean score of 2.6 ($SD=1.1$), respondents evidenced slightly more satisfaction than dissatisfaction with their current financial situation.

Savings and Debt

Respondents' financial management practices were gathered via questions about savings, budgeting and debt accumulation. A majority of respondents (74.5%) indicated they save money regularly, 21.7% revealed they could live on savings for 12 or more months, 22.4% reported that they could live on savings alone for 1 to 3 months and 17% could live on savings for less than 1 month. Respondents were asked if they currently used 4 specific financial management tools. Nearly one-half (48.7%) adhered to a monthly budget, 39% had a will, 27.8% had a living will and 20.4% had a formal financial plan, while 25.8% indicated they did not employ any of these methods.

When testing the relationship between reported financial security and the various financial practices that are listed above, independent samples t-tests showed that those who reported saving regularly, having a will or having a living will reported greater

Table II: Sample Employment Demographic Characteristics

Demographic	n (%)
Employment Status	
Not employed	14 (3.6%)
Employed part-time	123 (31.7%)
Employed full-time (32hrs/wk) in one office	185 (47.7%)
Employed full-time (32hrs/wk) in multiple offices	53 (13.7%)
Self-employed (either part- or full-time)	12 (3.1%)
Retired, not working	1 (0.3%)
Weekly Hours Worked	
Less than 16 hrs	27 (7.2%)
16–32 hrs	163 (43.7%)
33–39 hrs	108 (29.0%)
40–44 hrs	60 (16.1%)
45–49 hrs	8 (2.1%)
50+ hrs	7 (1.9%)
Area of Practice*	
Private practice	295 (76.0%)
Specialty practice	39 (10.1%)
Education	38 (9.8%)
Public or community health	49 (12.6%)
Multiple practices	39 (10.1%)
Other	26 (6.7%)
Years in Professional Practice	
<2 yrs	61 (15.7%)
2–5 yrs	65 (16.8%)
6–10 yrs	30 (7.7%)
11–15 yrs	35 (9.0%)
16–20 yrs	30 (7.7%)
21–25 yrs	39 (10.1%)
25+ yrs	128 (33.0%)
Member of ADHA	
Yes	300 (77.3%)
No	88 (22.7%)

*Respondents were allowed to 'check all that apply'; hence, totals exceed 100.0%.

financial security (Table V). There were no differences in reported financial security for those who did or did not maintain budgets or those who did or did not have a written financial plan.

When identifying sources of debt, the highest percentages were observed for the following financial obligations: mortgage (68.6%), credit cards (52.6%) and car loans (40.7%). When asked to describe the level of their debt, 41.2% viewed it as no problem, 36.9% saw it as a minor problem and 15.5% determined that it was a major problem. A small percentage (6.4%) reported they had no debt. ANOVA results indicate that individuals with no or non-problematic debt ($M=2.32$, $SD=0.90$ and $M=2.10$, $SD=0.66$, respectively) reported greater financial security than did those who perceived their debt to be a minor problem ($M=2.92$, $SD=0.87$) (Table VI).

Financial Goals and Beliefs

Respondents were asked to rate the importance of 6 goals they wished to achieve in the next 10 years. Saving for retirement ($M=2.7$) and paying off debt ($M=2.9$) were the most important goals. Receiving a higher education ($M=4.2$) and buying or improving a home ($M=4.0$) were the least important goals according to respondents.

Respondents also revealed what they believed to be their current financial status: "behind schedule," "on track" or "ahead of schedule," compared to others for several goals. Most respondents thought they were on track with savings in general and managing debt but felt they were behind schedule with saving for retirement. ANOVA results for financial security as a function of respondents' perceived status of financial goals revealed that those who reported being ahead of schedule were more financially secure than those who were on track (Table VI).

Workplace Benefits

Nearly all respondents ($n=361$, 93.1%) had health insurance coverage, of which 42% ($n=152$) were insured through their spouse's employer. Only 24.7% ($n=96$) had a traditional pension plan (or defined benefit plan). Nearly half ($n=190$, 49.0%) were eligible for an employer's defined contribution retirement savings, such as a 401(k) or 403(b). Of those, 85.7% ($n=162$) personally contributed to the employer-sponsored plan. With regard to attitudes about employer-sponsored benefits, the majority of respondents believed it was important or very important for their employers to do the following: match retirement contributions (83.3%), provide retirement savings plans (95.3%) and provide health insurance (93.3%).

Retirement Mindset

When asked how much thought they had given to retirement, 97% ($n=376$) had given it a great deal or some thought, and 3% ($n=12$) had given it no thought. A majority of respondents ($n=305$, 78.6%) revealed they had personally saved for retirement. In addition, 67.5% ($n=262$) believed that the largest share of their retirement income will consist of employer-sponsored retirement savings plans (33%) and other personal savings/investments (34.5%). Chi-square analysis revealed that those who indicated they have personally saved for retirement (as opposed to those who did not) were more likely to have thought a great deal about retirement, to be over 50 years of age and to be married. This group was more likely to view their personal savings as their largest source of income in retirement, as op-

Table III: Sample Personal Finances and Assets

Assets	n (%)
Spouse/Partner Employment Status	
Employed full-time	215 (55.4%)
Employed part-time	10 (2.6%)
Self-employed	31 (8.0%)
Employed full- and part-time	3 (0.8%)
Not employed	35 (9.0%)
Not applicable	94 (24.2%)
Personal Income for 2008	
Less than \$20,000	49 (12.8%)
\$20,000-\$29,999	28 (7.3%)
\$30,000-\$39,999	44 (11.5%)
\$40,000-\$49,999	67 (17.5%)
\$50,000-\$79,999	147 (38.5%)
\$80,000+	47 (12.3%)
Household Income for 2008	
Less than \$30,000	25 (6.6%)
\$30,000-\$49,999	39 (10.3%)
\$50,000-\$79,999	82 (21.6%)
\$80,000-\$99,999	74 (19.5%)
\$100,000+	160 (42.1%)
Savings and Investments	
Less than \$10,000	102 (26.3%)
\$10,000-\$29,999	57 (14.7%)
\$30,000-\$49,999	29 (7.5%)
\$50,000-\$79,999	34 (8.8%)
\$80,000+	166 (42.8%)

Table IV: Current Financial Status

Variable	n (%) / M (SD)
Financially Independent	
Yes	331 (85.3%)
No	57 (14.7%)
Satisfaction with Current Financial Situation	2.6 (1.1)
Appreciation of Material Goods Possessed	1.6 (0.6)
Worry About Financial Future	2.3 (1.1)
Struggle to Make Ends Meet	3.5 (1.2)
Confidence in Financial Life So Far	2.5 (1.1)
Overall Financial Security	1.7 (1.0)

Note – For ranked questions, lower scores (1–5) indicate more positive attitudes/feelings

posed to those who had not saved personally, who were more likely to view Social Security, retirement employment or refinancing their home as their largest source of retirement income.

Finally, respondents were asked to rate their confidence in their ability to save enough money to af-

ford a comfortable lifestyle in retirement. The average score ($M=2.8$, $SD=1.1$) suggests that respondents tend to be confident in their ability to save enough for retirement.

In response to questions regarding financial management education, 71.7% believed that it should be included in the basic dental hygiene curriculum, and 84.3% said they would attend a continuing education program about financial management and retirement planning.

Discussion

The main objective of this study was to gain an understanding of the financial management practices and attitudes of dental hygienists. Those surveyed are very mindful of future financial security. The highest ranked goals for respondents were saving for retirement and paying off debt, although 50% reported they felt they were behind schedule in saving for retirement. Dental hygienists have shown that they value employer-sponsored retirement plans and most that are eligible contribute wages to them.

Generally, employee benefits for dental hygienists are lacking. Providing health insurance ranked as one of the most important benefits among respondents, though only 33% were covered by their own employer, a figure corroborated by the recent ADHA Job Market and Employment Survey.² This discrepancy is in spite of the fact that nearly 50% were employed full-time (32 hours or more) in 1 office setting.

In terms of savings and retirement confidence, there appears to be a disconnection between stated goals and practices with perceived financial security. This parallels the study of young Americans with similar inconsistencies in aligning their goals with their actions.¹⁰ Most respondents in the current study reported saving money on a regular basis, and more than half described themselves as financially secure. The majority expressed confidence in affording a comfortable lifestyle during retirement. However, only 21.7% revealed they could live on savings for

Table V: Independent Samples t-Test Results for Financial Security as a Function of Various Financial Practices

Financial Practice	M	SD	t	p
Save regularly	2.44	0.85	-8.31	<.001**
Do not save regularly	3.41	1.06		
Stick to a monthly budget	2.63	0.97	0.97	.33
Do not stick to a monthly budget	2.73	1.04		
Have written financial plan	2.54	0.98	-1.40	.16
Do not have written financial plan	2.72	1.01		
Have living will	2.51	1.01	-2.16	.03*
Do not have living will	2.75	1.00		
Have will	2.53	1.00	-2.42	.02*
Do not have will	2.78	1.00		

Note – Lower scores indicate greater financial security.

*denotes p value <05

** denotes p value <0.01

Table VI: ANOVA Results for Financial Security as a Function of Level of Debt, Status of Financial Goals, and Thoughts about Retirement

Independent Variable	M	SD	F	p
Level of Debt				
Major problem	3.83 a	0.91	76.13	<.001**
Minor problem	2.92 b	0.87		
Not a problem	2.10 c	0.66		
No debt	2.32 c	0.90		
Status of Financial Goals				
Behind schedule	3.96 a	0.96	32.36	<.001**
On track	2.96 b	0.95		
Ahead of schedule	2.15 c	0.81		
Thoughts about Retirement				
Great deal of thought	2.55 a	1.06	3.87	.02*
Some thought	2.82 ab	0.92		
No thought	2.92 b	0.90		

Note – Lower scores indicate greater financial security. Subscript differences indicate mean differences.

*denotes p value <05

** denotes p value <0.01

12 or more months if they stopped receiving income today, and 39.4% reported they could live on savings alone for 3 months or less. For those dental hygienists who are set to retire in the next decade, it would behoove them to assure that they have set aside adequate resources.

Although dental hygienists showed optimism in their financial futures and were confident in being

able to afford a comfortable lifestyle during retirement, their reported savings to date may fail to meet their expectations. They appear to accept responsibility as shown by their anticipation that personal savings and employer-sponsored retirement plans would provide the greatest share of their income, and lack confidence in Social Security benefits to provide substantial support.

As suggested by Wharton Economist David Babbel, women need education on financial investment choices.¹¹ The current study reveals dental hygienists, many of whom will reach retirement age in the next decade, have a great deal of interest in achieving financial security today and a retirement income which matches their vision for the future. Respondents agreed that adding financial literacy to the dental hygiene and continuing education programs was a necessary step in this process.

Limitations and Recommendations for Future Research

This study was limited to descriptive research on the current financial status and practices of dental hygienists as reported. The reliability of self-reported data can be difficult to interpret objectively. Another limitation may be that if individuals have little knowledge of sound financial management practices, they may be poor judges of their own financial status.

Recommendations for future research include a focus on the effectiveness of educational interventions to increase the financial literacy of current and future dental hygiene professionals. The authors of this report are currently conducting research on the practices of graduating dental hygiene students. This research will evaluate the senior students' knowledge as it pertains to general financial literacy, with regard to investments, retirement savings and

major financial decisions, such as home buying and loan repayment. The effectiveness of an educational intervention on financial management practices will be measured in follow-up research, which will assess financial practices after a period of employment in the dental hygiene profession.

Conclusion

The results of this study suggest that dental hygienists have confidence in their ability to provide a secure financial future for themselves. The misfortune is that the profession has not provided direction for dental hygienists who lack these resources in their workplace. Dental hygienists who practiced sound financial planning independently, such as adhering to monthly budgets, having a will, lower debt and saving regularly reported a higher level of financial security than those who did not. Most respondents expressed interest in education about financial management both in the dental hygiene curriculum and continuing education courses.

The current survey paralleled the findings of recent literature, revealing a significant number of hygienists nearing retirement in the next 10 to 15 years.² Given the results of this and previous studies in terms of employer-sponsored benefits, the onus is on the individual to protect their own financial future. The introduction of financial management practices in the dental hygiene curriculum may increase career satisfaction and longevity.

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Repetitive Coronal Polishing Yields Minimal Enamel Loss

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Introduction

Many dental offices provide routine, traditional dental polishing as part of the dental prophylaxis. This procedure involves polishing all accessible tooth surfaces to remove plaque and stain.¹ However, the American Dental Hygienists' Association endorses selective polishing, limiting polishing to areas of stain that cannot be removed by other methods.² Prominent dental hygiene textbooks support it as well, and the majority of dental hygiene programs teach selective polishing in their curricula.³⁻⁵ This position is partially based on research indicating a loss of enamel from polishing procedures. However, the common perception is that licensed dental hygienists and dentists are reluctant to employ selective polishing in their clinical practice.⁶⁻⁸ The dichotomy between education and clinical practice indicates a need for further scientific investigation.

Many studies have demonstrated that polishing procedures and materials can abrade enamel, cementum and dentin. However, the reported tissue loss is inconsistent from study to study, and clinical significance has not been established.⁹⁻¹⁶

When comparing the previous studies, it becomes apparent that each one used a separate set of parameters. Variation in methods and materials include in vivo versus in vitro experiments, bovine versus human specimens, number of specimen, exposure time, pressure, revolutions per minute and abrasivity of polishing agents. Table I contains a summary of the parameters and results from each study.

Abstract

Purpose: The American Dental Hygienists' Association recommends selective polishing because of risk of enamel removal and lack of documented therapeutic value. The initial study documenting enamel loss from polishing used methods not acceptable for clinical use, while results from other studies are inconsistent. This study examines the effect of simulated life-time polishing on enamel thickness. Enamel loss from polishing is compared to the enamel thickness just coronal to the cementoenamel junction (CEJ) to relate results to clinical application.

Methods: Eight premolars and 18 molars were polished 150 times with coarse prophy paste, then pre- and post-polishing micrometer measurements were compared. Eight unpolished premolars and 18 unpolished molars were used as control groups. Average enamel thickness from 10 premolars and 10 molars just coronal to the CEJ was chosen to represent minimal enamel thickness, and was calculated using digital radiography. T-tests were used to compare group means.

Results: The mean measurement difference was significantly higher for the premolar treatment group than the control group, but no difference was noted between molar treatment and control groups. Neither treatment group demonstrated significant abrasion when compared to average minimal enamel thickness. Root abrasion was noted on 5 molars.

Conclusion: The results of our study indicate that polishing may remove enamel, but the quantity removed is unlikely to be clinically relevant. Root surface abrasion seen on molars is disturbing, considering stain often occurs on exposed mandibular anterior root surfaces and may cause repeated and prolonged polishing. Further investigation into alternative stain removal methods is recommended.

Keywords: polishing, enamel, abrasion, root, premolars, molars

This study supports the NDHRA priority area, **Clinical Dental Hygiene Care:** Assess the use of evidence-based treatment recommendations in dental hygiene practice.

While Table I reveals a wide range of variation in material/methods and results, other differences exist. For example, Vrbic et al,⁹ Biller et al¹⁰ and Rühling et al¹¹ pre-polished their specimens to smooth them prior to treatment. Vrbic et al investigated fluoride uptake in teeth and pre-polished as a cleansing step.⁹ Biller et al¹⁰ and Rühling et

Table I: Summary of previous research on abrasive effects of polishing

Date	Author	Specimen	n	Time (sec)	Pressure (grams)	RPM	Agent	Number of reps	Quantity of tissue removed/results
1967	Vrbic et al	Human in vitro	5	30	200	3000	Coarse pumice	1	3–4 µm enamel
1975	Koch et al	Human in vitro	5–10	30	200	1200	Varies	1	0.6–1.7 µm
1978	Stookey	Human in vitro	8	10	150	1500	Grade 4F pumice	9	1.57 µm dentin/repetition
1978	Stookey	Human in vitro	8	10	250	1500	Grade 4F pumice	9	0.08 µm enamel/repetition
1979	Swan	Human in vitro	1	15	140	1100 3000 4000	Prophy paste	1	4.83 root tissue 11.43 root tissue 29.21 root tissue
1979	Swan	Human in vitro	1	30	140	1100 3000	Prophy paste	1	9.14 root tissue 14.73 root tissue
1980	Biller et al	Human in vitro	12	30	Human: light medium heavy	2000	Coarse prophy paste	1	1.0 µm cuspal en. 2.4 µm cerv. en. Enamel prisms smeared
1980	Biller et al	Bovine in vitro	6	30	Human: light medium heavy	2000	Coarse prophy paste	1	4–5 µm enamel
1981	Thompson and Way	Human in vitro	40	30	300	20 psi	Varies	1	5.5–8.7 µm enamel
1987	Christensen and Bangarter	Human in vivo	28	5	150	2500	Varies	1	0.24 µm enamel Speculate: outer 3–4 µm disturbed
2004	Rühling et al	Bovine	3	15	150	2500	Varies	40	14.11 µm enamel
2004	Rühling et al	Bovine	3	15	150	2500	Varies	40	5.06 µm cementum

al¹¹ used bovine teeth that have distinct longitudinal surface ridges that interfere with experimental procedures. Biller et al did not pre-polish their human teeth.¹⁰

Three methods of measurement were used to detect abrasion. Most studies employed chemical assays.^{9,10,13–15} The most probable explanation for the use of chemical assays is the ability to obtain the most accurate measurement for small values, since all these methods used few polishing repetitions on enamel. Rühling et al¹¹ and Swan¹² used physical measuring gauges. Swan measured in inches $\times 10^{-4}$, which is converted to µm (Table 1).¹² Swan measured root structure, which abrades much faster than enamel, and Rühling et al performed 40 repetitions.^{11,12} Swan measured cementum, which abrades much faster than enamel.¹² Both of these procedures resulted in greater tissue loss that could be detected by physical measurements. Thompson et al used a profile projector to magnify and measure extremely small differences from just 1 polishing.¹⁶

Critical Examination of Previous Research

Only 1 study attempted to simulate effects of long-term polishing, and the specimens were bovine teeth.¹¹ Biller et al noted differences in polishing abrasion between human and bovine teeth, finding bovine teeth to be more susceptible to abrasion.¹⁰ Because of this, abrasion conclusions developed from bovine experiments may not be suitable for human application.

All remaining research was conducted with limited polishing repetitions. Stookey's¹⁴ 9 procedures represented the only study other than Rühling et al¹¹ with more than 1 polish. Stookey noted that abrasion per polishing decreased as the number of polishings increased.¹⁴ Therefore, studies with only 1 polishing event probably cannot be extrapolated for long-term effects.

Vrbic et al is the study most commonly referenced in literature as evidence of enamel abrasion from polishing.^{3,4,9,17} This group investigated fluoride uptake from various fluoride modalities and

looked for ways to increase fluoride concentration in enamel. Polishing procedures were used as a method of fluoride delivery. Coarse, laboratory-grade pumice mixed with fluoride solution was used for the fluoride uptake procedures. Laboratory-grade pumice is inappropriate for clinical human use due to its abrasivity.^{3,4,18} The experimental method also included 30 seconds of polishing.⁹ Vrbic et al admitted that 30 seconds is an "unreasonably long period of treatment from a clinic standpoint."¹⁹ When coarse pumice and long polishing duration are combined, the resulting enamel loss exceeds the expected loss in actual clinical practice.

Twenty years after Vrbic et al⁹ published their study, Christensen et al investigated clinical parameters that are actually practiced in dental offices.¹⁵ They earlier determined that 2,500 rpm, 150 g pressure and 5 second duration were realistic polishing parameters.²⁰ The resulting enamel loss from 1 polish in their study was 0.24 µm, approximately 6 to 8% that of the Vrbic et al⁹ findings.¹⁵

Even allowing the Vrbic et al⁹ parameters to be clinically acceptable, a worst-case scenario can be examined by applying the aforementioned methods to the clinical situation. For patients receiving 2 dental prophylaxes a year beginning at age 5 and continuing until age 80, we could expect a total of 150 polishing procedures. Multiplying 4 µm by 150 provides 600 µm, or 0.6 mm enamel loss. Therefore, in the extremely abrasive conditions of the Vrbic et al⁹ study, a little over half a millimeter of enamel would be removed over a 75 year period of time. If the parameters found in Christensen et al¹⁵ are used for the same situation, 36 µm of enamel loss would be expected. The clinical relevance of either amount of tissue loss has not been evaluated.

The clinical relevance of polishing abrasion is directly related to enamel thickness. Thickness of enamel varies from surface to surface and from tooth to tooth, but ranges from approximately 2.5 mm on occlusal cusp tips to a "knife edge" thickness at the cementoenamel junction (CEJ).²¹⁻²⁴ A minimal acceptable thickness of enamel over dentin has not been determined. After searching literature and conversing with dental professionals, one might conclude that any amount of enamel, if present, may be sufficient to provide dentinal protection. The enamel layer feathers down to an indeterminate thickness at the CEJ, the thinnest area of enamel on a tooth. Enamel thickness just coronal to the CEJ provides an acceptable estimate of minimal enamel thickness that can be removed before becoming relevant in the clinical situation.

The aim of this study was to investigate the realistic abrasive effect of polishing by simulating 75 years of semi-annual, 5 second polishing, and to compare enamel loss with enamel thickness just coronal to the CEJ to ascertain clinical relevance of the abrasion.

Methods and Materials

Specimen Collection

This work was reviewed and approved by the Institutional Review Board of the University of Alaska Anchorage. Extracted teeth were collected over a 6 month period at a local oral surgery office from patients previously referred for extractions. The initial attempt to collect only impacted third molars that had never been polished produced few specimens, so collection criteria were broadened and included all extracted teeth. Patient informed consent was obtained and specimens were steam sterilized before retrieving them from the oral surgery office. Research has shown enamel hardness is unaffected by steam sterilization.²⁵ Because of limited availability, whole, unrestored premolars were chosen for the pilot study and whole, unrestored third molars were chosen for the larger study. During the 18 month tooth collection and equipment preparation phase, teeth were individually stored in 0.9% sodium chloride solution. Mineral loss as each tooth/saline unit reached equilibrium was limited by using only a small quantity of solution to cover each tooth. Multiple teeth from individual donors were equally distributed between treatment and control groups, and other teeth were randomly assigned to minimize bias.

Study Design

A crimp height micrometer (#342-371, Mitutoyo USA, Aurora, Illinois) was chosen for measurements because of the manufacturer's stated 1 µm resolution and 3 µm accuracy. Using epoxy putty and standard zip ties, the micrometer was attached onto a compound microscope (GALEN™ III, Leica Inc., Buffalo, New York) in the nose piece position, with the nose piece removed (Figure 1). To provide stability for handling purposes, teeth were mounted in blocks of Corian® (DuPont™, Buffalo, New York) countertop material. Three separate 0.5" diameter holes were drilled in 1" by 3" blocks of Corian®. Teeth were mounted in each block with epoxy putty. To increase retention, grooves were placed in the tooth roots prior to mounting using a #7406 12-bladed high speed friction grip burr.

The lingual surfaces of the teeth were prepared with a #35 inverted cone carbide burr and an

Figure 1: Measuring apparatus



Micrometer is mounted on microscope in nosepiece position. Teeth are mounted in blocks which are placed on stage. Microscope adjustment knobs allow precise positioning.

amalgam restoration (Dispersalloy® regular set, DENTSPLY International Inc., Milford, Delaware) was placed. With the amalgam material in the putty stage, the Corian® block was positioned onto the microscope stage and the micrometer point was pressed into the restoration, forming an impression to guide the micrometer point for accurate measurements. Each Corian® block was labeled with a number, and each tooth was designated with a letter (A, B or C). Half the blocks (8 premolars and 18 molars) received treatment and the other half (8 premolars and 18 molars) served as controls. Mounted teeth were stored in distilled water.

A wooden polishing apparatus was made to hold a HygienePro™ Air portable prophylaxis polisher (NSK America Corp., Schaumburg, Illinois). A slot at the opposite end held the individual Corian® blocks, orienting the teeth horizontally (Figure 2). NUPRO® Prophylaxis Paste with Fluoride, coarse grit (DENTSPLY International Inc., Milford, Delaware) and DENSCO® Prophy Cups (soft, blue, ribbed, Water Pik, Inc., Fort Collins, Colorado) were used for polishing because many hygienists select coarse grit paste, and also to simulate a maximally-abrasive clinical scenario.⁶ Paste cups came from 2 boxes, 1 for premolars and 1 for molars, thereby eliminating any batch-related variations within each group. Lead strips wrapped around the handpiece provided a consistent polishing pressure of 150 g (± 10 g), as measured on an Acculab Sartorius Group EC-211 electronic scale (Bohemia, New York), with periodic re-measurements during the study to ensure consistent pressure was maintained. The handpiece design allowed selec-

Figure 2: Polishing apparatus



Polisher is held in position by a pin and can be moved forward, backward, or pivoted as needed. Lead weights provide consistent pressure, ~150 gm. Handpiece allows selection of cup rotation speed; 2500 rpm was used.

tion of a 2,500 rpm rotational speed used throughout the study. These parameters match those of Christensen et al.¹⁵ Each tooth in the treatment group was subjected to a 5 second polishing 150 times on the buccal surface to simulate 75 years of semi-annual polishing. The slot on the polishing apparatus was slightly larger than the thickness of the Corian® blocks, allowing slight back and forth movement of the blocks. By moving the block back and forth during polishing, the cup was oscillated approximately 1 to 2 mm in a cervical-occlusal direction and distributed the rim pressure over the polished area. Each tooth was rinsed with distilled water after 5 polishes. Treatments were performed in sets of 50 polishing cycles per tooth, using new polishing cups and prophy paste for each set on every tooth. This was considered acceptable because each cup and paste unit is designed for clinical use on multiple-surfaces of a full dentition. Because of the broad buccal surface on molars, guide marks were placed on the occlusal and proximal surfaces to ensure the polished areas covered the area measured by the micrometer.

Tooth Measurement

Since 1 person completed all the measurements, each Corian® block was numbered on the underside to provide a means of tracking and still allow for unbiased measurements. Two blind buccal to lingual width measurements were taken on each tooth before polishing, as well as 2 blind measurements afterwards. A mean measurement was calculated for each tooth from each pair of measurements, rounded to a hundredth of a millimeter

(10 µm). The micrometer's tongue ratchet ensured a constant measuring force. Post-polishing measurements were subtracted from pre-polishing measurements. The mean changes in width for the 2 groups, treatment and control, were compared using a 1-tailed t-test.²⁶

Radiographic Enamel Measurement

Dental researchers have used digital radiography to measure endodontic canals and periodontal/peri-implant bone loss.²⁷⁻³¹ In this study, digital radiography was used to measure the minimum enamel thickness of buccal surfaces on 10 premolars and 10 molars just coronal to the CEJ. Photostimulable phosphor plates were exposed (66 KV, 8 mA, 0.080 seconds) with a proximal surface of each tooth against the plate. To limit distortion, orthodontic wax was used to position the buccal surface as parallel as possible to the position indicator device. A Scan X® digital scanner (Air Techniques, Inc., Melville, New York) was used to input images into PatientGallery digital imaging software (Raster Builders, Inc., Greenbrae, California). A grid with 1 mm markings (X-Ray Grid Posterior, Medidenta International, Inc., Woodside, New York) placed between the tooth and phosphorous plate during exposure allowed measurement calibration. Measurements were calculated to the hundredth of a millimeter at 0.1 mm coronal to the CEJ. Only the most radioopaque region was measured to limit distortion from overlap along the entire buccal surface. Mean enamel thickness for each group was compared to mean enamel loss in the respective treatment group using a 2-tailed t-test.²⁶

Results

Visual examination of all teeth used in this study revealed no discernible demineralization, and minor to no damage from extraction procedures. Methods of this study were unaffected in cases where forceps damage, such as small fracture lines was detected.

Actual micrometer accuracy was observed to be slightly less than the manufacturer's stated accuracy of 3 µm. An automotive mini-blade gauge

Table II: Differences in pre- and post-polishing measurements

Results: µm Enamel Loss from Polishing				
Difference in pre- and post-polishing measurements (µm)	Premolar Treatment	Premolar Control	Molar Treatment	Molar Control
20	10	-3	11.5	
15	0	-3.5	-2	
40	5	14	-0.5	
20	5	49.5	-1.5	
20	5	3	-5	
10	15	-3	-1.5	
5	15	-17	-4	
30	-5	43.5	5.5	
		-23	-4	
		22.5	-7	
		-2	-8.5	
		0	-7.5	
		2.5	1.5	
		6.5	-7	
		-1.5	2	
		3.5	-1	
		-18.5	-1	
		25	5	
Mean	20.00	6.25	5.47	-1.39
Std Dev	11.02	6.94	19.40	5.16
Std Error	3.90	2.45	6.86	1.83

set (Powerbuilt, Longbeach, California) was used to determine micrometer accuracy. Average variation in micrometer measurements from the known thickness of the automotive blades was found to be $\pm 7 \mu\text{m}$, which is over twice the manufacturer's claimed accuracy. The experimental design included rounding measurements to the nearest 0.01 mm (10 µm) and averaging 2 readings to provide reliable and valid micrometer readings.

Pilot Premolar Study

There was a significant ($p<0.05$) difference between pre- and post-polishing measurements (Table II). The mean difference for the control was $6.25 \mu\text{m} \pm 2.45$ (standard error) and was attributed to the $\pm 7 \mu\text{m}$ limitation of measurement accuracy. The mean difference for the treatment was $20 \mu\text{m} \pm 3.90$ (Figure 3). This demonstrated an abrasive effect of polishing.

The mean minimal enamel thickness measured

at 0.1 mm coronal to the CEJ was shown by radiographic analysis to be $81 \mu\text{m} \pm 8.07$. This was significantly greater ($p < 0.05$), approximately 4 times greater than the mean enamel loss caused by the treatment (Figure 4). These results indicated the study design was adequate and a larger study could be performed. A minimal sample size of 16 was calculated based on the variation found in the treatment group and assuming a power level of 0.75 and delta value of 10 μm .

Molar Study

There was no significant difference between pre- and post-polishing measurements. The mean difference for the control was $-1.39 \mu\text{m} \pm 1.83$ (standard error) and was attributed to the $\pm 7 \mu\text{m}$ limitation of measurement accuracy. The mean difference for the treatment was $5.47 \mu\text{m} \pm 6.86$, therefore no abrasive effect was demonstrated (Table II).

The mean minimal enamel thickness for molars as determined by radiographic analysis was $82 \mu\text{m} \pm 4.01$. This value is similar to that found with the premolars, and again, is significantly greater than the mean enamel loss of the treatment group. These results suggest that a lifetime of routine polishing within our study's parameters is likely to have a minimal effect, if any, on enamel thickness.

Additionally, small semi-circular indentations were observed post-treatment on the buccal surface of 5 molars just apical to the CEJ. These indentations are adjacent to the areas of polished enamel and are approximately the diameter of a prophy cup.

Discussion

Many previous studies on enamel abrasion from polishing used chemical analysis of 1 polishing event to calculate enamel loss.^{9,10,12,15} Because this study involved repeated polishing, direct measurement of accumulated polishing abrasion was possible. By comparing enamel loss with minimal enamel thickness, this study was designed to provide dentists and hygienists with informative data to consider when making patient-related decisions.

The degree of variation observed was higher than expected. The small measurement differences in this study approach the limit of the micrometer's accuracy and could contribute to the variation. Disimilarities between tooth types may have introduced unaccounted factors that increase the degree of variation. Additionally, the fluoride content of individual teeth may have varied, as well as previous exposure to polishing. Either of these factors

Figure 3: Enamel loss from polishing and enamel thickness at the CEJ on premolars

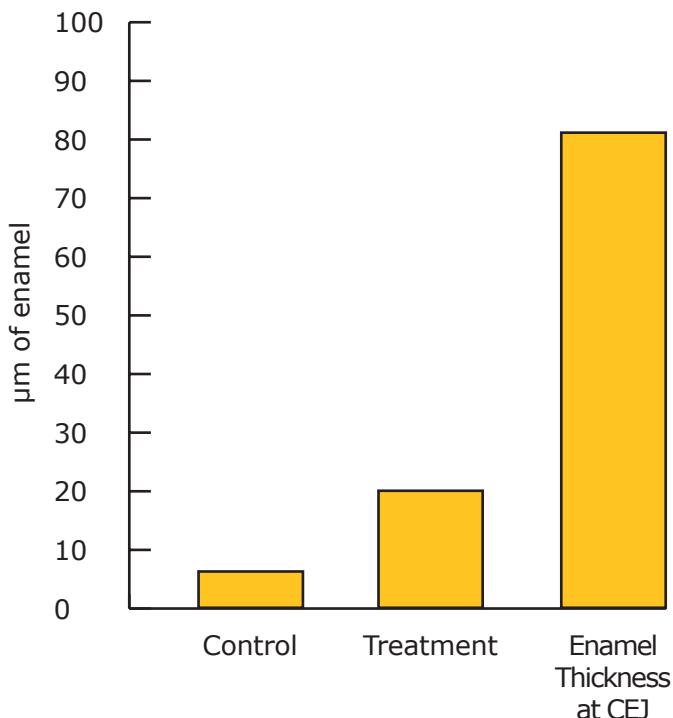
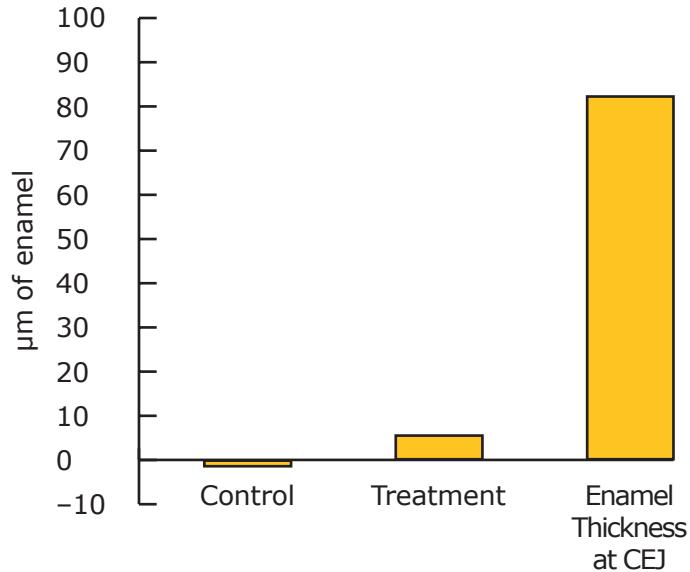


Figure 4: Enamel loss from polishing and enamel thickness at the CEJ on molars



could affect abrasion. While a larger sample size would strengthen the data, the results obtained still provide valuable insights.

Data from this study suggests that less enamel is lost during polishing than was previously indicated by Vrbic et al.⁹ Even though current polishing guidelines recommend using the lowest speed possible that will allow the prophy cup to rotate, just enough pressure to make the cup flare slightly and 1 to 2 second duration,⁴ this study was conducted using Christensen et al's¹⁵ parameters, so abrasion

results could be compared. Christensen et al found that 0.24 μm of enamel was removed by one polishing event.¹⁵ Dividing the premolar outcome by 150 results gives an average enamel loss of 0.13 μm per polish. The difference is most probably explained by Stookey's hypothesis that the first few polishes remove more enamel because of surface roughness.¹⁴ As irregularities are smoothed, less enamel is removed.^{14,19} It is unclear what effect may actually occur *in vivo* with cycles of demineralization and remineralization.

The molar results indicate no significant loss from repetitive polishing, which differs from the premolar results. One cause may be that variation within the treatment group was larger than anticipated, thereby lowering the power level and increasing the likelihood of a Type II error, i.e. failure to detect an effect when an effect exists. Another possible explanation of the difference in results between the 2 treatment groups is that the polishing cup adapted better to the single-lobed buccal curvature of the premolars than the multiple-lobed buccal curvature of the molars. Suction was often created between the polishing cup and premolar, which may have exerted additional pressure, and thus abrasion, on the premolar enamel. It was also noted that the polishing cup tended to slip away from the target area and required more guidance on the molars than on the premolars. Any of these situations, or a combination of them, could explain the difference in results between the 2 studies.

Vrbic et al's research demonstrating enamel loss from polishing initiated concern about indiscriminate polishing.⁹ Concern arose from not only quantity, but also quality of enamel lost because the outer layer of enamel has a relatively high fluoride content compared to inner layers.^{9,32,33} Research has shown that polished teeth take up less fluoride than both untreated and brushed teeth following fluoride application.^{9,33} Other research data reveal that unpolished and/or brushed teeth have similar fluoride levels as polished teeth following professional fluoride treatments.³⁴ Additionally, Stearns' research indicates a gain of fluoride after polishing with a fluoride paste when compared to pre-polished concentrations.³⁵ Vrbic et al's research demonstrated that the pre- versus post-polished enamel had similar fluoride concentrations due to fluoride uptake from the fluoridated pumice slurry.⁹ It seems like these various studies show that, at a minimum, the fluoride-rich outer layer is replaced by a new outer layer that has similar fluoride content when using fluoridated paste.

The concern about removing fluoride-rich enamel, coupled with research indicating lack of thera-

Figure 5: Root surface abrasion seen apical to the mesiobuccal lobe



Figure 6: Root surface abrasion matches prophy cup diameter



peutic value, prompted professional organizations to question the practice of routine polishing.^{34,36-38} An added benefit of selective polishing is improved patient education in home care. Working with patients on their plaque removal techniques instead of polishing to remove plaque uses chair time efficiently and productively.

Some dental surfaces can be damaged by polishing. Demineralized white spot lesions abrade 3 times more than normal enamel. Additionally, stronger outer enamel may cover a decalcified inner layer. Removal of this outer layer can expose the more vulnerable layer beneath.³⁹ Exposed dentin is 20 times more susceptible to polishing abrasion than enamel.¹⁴ Cementum, the least mineralized dental tissue, is obviously the most susceptible. It is interesting to note that cemental abrasion increases exponentially as rotational speed is increased.¹² Dental materials such as gold and composite can also be scratched by polishing.^{11,40} Clinicians should take care when polishing any of

the aforementioned surfaces, consider the benefits and risks and choose appropriate pressure, speed and agents for the surfaces that are polished.

The abrasions on the root surfaces of 5 molars are troublesome. Post-polishing inspection revealed semi-circular indentations on the root surfaces of 5 molars (Figures 5, 6). In hindsight, pre-polishing photographs would have been helpful to compare root appearance before and after treatment, but these were not taken as root abrasion was not the focus of the study and was not anticipated to be noted. Because molars have a shorter crown than premolars, the polishing cup tended to extend past the CEJ when oscillated, thus allowing contact of the cup on the root. Considering the limited contact duration (only a fraction of the 5 second polishing time for each of the 150 repetitions), the extent of cementum/dentin abrasion is startling.

From a clinical perspective, stain present on exposed root surfaces of mandibular anterior teeth is often removed by polishing and may require significantly longer polishing duration than used in this study. Additionally, this stain generally recurs by the next prophylaxis appointment, and so the area is repeatedly polished at each recall. The long-term, summative effect on the root may be damaging to the tooth. Considering that other methods of stain removal such as hand and ultrasonic instrumentation also remove root structure, new methods of stain removal should be explored to prevent hard tissue loss.¹¹

The American Dental Hygienists' Association has supported selective polishing for many years.² The American Dental Association's Commission on Dental Accreditation (CODA) used to recommend traditional coronal polishing instruction in dental hygiene curricula, then changed to selective polishing.^{41,42} Recent CODA revisions now endorse evidence-based patient care.⁴³ The purpose of this study was to provide data that can be used by practicing clinicians and educators in making evidence-based decisions regarding polishing procedures.

Conclusion

Enamel removal as an argument for avoiding polishing is not supported by this study. The data demonstrate a significant loss of enamel on pre-

molars when compared to the control group, and no evidence of significant loss on molars. However, neither treatment group demonstrated enamel loss that was equal to nor greater than the minimal enamel thickness measured in this study (Figures 3, 4). Further research should investigate the effect that mineral cycling in the oral cavity might have on cumulative polishing abrasion.

Very minimal polishing was shown to cause definitive abrasion on the root surface. Caution should be exercised when polishing at or beyond the CEJ. Considering stain that often recurs on mandibular anterior root surfaces, additional research into alternative, non-mechanical methods of stain removal might be helpful.

Individualized polishing has a place in dentistry – many dental surfaces can be damaged by polishing. Polishing is contradicted on some dental restorations, hypomineralized enamel and exposed root structure, as inadvertently demonstrated in this study on molar root surfaces.^{11,12,14,39,40} We found, however, that very little sound enamel is actually removed by polishing. In today's climate of evidence-based dentistry, clinicians should be aware of this finding and make informed clinical decisions regarding patient treatment.

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